Morse Micro

HaLowLink 1

User Guide

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1 What is the HaLowLink 1?

Your HaLowLink 1 allows you to use Morse Micro's HaLow Wi-Fi chip to:

- easily set up a new network that supports HaLow
  -> **Router with HaLow Access Point (green Status LED)**
- let other HaLow-enabled devices connect to your existing network
  -> **HaLow Access Point (green Status LED)**
- let existing non-HaLow (i.e. 2.4 GHz Wi-Fi and Ethernet) devices, including normal computers, use HaLow's range
  -> **HaLow Extender (aqua Status LED)**

It's flexible and powerful enough that it can perform all these roles. For more information on how these roles can be useful, see the **Use Cases** section below.
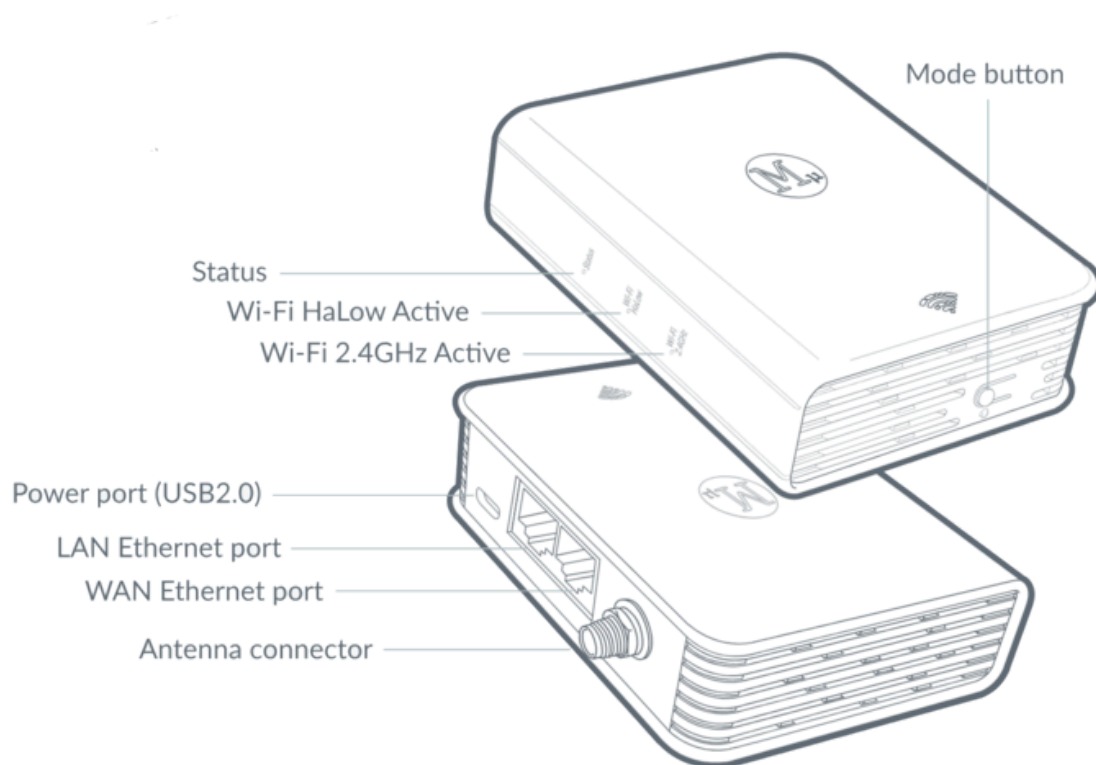
1.1 Router with HaLow Access Point

This is the default mode of operation for HaLowLink. It has an IP address of 192.168.12.1, and hands out addresses to devices connected to the LAN side via Ethernet, Wi-Fi or HaLow in this range. The WAN Ethernet port is the default uplink connection, and will obtain an address as a DHCP client. In this mode the HaLowLink is most similar to a typical home router/gateway, and it is not possible to access the web interface except via the local network.

1.2 HaLow Access Point (AP)

Similar to access points (APs) available on the market, this allows you to add a HaLow Access Point to your existing network. You still use your WAN Ethernet port for the uplink connection, but any attached HaLow devices will use DHCP to obtain addresses on your existing network subnet. This means no traffic forwarding/NAT is required. This is the most appropriate mode for most use cases, as it makes it straightforward for anyone on your network to interact with HaLow connected devices.

It will also be possible to access the web interface via your existing local network by determining which IP is assigned to the HaLowLink. However, the 192.168.12.1/24 network will remain accessible on the LAN port. This functions as a separate management interface independent of the existing network which makes it simpler to reconfigure.

1.3 HaLow Extender

Extenders generally receive a Wi-Fi signal and rebroadcast it. In Wi-Fi jargon, these devices are stations/clients rather than APs in regards to the HaLow network.

The goal of this mode of operation is to help get another device connected to a HaLow network. That device might be connected to the HaLowLink via Ethernet or 2.4 GHz Wi-Fi, and then the HaLowLink passes that traffic via HaLow, effectively extending the range of the non-HaLow device.

2 Getting started

2.1 Initial connection

Connect the provided antenna to the antenna connector first. Then connect your device to the HaLowLink 1.

2.1.1 Via Ethernet

1. Connect your HaLowLink 1 to power via the USB-C port with the power supply provided.
2. Connect your computer to the LAN port of the HaLowLink 1 with the Ethernet cable provided.

2.1.2 Via Wi-Fi

1. Connect your HaLowLink 1 to power via the USB-C port with the power supply provided.
2. Connect your computer or phone to the Wi-Fi network of the HaLowLink 1 by scanning the QR-Code or using the Wi-Fi SSID/password on the label.

2.1.3 Via USB-C

1. Connect your HaLowLink 1 to your computer directly with the USB-C cable provided. Make sure to use a USB-C port to ensure sufficient power.

2.1.4 Connecting to an existing network/internet

Optionally, if you want your HaLow devices to access the internet or an existing network, connect an Ethernet cable from the WAN port of the HaLowLink 1 to a network with a DHCP server.

2.2 Home Page

Once you've connected to the HaLowLink's network, you can then use your web browser to connect to http://192.168.12.1. To login, use the Device Username and Password on the bottom of the HaLowLink; we recommend letting your browser save the password.

You should now be able to see the **Home** page, where initially, you will have '0 Connected Devices' on your HaLow network.

The Home Page will automatically update if changes happen to your network. To view more information, click on the large numbers on the card or on the 'expand' icon in the top right. Make sure the 'Uplink' card has a tick if you want your HaLow devices to have access to an existing network or the internet.

2.3 Wizard

As described in **What is the HaLowLink 1?** above, when you first start your HaLowLink 1 it will be a **Router with HaLow Access Point**. If you'd like to change this mode, go to the **Wizard** option in the menu on the left hand side:

You should see that the option 'HaLow Wi-Fi devices will get an IP on this device's local network' is selected; i.e. this device is acting as a router.

The wizard helps you quickly switch between different device modes, making many configuration changes for you automatically. Because it has to make many changes, using the wizard may remove some of your customisations.

2.3.1 Network Mode - HaLow Access Point

If possible, we recommend changing your device to '*HaLow Wi-Fi devices will get an IP on your existing router's network*'. That is, change from **Router with HaLow Access Point** to **HaLow Access Point**. As described above in **What is the HaLowLink 1?**, this ensures that HaLow devices are a seamless part of your existing network.

