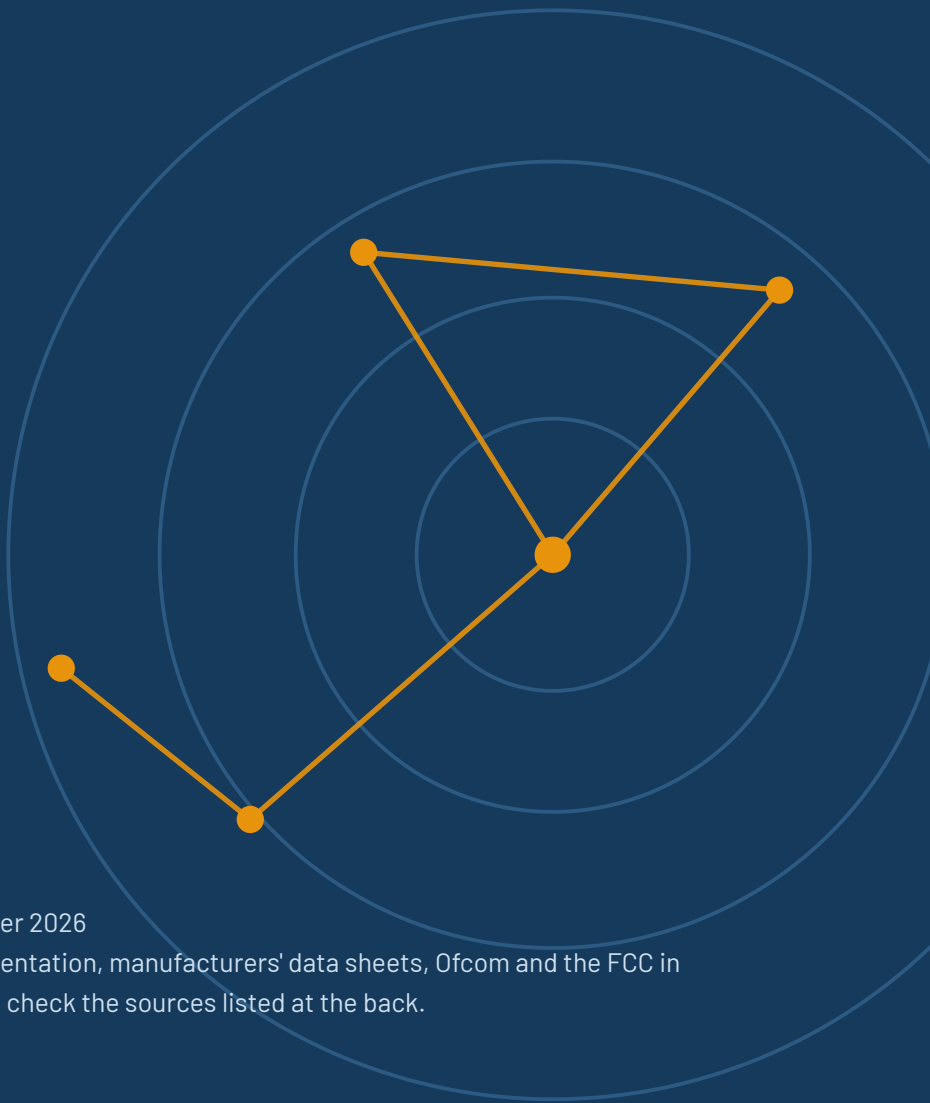
SHACKWIKI GUIDE

MeshCore

A beginner's guide

Off-grid text messaging over LoRa radio: choosing hardware, flashing companions and repeaters, keeping them updated, antennas, cable, connectors, batteries and solar power, for the UK and the USA.



ShackWiki · shackwiki.com
Written by Mick, 2E0CPU · Edition 1, November 2026
Facts checked against the MeshCore documentation, manufacturers' data sheets, Ofcom and the FCC in November 2026. MeshCore changes quickly: check the sources listed at the back.

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How to use this guide

If you just want to get on air, read chapters 1 to 3, then chapter 5. Come back to the rest when you want better range or decide to put up a repeater. Commands are shown `like this`. Where the UK and the USA differ, both are given.

Figures marked as estimates are worked out from published data with the method shown, so you can redo them for your own setup. Measure your own equipment where it matters.

CHAPTER 1

What MeshCore is

MeshCore is free, open-source firmware that turns small, cheap LoRa radio boards into a text messaging network that works without mobile signal, the internet or a licence.