This option will only work, however, if you have connected your WAN port to your existing router and your HaLowLink 1 has obtained an IP address. To confirm this is true, go to the **Home** page and make sure you have tick on the **Uplink** card:
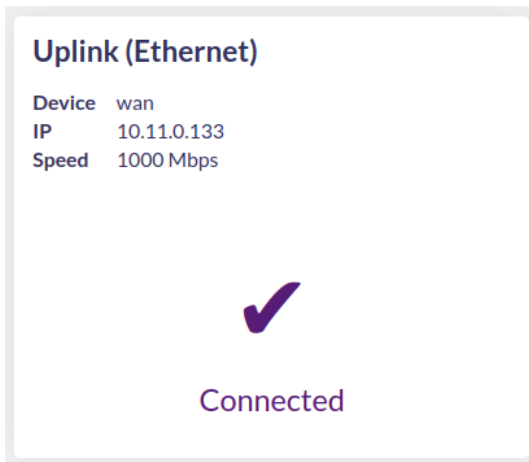
2.3.2 Network Mode - Router with HaLow Access Point and a 2.4 GHz Wi-Fi Uplink

If you do not have easy access to an Ethernet port on your existing network, but do have access to Wi-Fi, you should select the final network mode, '*HaLow Wi-Fi devices will get an IP on this device's local network and use 2.4 GHz Wi-Fi for an uplink (not an Ethernet cable)*'. Once you've clicked **Save & Apply**, however, you will need to provide credentials:

- Go to the Home page, and click the 'Disconnected' cross on the uplink card

- Search for your Wi-Fi network and enter your password, then save the credentials:

Uplink (2.4 GHz)   ×

SSID   folly
Device   phy0-sta0
Connected   no

▼ **Connect to Access Point**

Credentials
            SSID   mywifinetwork   ▼   🔍
            Key/Password   ••••••••••   *
            Encryption   WPA2-PSK   ⌄

            Save & Apply

- Wait for 'connected' to change to 'yes' (and green). You should now see that the Home page has a tick on the Uplink, and your HaLowLink 1 will have access to your existing network.

2.3.3 HaLow Mode - 802.11s Mesh and EasyMesh

By default, your device is configured as an Access Point. Because of HaLow's incredible range, for most purposes this is sufficient. However, to achieve even more range, or if there are physical barriers between devices, it's possible to use multiple HaLowLinks to create a mesh.

1. Configure your **Access Point** as a mesh device (either 802.11s Mesh or EasyMesh) via the wizard.
2. Configure additional mesh devices in **Extender** mode (aqua status LED) by pairing them to the original device. For more details, see [3 HaLow Extender](#) below. When it pairs, it will automatically configure itself as a mesh device. However, if it was previously connected to a normal Access Point, make sure to **reset** your Extender and re-pair it to ensure it is configured as a Mesh Extender. If you simply change the configuration on the Access Point your Extenders will connect but will not form a mesh.

If you have configured your device in one of the mesh modes we do not recommend making significant networking changes in the UI as it is very easy to misconfigure the mesh. In particular, for EasyMesh, not all settings are visible in the web interface.

3 HaLow Extender

By default, your HaLowLink 1 comes configured as a HaLow Access Point. However, as described in **What is the HaLowLink 1?**, it can also be used as an **Extender** when you have more than one HaLowLink 1 device. This will let existing Wi-Fi and Ethernet devices make use of HaLow's long range.

To switch your HaLowLink 1 device to **Extender** mode, you never need to use the web interface. Refer to the diagram in below, and switch modes as follows:

1. Connect your HaLowLink 1 to mains power via the USB-C port with the power supply provided.
2. Wait until the Status LED is **solid green**.
3. Hold down the **Mode** button. The Status LED will first start flashing slowly green, and then start flashing quickly aqua. Release the button when it's flashing aqua.
4. Wait until the Status LED is **solid aqua** to indicate it's loaded and running in Extender mode.
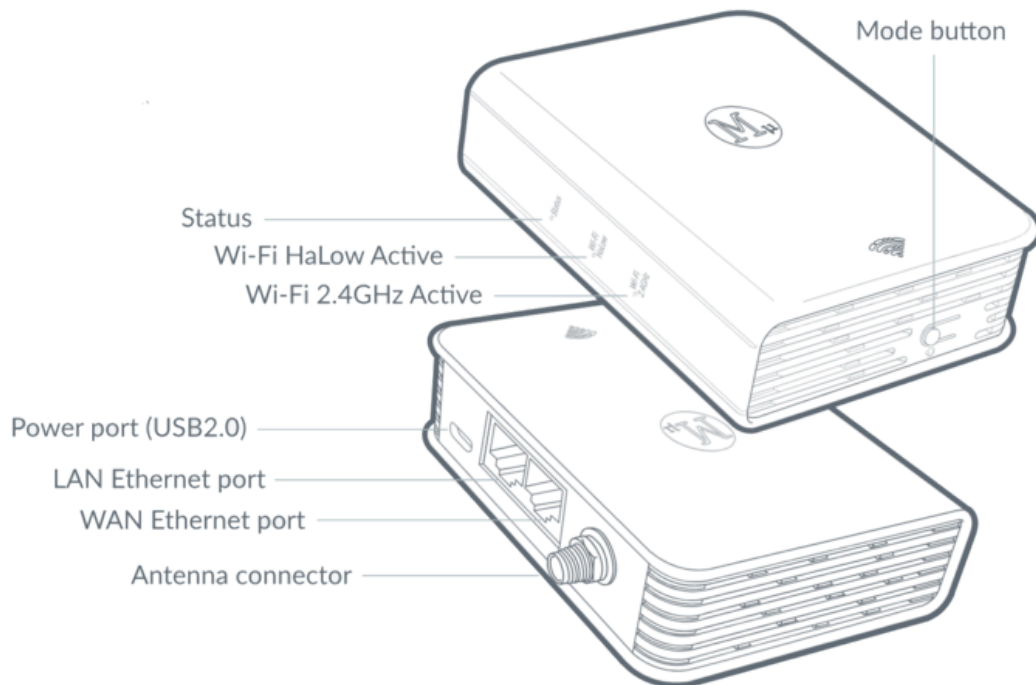
3.1 Pairing

In Extender mode your device will not be accessible at 192.168.12.1. Instead, you should **pair** it to an existing HaLowLink 1 by:

1. Pressing and immediately releasing the mode button on your HalowLink 1 Access Point (with a **green** Status LED). The Wi-Fi HaLow LED will begin slowly flashing to indicate it's ready to pair.
2. Pressing and immediately releasing the mode button on your HalowLink 1 Extender (with an **aqua** Status LED). The Wi-Fi HaLow LED will begin slowly flashing to indicate it's searching for an Access Point to pair with.
3. Wait until the Wi-Fi HaLow LED is **solid purple**. Your Extender has now stored the Wi-Fi credentials, and is ready to use!

If pairing hasn't succeeded after 120 seconds, the Access Point Wi-Fi HaLow LED will stop flashing and the Extender Wi-Fi HaLow LED will turn off. You can now try pairing again from the beginning.

3.2 Using your Extender

You can connect devices to your Extender via an Ethernet cable or via 2.4 GHz Wi-Fi, and this will let them use the Extender's HaLow connection. For the Wi-Fi credentials, refer to the label **on your Extender**. These will not be the same as the credentials on your Access Point.

4 Restoring Factory Settings

If you no longer want to use your HaLowLink 1 as an Extender, you've lost access to your device, or you simply want it to go back to the way it was, you can return it to Access Point mode (Green Status LED) by restoring factory settings:

1. Connect your HaLowLink 1 to mains power via the USB-C port with the power supply provided.
2. Wait until the Status LED is **solid green** or **solid aqua**.
3. Hold down the **Mode** button. Once the Status LED starts **flashing slowly green**, release the button.
4. Wait until the Status LED is **solid green** to indicate it's running in Access Point mode.
5. You can now access your device at http://192.168.12.1 again, as described in **Initial Connection**.

Warning: if, at Step 3, you hold down the button until it's flashing quickly aqua, the device will reset but change into Extender mode, as described in the **Extender** section.