You carry a small radio, called a **companion**, and talk to it from your phone over Bluetooth. Your radio sends your message on a licence-exempt band, 869.618 MHz in the UK and 910.525 MHz in the USA, and fixed **repeaters** on rooftops and hills pass it on until it reaches the person you're writing to. A message can hop many times, so a network of repeaters can cover a whole county.

LoRa (short for "long range") is a radio modulation from Semtech designed to be decoded at very low signal levels. It trades speed for range: a MeshCore message takes around a second to send, but a few hundred milliwatts can carry it tens of kilometres between high points.

What it's good for

- Keeping in touch with family or friends where there's no phone signal: hills, boats, festivals, rural areas.
- Community and club chat channels across a town or region.
- A backup when mobile networks are down. It isn't an emergency service, though: nobody is guaranteed to be listening.
- Experimenting with radio, antennas, solar power and networks, which is where a lot of radio amateurs come in.

What it isn't

- **Not fast.** It carries short text messages, not photos or voice. In current firmware a channel message holds about 160 bytes, including your name.
- **Not private about everything.** Message text is encrypted, but your node name, any position you choose to share, and when you transmit can be seen by anyone listening.
- **Not a guaranteed service.** Coverage depends entirely on where the repeaters are, and they are run by volunteers.

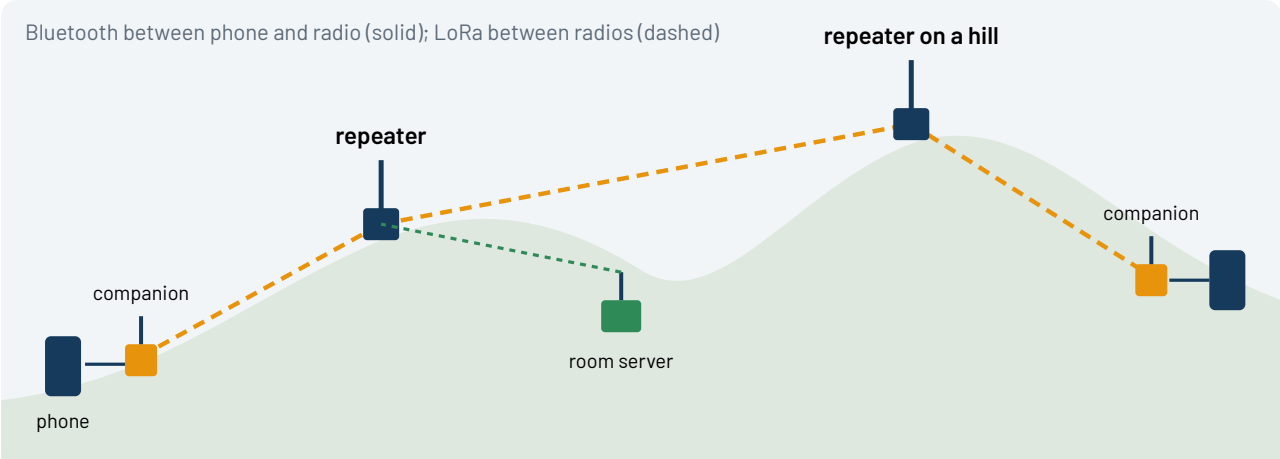
MeshCore and Meshtastic

Meshtastic is the better-known LoRa mesh project, and many boards run either. The main design difference is routing. Meshtastic uses managed flooding, in which ordinary nodes can rebroadcast what they hear, and newer versions add next-hop routing for direct messages. In MeshCore only repeaters relay, and once a route to someone is known, direct messages follow that route instead of flooding the whole network. That keeps busy networks quieter. The two aren't compatible with each other, so you have to use what your local network uses. ShackWiki's *Meshtastic vs MeshCore* page compares them in more detail.

The upstream MeshCore code is released under the MIT licence, so anyone can use and build on it. Some builds and apps around it, such as stand-alone device firmware, are separate projects with their own terms. The firmware, apps and documentation are linked from **meshcore.io**.

CHAPTER 2

How a MeshCore network works



Phones only talk to their own radio. Radios talk to each other on LoRa, and repeaters carry messages between areas.