Mode button

Status
Wi-Fi HaLow Active
Wi-Fi 2.4GHz Active

Power port (USB2.0)
LAN Ethernet port
WAN Ethernet port
Antenna connector
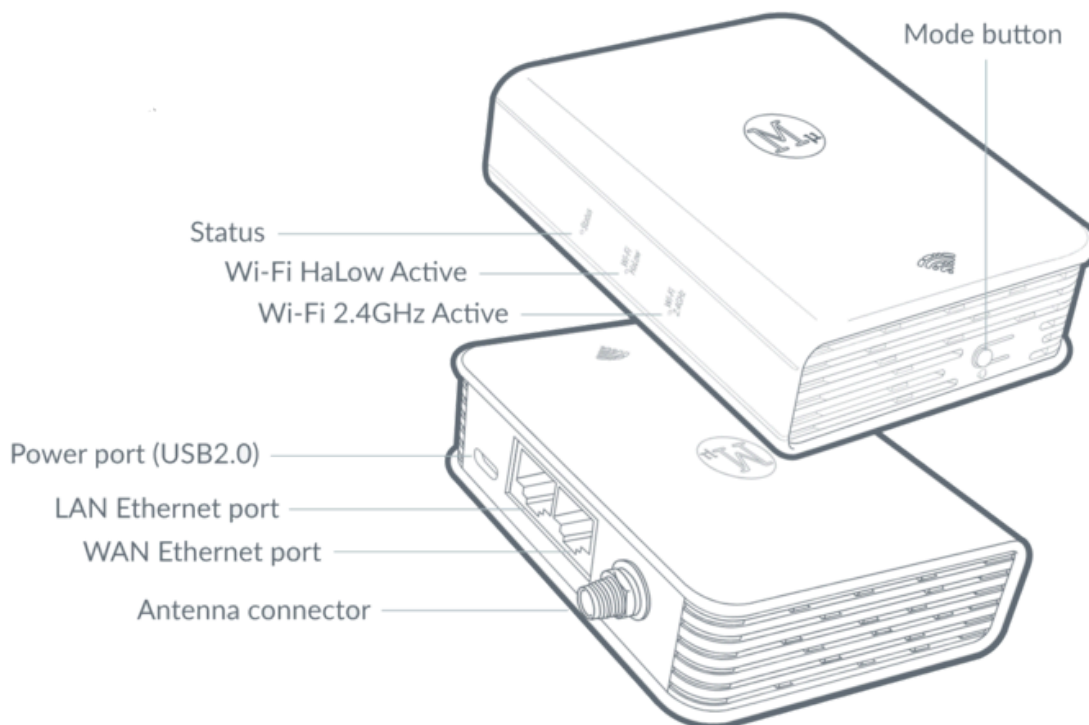
5 Use Cases

These are some common use cases for the HaLowLink 1 with some pointers on how to achieve them. If you have previously configured your HaLowLink 1 in some way, you may want to **Restore Factory Settings** before following these instructions.

5.1 Adding a HaLow Access Point to your existing network via Ethernet
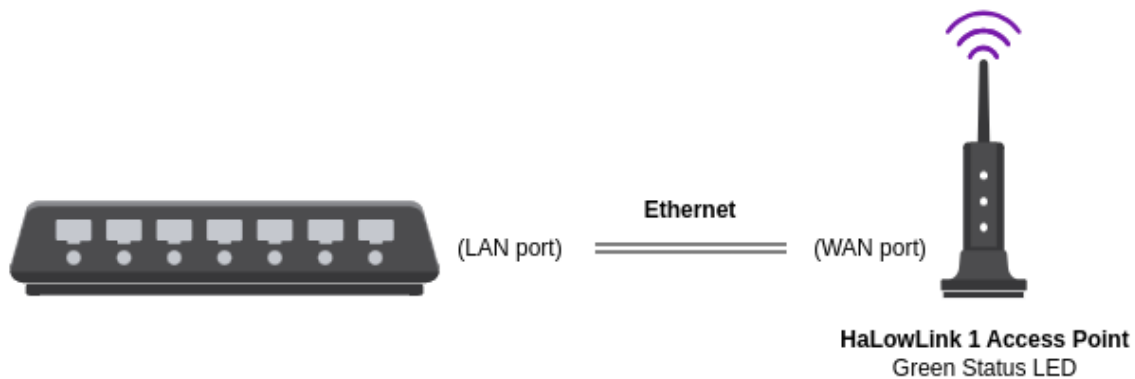
The primary use case for a HaLowLink 1 is to add HaLow support to your existing network, allowing any HaLow-enabled client to work in the same way as any other Wi-Fi client.

- Make sure your HaLowLink is in Access Point mode (green status LED).
- Connect the WAN port of your HaLowLink 1 to your network; in the home, this usually means placing it next to your router and connecting the WAN port to a LAN port.
- HaLow devices can then connect via the SSID/password printed on the sticker.

Although it will work as is for many use cases, for the best experience we recommend using the **Wizard** to set *'HaLow Wi-Fi devices will get an IP on your existing router's network'*, which will change it from a Router with HaLow Access Point to a HaLow Access Point. See the **Wizard** section above for more details.

5.2 Adding a HaLow Access Point to a network via 2.4 GHz Wi-Fi

2.4 GHz Wi-Fi

HaLowLink 1 Router with
HaLow Access Point
Green Status LED
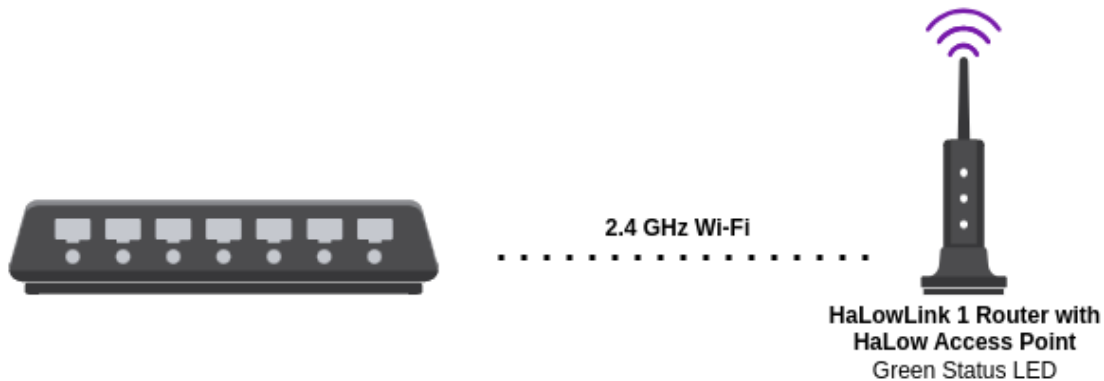
If it's not possible to connect your HaLowLink via Ethernet, you can connect your HaLowLink via 2.4 GHz Wi-Fi. You should only do this if Ethernet is not possible, as it will require your HaLowLink to act as a router, forwarding traffic from 192.168.12.x over the Wi-Fi link.

- Make sure your HaLowLink is in Access Point mode (green status LED). See **Restoring Factory Settings** if it's not.
- Go to the **Wizard** in at http://192.168.12.1 and set the 'Network Mode' to '*HaLow Wi-Fi devices will get an IP on this device's local network and use 2.4 GHz Wi-Fi for an uplink (not an Ethernet cable)*', then go to the **Home** page to configure your credentials. For more details, see the Network Modes section above.
- HaLow devices can then connect via the SSID/password printed on the sticker.

This may be particularly useful on networks you don't have administrator access to, and in fact the HaLowLink can act as a **travel router** in this situation, providing your own private network not just HaLow Access Point but also a 2.4 GHz Wi-FI access point and Ethernet connectivity.

5.3 Using HaLow to extend an existing network - 'Virtual Wire'
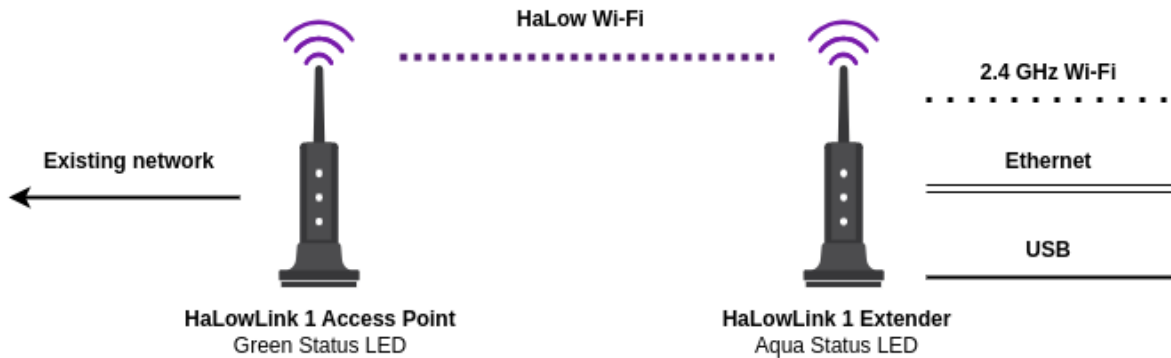
This will require **two** HaLowLink devices, and will make a HaLow link a transparent part of your network, functioning just like an Ethernet cable.

First, you should add a HaLow Access Point to your network (see 1 or 2 above). Once your network supports HaLow, you should follow the instructions in the **Extender** section above. In summary:

1. Make sure your HaLowLink is in Extender mode (aqua status LED).
2. Pair your Extender with your Access Point by pressing and releasing the mode button on your Access Point, then pressing and releasing the mode button on the Extender. The HaLow LED will slowly flash, usually for around 10 seconds, before turning a solid purple on the Extender to show it's connected.
3. Now any device connected to the Extender - via USB, 2.4 GHz Wi-Fi, or Ethernet - will make use of the HaLow link to connect to your network. See (4), (5) and (6) below for more instructions.

5.4 Connect your computer to a HaLow network via USB-C

HaLowLink 1 Extender
Aqua Status LED
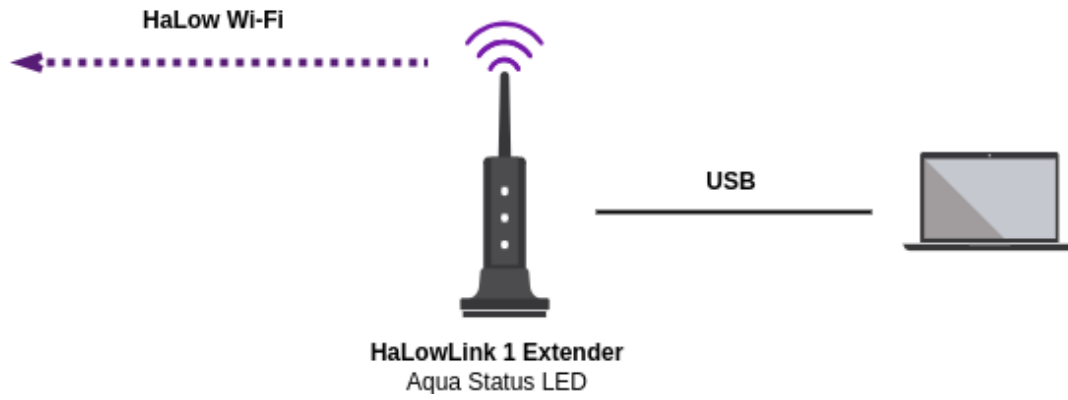
Follow the instructions above in (3) to set up an Extender, then:

1. Connect your computer via the provided USB-C cable to your Extender (aqua status LED).
2. A new Ethernet adapter should appear on your computer. Make sure it's configured as a DHCP Client.
3. You can now send traffic via the HaLow link. Note that because it's an Ethernet connection, by default your computer will likely use it in preference to any existing Wireless connection. See the **Troubleshooting** section for more information.

5.5 Connect an Ethernet device to a HaLow network

HaLowLink 1 Extender
Aqua Status LED
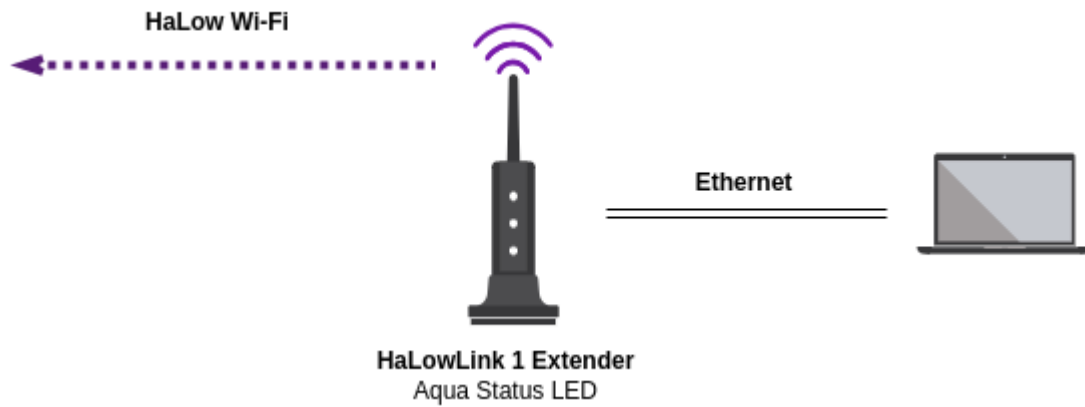
Follow the instructions above in (3) to set up an Extender, then:

1. Connect your device via an Ethernet cable to your Extender (aqua status LED).
2. Your device should now acquire an address via DHCP.

5.6 Connect a non-HaLow Wi-Fi device to a HaLow network

HaLow Wi-Fi

2.4 GHz Wi-Fi

HaLowLink 1 Extender
Aqua Status LED
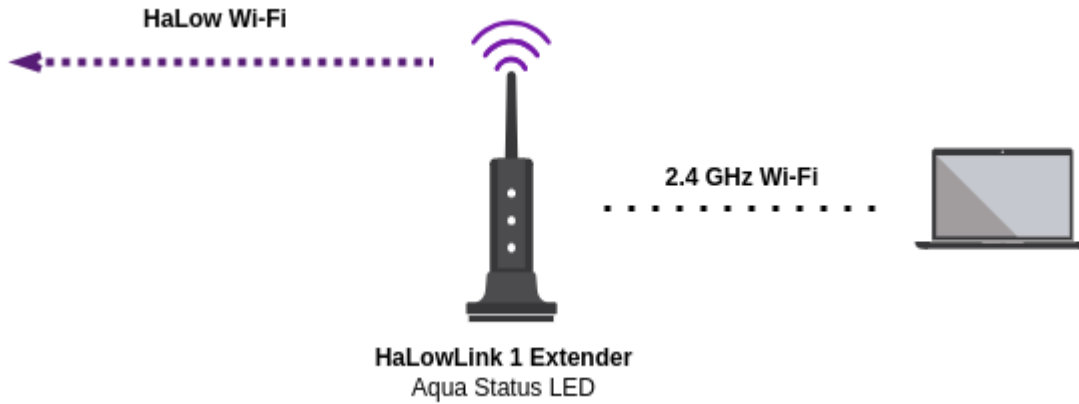
This could be a computer, tablet, phone, or any IoT device.

Follow the instructions above in (3) to set up an Extender, then:

1. Set the SSID/password of the Extender (NOT the Access Point) via scanning the QRCode on the bottom of the Extender or copying the credentials from the same sticker.
2. Your device should now acquire an address via DHCP.

5.7 Experimenting with HaLow
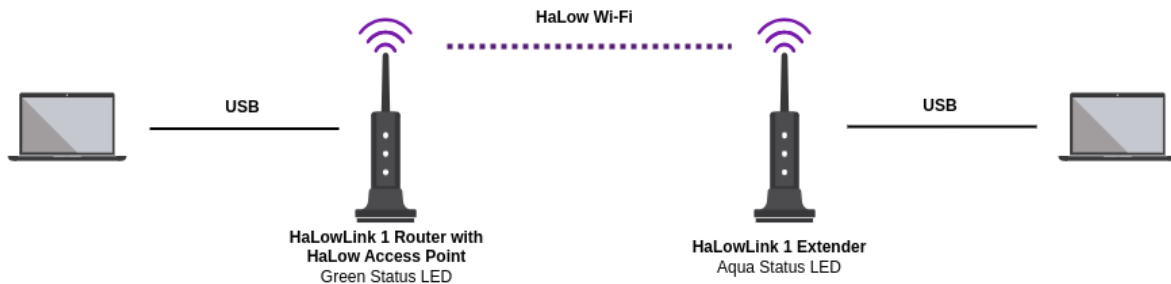
If you're currently just experimenting with HaLow's amazing range and penetration, the easiest way to test this out with a HaLowLink 1 is to have two devices and two laptops, where the laptops provide power to the HaLowLink. This allows you to easily move around.

1. Connect one laptop via USB-C to your Router with HaLowLink 1 Access Point (i.e. the factory default configuration), and go to http://192.168.12.1 (as described in **Getting Started**).
2. Connect another laptop to an Extender via USB-C, then set up the Extender as described in (3).
3. You should see the Extender appear on the **Home** page of the Access Point in the 'Connected Devices', and the 'Local Network' card should show the IPs of both the Extender and your other laptop.

Local Network   ✕

IPv4 10.42.0.1/24
IPv6 fdc4:e50f:f066::1/60

MAC Address	Hostname	IPv4	Expiry	IPv6	IPv6 Expiry
00:E0:4C:68:00:6B	mma-1375.lan	10.42.0.179	658 min(s)		

4. You can now test out the connection from one laptop to the other via HaLow. For more information about how to do this, see **Exploring HaLow Connectivity** in the next section.

Note that because the USB link is via Ethernet, by default your computer will likely use this in preference to any existing Wireless connection. See the **Troubleshooting** section for more information. If you're familiar with OpenWrt, you can stop this happening by configuring the DHCP server to return nothing for Option 3 (gateway).