The four kinds of node

Firmware role	What it does	Typical hardware
Companion	Your personal radio. It sends and receives your messages and connects to a phone or computer by Bluetooth (BLE), USB or, on some ESP32 builds, Wi-Fi. A companion **never repeats** anyone else's traffic.	Pocket-sized board or tracker with a battery
Repeater	Fixed relay. It passes on packets for others, which is what makes the mesh reach further. It has no chat app of its own; you manage it by USB or remotely over the mesh.	Low-power board, good antenna, high up, often solar
Room server	A simple bulletin board. Members log in and catch up on posts they missed; the FAQ says it keeps the last 32 unseen messages for each user.	Usually mains-powered, indoors or on a mast
Sensor	Reports readings such as temperature or battery voltage over the mesh, on boards built with sensors.	Specialist builds

One board runs one role at a time. You choose the role when you flash the firmware, and change it by flashing again. The MeshCore FAQ recommends running repeaters and room servers on separate boards.

How messages find their way

Flooding. The first time you message someone, your radio doesn't know where they are, so the message *floods*: repeaters that hear it and are allowed to forward it send it on once. Each repeater ignores copies it has already passed on, and its scope rules and hop limits decide what it carries, so the flood spreads outwards until it reaches them, runs out of repeaters, or hits those limits. Each repeater adds a short ID, its **path hash**, to the packet as it passes, so the packet records the route it took.

Direct routing. The other radio sends the route back in a returned-path packet, which can also carry its acknowledgement. From then on, direct messages between you travel only along that path, which keeps the rest of the network quiet. If a repeater on the route goes off air, or one of you moves, the stored route stops working; resetting the path in the app makes the next message flood again.

Path hash size. Path hashes can be 1, 2 or 3 bytes. One byte is the default, but on a big mesh two repeaters may end up with the same 1-byte ID, so larger networks use 2 or 3 bytes. Firmware 1.14 and later can forward packets with any of the three sizes. On a repeater, `set path.hash.mode` sets the size used in its own adverts. Follow the convention of your local group.

Scopes. A scope is a region name, such as `yorkshire` or `sco`, added to flood messages so repeaters know how far to carry them. Repeaters can be told to carry some scopes and drop others, which stops a chat in one county from filling the airwaves in the next. Scope names are set up locally; on air the scope travels as a short code worked out from the name. Many UK repeaters drop messages with no scope at all, so setting your local scope is part of getting on air. Since firmware 1.15 a companion can have a default scope.

Adverts. Every node can broadcast an *advert*: its name, public key and, if you choose, its position. Adverts are how radios discover each other and appear in your contacts list. They use airtime, so repeaters send flood adverts only every couple of days by default.

Channels, direct messages and rooms

Type	Who can read it	Good for
Public channel	Anyone with a MeshCore radio	Saying hello, first tests
Hashtag channel, e.g. #yorkshire	Anyone who knows the name, because the key is made from it	Local and topic chat
Private channel	Anyone you give its random key or QR code to	Family, club or team
Direct message	Only the contact it's sent to	One-to-one
Room server	Members who log in to that room	Messages kept for later

All of these share one radio channel, so adding chat channels doesn't add capacity. For direct messages both radios need each other as contacts, swapped by advert, QR code or public key. Keep your private key, and any backup that contains it, to yourself: anyone with it can pretend to be you.

> **"Heard" and "Delivered"**
>
> **Heard repeats** on a channel message counts the retransmissions your radio heard: proof that at least one repeater passed it on, not how far it went or that anyone read it. **Delivered** on a direct message means the other radio acknowledged it. A missing tick doesn't always mean failure; sometimes the acknowledgement is what got lost.

CHAPTER 3

The rules: UK and USA

You don't need a licence to use MeshCore in either country, but you do have to stay within the power and airtime rules for the band. The antenna and cable count towards the power, not just the radio's setting.

Settings at a glance

	UK	USA
Preset in the app	EU/UK (Narrow)	USA/Canada (Recommended)
Frequency	869.618 MHz	910.525 MHz
Bandwidth	62.5 kHz	62.5 kHz
Spreading factor	SF8	SF7
Coding rate	CR8 (4/8)	CR5 (4/5)
Repeater command	`set radio 869.618,62.5,8,8`	`set radio 910.525,62.5,7,5`
Band and rules	869.40–869.65 MHz, Ofcom IR2030/1/19	902–928 MHz, FCC Part 15
Power limit	500 mW ERP (27 dBm)	Whatever the device's FCC authorization covers (see below)
Airtime limit	10% duty cycle (6 minutes an hour)	No duty-cycle figure, but use under §15.249 depends on meeting its field-strength, emissions and equipment authorization requirements

Check the coding rate on new repeaters

The firmware's built-in default is `869.618,62.5,8,5`, with coding rate 5. UK groups such as MeshCore Yorkshire use coding rate 8, so set all four values on anything you flash, and look again after an update or restart. Frequency, bandwidth and spreading factor must match exactly or radios can't hear each other. A few regions use their own settings, so ask your local group.