6 Quick Config

For most users the **Wizard** page will be sufficient to configure a HaLow Access Point (green mode), and an Extender (aqua mode) can be configured via the button as described above. However, if you want to make simple minor changes to your configuration - such as changing your Wi-Fi password or encryption method, or setting a Static IP - you can do so via the **Quick Config** page. To help you understand the changes you're making, these will be reflected in the diagram at the top of the page as you make them.

WARNING: it is easy to change the configuration of your device here in a way that causes you to lose access to it, particularly if you're changing network interfaces. If this happens, see the section above on **Restoring Factory Settings**.

6.1 Network Interfaces

This section lists the logical networks available on your router, each of which can be configured with either a Static IP (and potentially a DHCP Server) or as a DHCP Client. If you have multiple 'Ethernet' ports or WIreless interfaces on the same network, a bridge will automatically be created. Note that to attach new Wireless interfaces to the network, you will need to use the Wireless section.

6.2 Wireless

This will allow you to configure the Wi-Fi interfaces on your HaLowLink. Note that it is possible to create multiple interfaces for a particular radio.

6.3 Advanced Usage

The **Quick Config** page is designed to correspond to the underlying text based configuration and connect with the pages accessible via **Advanced Config** (see below). If you have **Advanced Config** enabled, you can use the 'cog' icons on the **Quick Config** to access these pages, which will allow you more flexibility in your setup. It will also allow you to simply 'Save' rather than 'Save & Apply', which will let you view and apply or revert the proposed changes by clicking on the 'Unsaved Changes' indicator at the top right.

For more about the underlying configuration format (known as UCI), see **Configuring via the Command Line**.

7 Advanced Config

The software running on your HaLowLink 1 is based on OpenWrt, a Linux operating system targeting network connected devices. Minor configuration changes are accessible via the **Quick Config** page, but for full access click the **Advanced Config** menu option on the left hand side.

- ◐ Advanced Config
- ↥ Upgrade
- ☑ Status 〉
- ✂ System 〉
- ▦ Services 〉
- ⊹ Network 〉
- ⌁ Statistics 〉
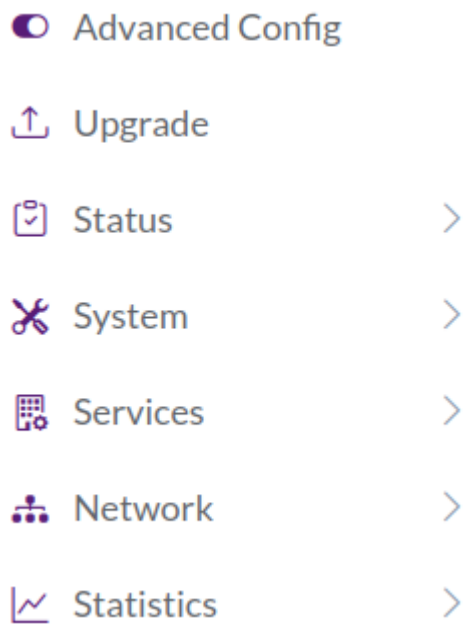
This will allow you to view detailed information about your device, change low-level configuration, install additional software if you have an internet connection (via **System -> Software**), and even access the Linux terminal (via **Services -> Terminal**).

You can also directly connect to your device via **ssh** using the same username and password you used to login. This is printed on the label.

For more information about OpenWrt, see https://openwrt.org/start.

8 Exploring HaLow Connectivity

Your HaLowLink 1 comes packed with useful utilities and pages to make the most of your HaLow connection. In particular, we recommend the following pages, accessible once **Advanced Config** has been enabled:

8.1 Status -> Channel Analysis

This will allow you to see the channels and signal strength of any other nearby HaLow networks. If there are many local HaLow networks, you may want to change the channel via the **Quick Config** page to avoid interference.

8.2 Status -> Realtime Graphs

This will show you a continuously updating graphical view of the link quality (see Wireless section) as well as other critical system metrics while you have the page open.

8.3 Network -> Diagnostics

This allows you simple access to command line tools to evaluate your network, including `iperf3` (to test bandwidth), `ping` and `traceroute` to explore connectivity, and `arp-scan` to discover all devices on the network. It also will show you the command it's executing, as you may also want to do this via the command line (see **Services -> Terminal**).

8.4 Statistics -> Graphs

Your HaLowLink 1 is running `collectd` to continuously monitor the behaviour of the device. Some of the information here is similar to Realtime Graphs, but it's updated at a lower frequency and stored while the device is running rather than just while you're on the page. It's also possible to configure other devices to point to this (e.g. Extenders) to aggregate all your statistics in a single place.

8.5 Services -> Terminal

For easy access to the Linux console, you can start a terminal on the device by going to **Services -> Terminal**. Note that you will have to re-enter your device password (refer to the sticker on the bottom of your HaLowLink).

From the command prompt, you will have access to the standard Linux utilities included in OpenWrt and those already mentioned via the Diagnostics page, as well as some other programs we've added. Here are some extra programs we've included that are particularly useful:

Utility	Purpose
`morse_cli`	Low level access to information from and settings on the Morse Micro HaLow chip.
`wavemon`	Terminal graphical program to monitor Wi-Fi signal strength and performance.
`nano`	Text editor, including syntax highlighting of UCI files. You may also use `vi`.
`tmux`	Terminal multiplexer, allowing persistent sessions and windows.

8.5 Services -> Range Test
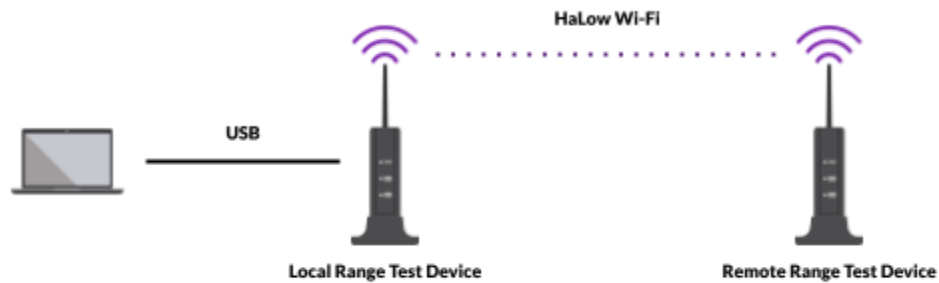
The Range Test application is designed as a simple way to analyse HaLow network performance by automating iPerf3 tests and collecting real-time statistics. It is a useful tool for quickly assessing signal strength, data throughput, and connection quality across different environments.

Before using this application ensure that all devices under test are running the same version of Morse OpenWrt. This tool can run with different types of evaluation kit (i.e. between an HaLowLink 1 and an EKH01) but the software versions must be the same.

To use the range testing tool:

1. Connect the devices being tested on the same HaLow network of any type outlined in this guide (Default AP/STA configurations are the most reliable).
2. Set up the devices in the desired locations and select a 'local' device to connect a laptop to.
3. In the management interface navigate to **Services -> Range Test**.
4. Select the HaLow IPv4 address from the 'Remote Device' dropdown. If it does not appear on first load, click the 🔍 icon to run another discovery. If this fails

to find a device which is connected to the same network as the local HaLowLink 1, a user may enter any IPv4 address into the 'custom' field pictured.
5. Fill in the 'Password' field using the device password (not the Wi-Fi password) if the remote device has one.
6. Optional - Provide user notes about the test in the 'Description' field.
7. Optional - If you want to log the coordinates of the local and remote devices and have the range calculated automatically enter the decimal degree values into the local and remote device coordinates fields respectively.
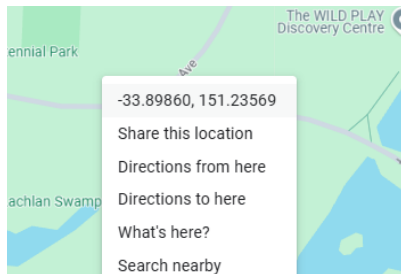
These values can be easily found by right clicking the relevant locations on Google Maps and then selecting the coordinates which will automatically put them in your clipboard (pictured).
8. If valid coordinates have been used from the previous step, the 'Range (m)' field should automatically populate, otherwise a range value must be supplied.

9. Optional - By clicking the ⚙ icon in the top left corner of the **Test Configuration** subsection, the data directions and protocols which will be tested can be modified.

   Note: data directions are named relative to the local device. If a 'Send' test is running it

means that the local device will send data to the remote device and vice versa with 'Receive' tests.

10. Click 'Start Test' and a progress bar will appear showing the status of the current test. This can be cancelled at any time by clicking the Stop button.
11. After the test completes, a row in the Results Summary subsection should appear, as pictured below.

Results Summary

Time	Remote Host	Description	Distance (m)	Location	Bandwidth (MHz)	Channel	UDP Send Throughput (Mbps)	UDP Receive Throughput (Mbps)	TCP Send Throughput (Mbps)	TCP Receive Throughput (Mbps)	Signal Strength (dBm)	Raw Data (JSON)	
4/15/2025, 5:00:30 PM	192.168.12.1 (halowlink1-afdf)	Testing in Centennial Park	340	map view	8	44 (924 MHz)	8.88	8.55	6.97	5.41	-88	Download	🗑

Download Results Summary (CSV)   Delete All

This result can be deleted by clicking the trash icon, or a JSON file containing all the raw data can be downloaded via the 'Download' button, which is intended to help engineers with remote debugging. The 'Download Results Summary (CSV)' button yields a CSV file of all the data represented in the results summary.

Note: test results are volatile to avoid overwhelming limited memory resources and will be deleted if power is removed or the device is rebooted.

Each sub-test is based around a 10 second iPerf3 test. The remote device will always act as the iPerf3 server and use the same command: `iperf3 -s -1 --json`. The local device will always act as the iPerf3 client, running a command in the following format:

`iperf3 -c <remote_IP> <protocol> <data_direction> -t 10 -O 2 --json`

For UDP tests the protocol arguments become `-u -b 40M/30` whereas for TCP tests only `-Z` is set. For the data direction arguments 'Receive' tests set the `-R` flag.

Note: if the throughput numbers are returning ~40 Mbps for UDP and 900+ Mbps for TCP then the test is likely defaulting to run over an Ethernet connection. This should be avoided.

9 Configuring via the Command Line

The HaLowLink 1 is an open device running Linux, and it is straightforward to gain direct access via either ssh or the **Services -> Terminal** page (accessible after enabling **Advanced Config**). Because it's based on OpenWrt, the primary mechanism of configuration is via UCI (https://openwrt.org/docs/guide-user/base-system/uci), which is fundamentally just a collection of files in `/etc/config` in a particular format.

9.1 Making changes

This happens in two steps:

- set new values in UCI
- reload_config to reload services

You can make changes to UCI via the `uci` command or by editing the files in `/etc/config`.

For example:

```
nano /etc/config/wireless
```

OR

```
uci show wireless
uci set wireless.default_radio0.mode=sta
uci commit
```

Doing a `uci commit` will cause the change to appear in `/etc/config/wireless`.

Once you've made changes (via either of those methods), to make them take effect use:

```
reload_config
```

Other files/services that are likely to be useful for network config are `dhcp`, `network` and `firewall`.

Aside from the UCI documentation mentioned above, the most useful resource is clicking 'Save' rather than 'Save & Apply' in the UI, which is possible if you've enabled **Advanced Config** in the menu. This will allow you to go up the top right ('Unsaved

Changes') and view a sequence of uci set commands corresponding to the change you just made. For example, after setting a static IP:

Configuration / Changes

Legend:

☐ Section added   ☐ Section removed   ☐ Option changed   ☐ Option removed

/etc/config/network

```
uci set network.lan.ipaddr='192.168.13.1'
```

Close   Save & Apply ▾   Revert
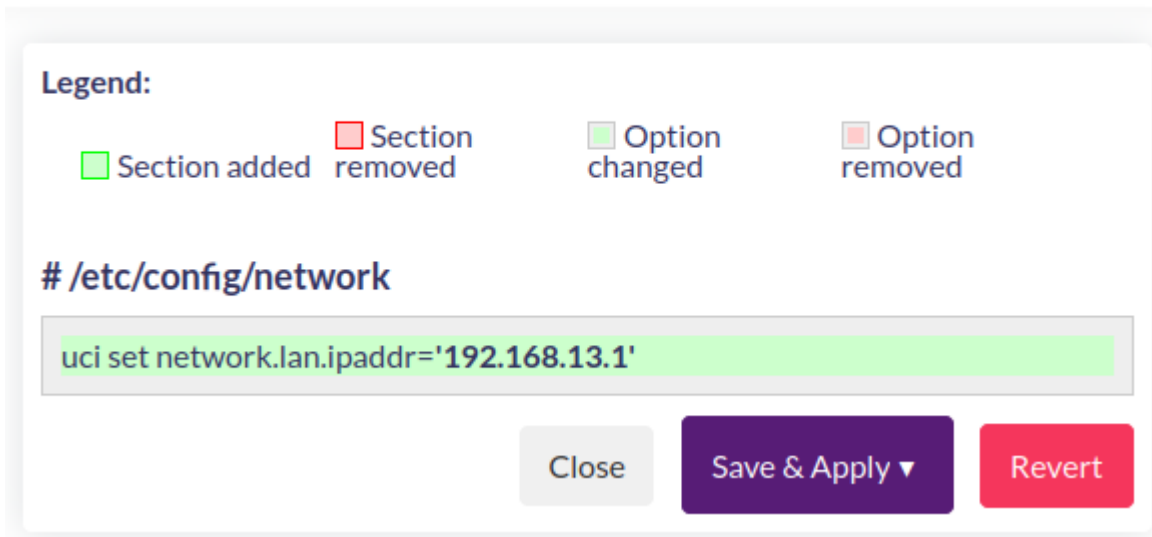
9.2 File/service structure

- `wireless` contains the radio devices (wifi-device) and the interfaces connected to that (e.g. wlan0, wlan1 - caused by a `wifi-iface`). Any `wifi-iface` has a `network`, which refers to an `interface` in the network UCI file. This corresponds to the Wireless section on the **Quick Config** page.
- `network` contains a mix of switches/bridges and logical interfaces; an `interface` in network may point to a bridge, in which case multiple Ethernet ports or `wifi-ifaces` might be attached to it.
  - confusingly, the wireless interfaces are not directly mentioned here, only in the wireless file. This means it's possible to incorrectly configure a network `interface` by NOT having a bridge and having multiple `wifi-ifaces` refer to it.
  - this corresponds to the **Network Interfaces** section on the Quick Config page.
- `firewall` controls nftables - i.e. forwarding/masquerading as well as simple accept/reject. Firewalls have another level of indirection - zones - such that you can potentially put multiple network `interfaces` in one zone.

- **dhcp** controls dnsmasq - i.e. DHCP *and* DNS. The usual setup is that there's always dnsmasq running, but if you don't want DHCP active on particular interfaces you set them to 'ignore'.

9.3 Debugging

If you've made a change and it's not working the way you expect:

```
logread -l 100 -f
```

will tail the logs. This is the primary mechanism OpenWrt of reporting that something went wrong, since you won't see it running `reload_config`.

Note that if you've manually edited the files rather than using uci set it's possible you've made them invalid. Use `uci show` to confirm that the UCI library can still parse them.

9.4 Applying configurations

As noted above, we recommend using `reload_config` to apply configurations. What this does is:

- check to see if any of the config files have changed
- trigger a *reload* on any services affected by these changes (i.e. not a restart)

There are other ways to do this. Notably, manually triggering a reload *will pick up uncommitted changes*:

- explicitly reloading a single service: `service network reload`
- explicitly restarting a single service: `service network restart`
- bringing down only the wifi interfaces and back up without restarting the network: `wifi down && wifi up`

10 Software Upgrades

To upgrade your software, use your browser to access the web interface (usually at http://192.168.12.1) as described in **Initial Connection**. Then select **Advanced Config**, and you should see the **Upgrade** menu item:
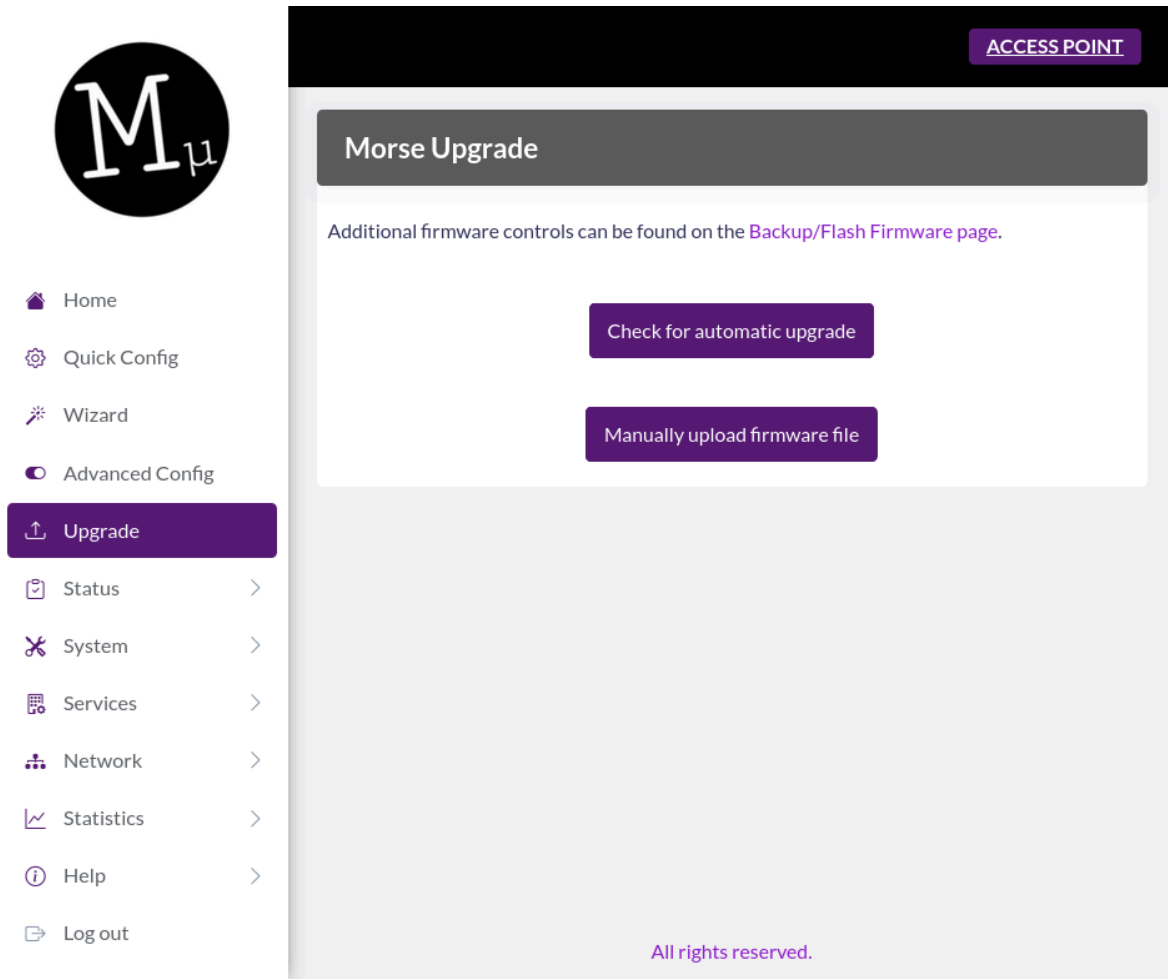
- **Check for automatic upgrade** will obtain the new version of firmware from the Morse servers.
- **Manually upload firmware file** will let you upload any compatible firmware.

11 Device Features

11.1 LED indicators
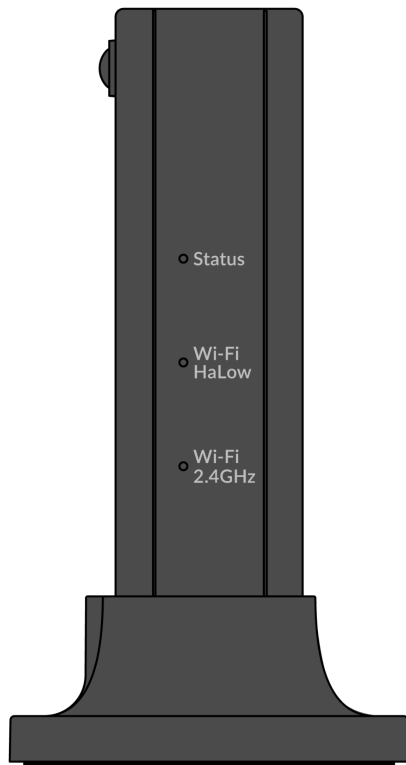
11.1.1 Status LED

Color	Meaning
Yellow flashing	factory reset in progress
Yellow solid	bootloader running
Green flashing	OpenWrt is booting
Green solid	OpenWrt is loaded and running

Aqua flashing	OpenWrt is booting into Extender mode
Aqua solid	OpenWrt is loaded and running in Extender mode
Blue flashing	OpenWrt is executing a software upgrade (do not disconnect power when this is happening)

11.1.2 Wi-Fi HaLow LED

Color	Meaning
Off	Wi-Fi HaLow is disabled (or not associated if Extender)
Purple solid	Wi-Fi HaLow is enabled (and associated if Extender)
Purple fast flash/flicker	Data is being transferred over HaLow
Purple slow flash	Pairing is in progress

11.1.3 Wi-Fi 2.4 GHz LED

Color	Meaning
Off	Wi-Fi 2.4 GHz Access Point is disabled
Green solid	Wi-Fi 2.4 GHz Access Point is enabled
Green fast flash/flicker	Data is being transferred over Wi-Fi 2.4 GHz

11.2 Ethernet/USB ports
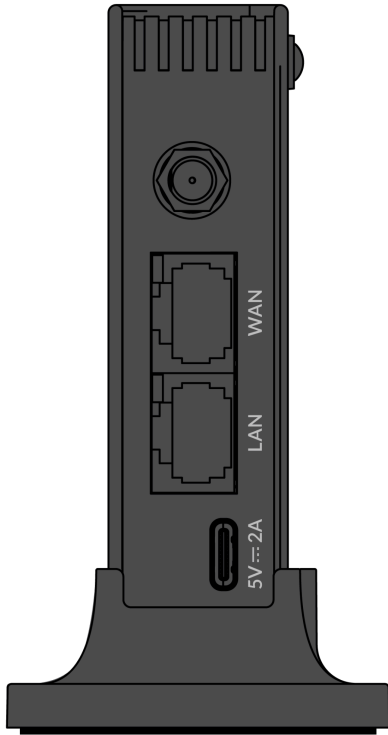
11.2.1 HaLow Access Point mode (green status LED)

Regardless of whether the HaLowLink is configured as a router or just an access point, these roles are correct. That is, USB-C and LAN will always be on a separate network to WAN, and the WAN port should be connected to your router.

Port	Role
USB-C	Either power only, or connect a computer to get a 192.168.12.x IP and access the management interface at 192.168.12.1.
LAN	Connect a computer to get a 192.168.12.x IP and access the management interface at 192.168.12.1.
WAN	Connect this to your existing network/router.

11.2.2 HaLow Extender mode (aqua status LED)

In Extender mode, all ports are bridged, and WAN has no special role.

Port	Role
USB-C	Either power only, or connect a computer to use the Extender's HaLow connection.
LAN	Connect a computer to use the Extender's HaLow connection.
WAN	Connect a computer to use the Extender's HaLow connection.

12 Troubleshooting

If you're having trouble with your HaLowLink 1, we recommend resetting the device by holding down the **mode** button, as described in **Restoring Factory Settings**. You can also contact Morse via https://morsemicro.com/halowlink1

Problem	Solution
The status light is not illuminated.	There is a problem with power to the device. Check that the USB-C port on the HaLowLink 1 is connected to the provided power supply or to a USB-C port on a computer. Do not use a USB-A to USB-C adapter.
The status light is still yellow after some time, or never stops flashing green after boot.	The flash partition is probably corrupt. To recover your HaLowLink, see **Recovering From Failed Upgrades** below.
I can't access the HaLowLink at 192.168.12.1.	If the status light is **solid green** and you can't access your HaLowLink at 192.168.12.1: • Make sure your computer is connected to either the LAN or USB port of the HaLowLink. • Check that your network connection is configured to use DHCP client, and has been allocated a 192.168.12.XXX IP. • If you're failing to establish a network connection to your device, see **Restoring Factory Settings**. If the status light is **solid aqua**, your HaLowLink is in Extender mode and will only be useful if connected to an Access Point. Simply connect other devices to it via Ethernet or 2.4 GHz Wi-Fi to use your HaLow-enabled network. You should not need to access its Web UI, but you may find its address in the DHCP lease table of your DHCP server.

I changed a configuration setting and now I can't access my HaLowLink 1, but I don't want to reset it.	If you need to access your HaLowLink 1 as part of troubleshooting a complex configuration change, you can connect your computer to the LAN or WAN port and configure it with the following settings: ● **IP**: 10.22.121.110 ● **Netmask**: 255.255.255.254 (if you can't set 255.255.255.254 due to OS limitations, use 255.255.255.0) As long as your HaLowLink 1 has a solid green or aqua light, it will be available at 10.22.121.111 (this is a secondary static IP assigned for diagnostic purposes).
I can see that the **Access Point** card has connected devices, but the **Local Network** card doesn't list them.	If you have configured your device as an Access Point only (i.e. the wizard option *HaLow Wi-Fi devices will get an IP on your existing router's network*), then these devices will appear in DHCP lease table of the existing DHCP server on your network. The **Local Network** on the HaLowLink 1 is being used primarily for easy access to the configuration, and will not have HaLow devices in it.. Alternatively, if you have temporarily lost power to HaLowLink 1 Access Point your devices may not yet have refreshed their DHCP leases. They will eventually renew their leases when their lease time expires.
When I connect my computer to my HaLowLink Extender directly over Ethernet, my internet gets slower.	Because your computer has a wired connection to the HaLowLink, most operating systems will prefer this connection over any wireless connection. However, if you're using a HaLowLink Extender, this means you will be restricted to the maximum bandwidth over the HaLow link (~22mbps). For your particular operating system, you should determine how to prefer your existing Wi-FI connection (e.g. via setting the HaLowLink connection to 'local only', removing the default route from the HaLowLink, or changing the route priorities).

When I connect my computer to my HaLowLink directly over Ethernet, my internet stops working.	This is the same problem as above, where your computer will prefer the HaLowLink connection over any wireless connection, but in this case it's probably your HaLowLink is not yet connected to the internet. For an Access Point, check the 'Uplink' on the homepage (which will report the WAN and 2.4 GHz state), and for an Extender check it has a purple light AND that the Access Point is correctly configured.
I changed the HaLow Mode or Network Mode of my HaLowLink 1, and my Extenders no longer work.	If you make significant changes to your configuration, any Extenders attached to your Access Point may no longer function as you expect. If you've just changed the Network Mode, we recommend plugging and unplugging your Extender to force it to reinitialise. If you've changed the HaLow Mode, you should follow the instructions in the **Extender** section to reset your device to Extender mode and redo the pairing procedure.
My connection isn't performing as I expect.	Check signal strengths on the Access Point by going to the **Home** page and clicking on the 'Connected Devices'. For more detailed information about the signal, go to **Status -> Realtime Graphs** (in **Advanced Config**). You can also see if there are other HaLow networks interfering by going to the **Status -> Channel Analysis** page, or go to **Network -> Diagnostics** to run iperf3 or ping tests.
My Extender's HaLow status LED is flashing quickly all the time even when I'm not using it.	Because the wireless and wired connection are bridged on the Extender, make sure you haven't created a network loop by connecting a LAN/WAN port of your Extender to the same network as your Access Point. To solve this, disconnect the incorrect Ethernet link.
I'm seeing strange or confusing behaviour not mentioned above.	Make sure you have the latest firmware by enabling **Advanced Config**, going to the **Upgrade** page and then clicking 'Check for automatic upgrade'. If you would like to report an issue to Morse Micro, go to **Help -> Support**, then click on **Create Archive**. Go to https://morsemicro.com/halowlink1 and let us know what the problem was.

12.1 Recovering From Failed Upgrades

If for some reason the software is corrupted or not booting - this is most often caused by losing power during an upgrade - the following procedure will allow a new image to be written to flash.

1. Remove all cables from the device.
2. Attach an Ethernet from the HaLowLink 1 directly to your computer.
3. While powered off, press and hold the mode button on the HaLowLink.
4. Attach the power cable and turn on power.
5. Watch for the Status LED to turn yellow, then blink white 5 times.
6. Release the button, the LED should remain yellow.
7. Configure your network connection with the following static IP and netmask:

    IP address: 192.168.12.2
    Netmask: 255.255.255.0

8. Open a web browser on the computer and navigate to http://192.168.12.1
9. Upload a firmware file and press 'update firmware'.
10. Do not remove the power until the device has installed the firmware and fully booted. You will see the following LED patterns to show progress:
    a. solid purple
    b. then red/purple flashing
    c. then solid purple
    d. then solid red
    e. then off (the device is rebooting)
    f. then yellow -> flashing -> solid (normal boot process)

The entire process will take approximately 10 minutes to complete.

13 Licensing and Source

Much of the software included in the HaLowLink 1 is covered by open source licences, including the GPLv2. For complete licensing information, and access to the source code, go to http://morsemicro.com/halowlink1

14 FCC compliance statement

FCC ID: 2A74O-9A6140

FCC compliance statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Exposure statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

15 IC compliance statement

ISED compliance statement

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

(1) L'appareil ne doit pas produire de brouillage;

(2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ISED Radiation Exposure statement

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.
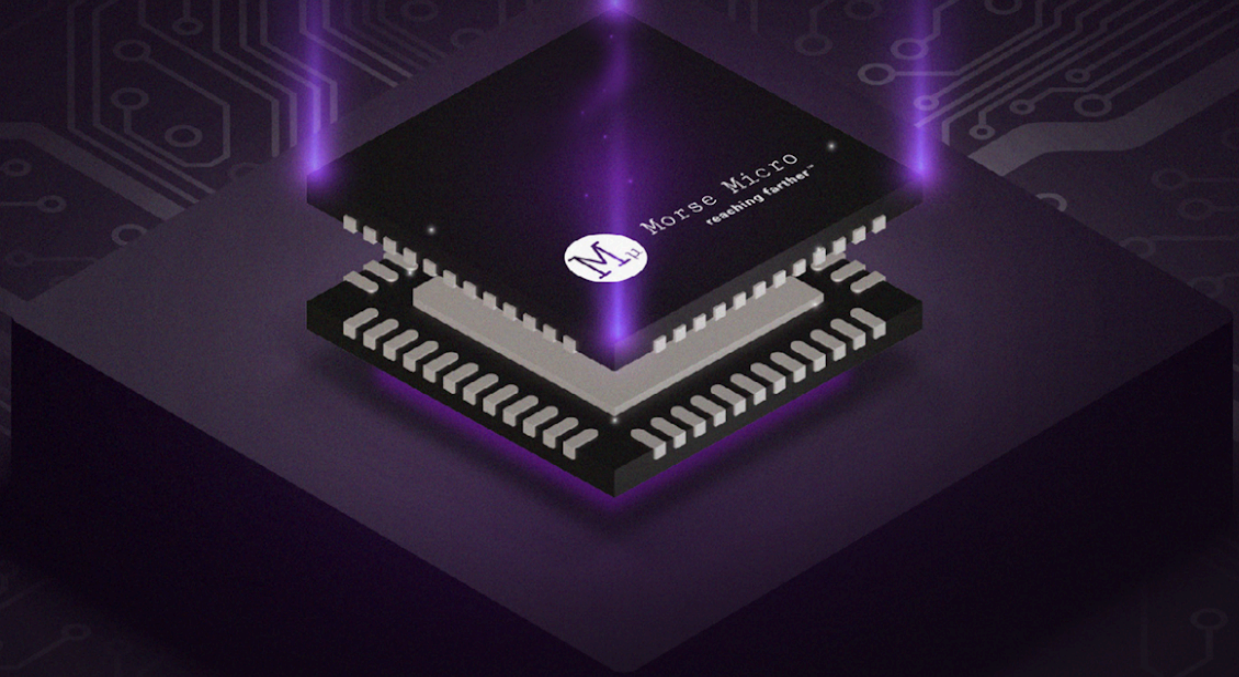
Cet équipement est conforme aux limites d'exposition aux radiations IC CNR-102 établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec une distance minimale de 20 cm entre le radiateur et votre corps.

This radio transmitter [29791-9A6140] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna Designation: Dipole Antenna, Gain: 2.34dBi

Le présent émetteur radio [29791-9A6140] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci−dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

Antenna Designation: Dipole Antenna, Gain: 2.34dBi

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