UK: Ofcom's rules

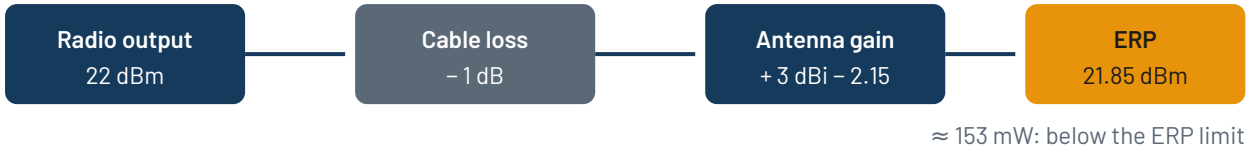
869.618 MHz sits inside 869.40–869.65 MHz, which Ofcom's interface requirement IR 2030 (entry IR2030/1/19) opens to any short-range device, licence-free, on two conditions:

- **No more than 500 mW ERP.** Effective radiated power, compared with a dipole, so antenna gain and cable loss are included.
- **No more than 10% of the time transmitting**, unless the device uses listen-before-talk and similar techniques to the EN 300 220 standard. Plan on 10%.

The 10% applies to each radio. A companion sending your own messages will never get close. A busy repeater can, because everything it forwards counts. MeshCore's airtime budget defaults to 50%, so on a UK repeater set it to 10% with `set dutycycle 10` (firmware 1.15 and later; on older firmware `set af 9` does the same).

Working out ERP

ERP (dBm) = radio output − cable and connector loss + antenna gain in dBi − 2.15



≈ 153 mW: below the ERP limit

Antenna gain is usually quoted in dBi. ERP is measured against a dipole, which has 2.15 dBi, so subtract 2.15.

Most LoRa boards go up to 22 dBm, which is legal into a small antenna but over the limit into a high-gain one. This table shows the highest radio setting that keeps you at 500 mW ERP:

Antenna	Gain	Cable loss	Highest setting for 500 mW ERP
Stubby whip on the radio	2 dBi	0.5 dB	22 dBm (radio maximum)
Typical whip or small collinear	3 dBi	1 dB	22 dBm (radio maximum)
Fibreglass collinear	5.8 dBi	1 dB	24.3 dBm
Long fibreglass collinear	8 dBi	1 dB	22.1 dBm
High-gain collinear	10 dBi	1 dB	20.1 dBm
Yagi (directional)	12 dBi	1.5 dB	18.6 dBm

Highest setting = 27 + 2.15 − antenna gain (dBi) + cable loss. Round down. Boards with a built-in amplifier need far lower settings; see chapter 4.

At 62.5 kHz wide, the UK signal nominally runs from about 869.587 to 869.649 MHz, leaving only about 0.75 kHz between its upper edge and the top of the band at 869.65 MHz. That leaves almost no room, so the radio's own emissions must also meet the standard. Buying a board sold for the 868 MHz band is a sensible start, but it doesn't by itself prove that its emissions comply.

USA: FCC Part 15

MeshCore in the US runs unlicensed under FCC Part 15 in the 902–928 MHz band. Part 15 has more than one set of rules for this band, and which one applies decides how much power is legal:

Rule	Power allowed	Does narrow-band MeshCore fit?
§15.247 digital modulation	1 W conducted, up to 6 dBi antenna	No: needs at least 500 kHz bandwidth; MeshCore uses 62.5 kHz
§15.247 frequency hopping	1 W with 50 or more hopping channels	No: MeshCore stays on one frequency
§15.249	50 mV/m at 3 m, about 0.75 mW EIRP in free space	Only if the device meets that field-strength limit, the emission limits and the equipment authorization rules (§15.201). The limit is very low

So the "1 watt in the 915 MHz band" you often read about applies to wideband or hopping systems, not to a fixed 62.5 kHz signal. A radio's FCC ID covers the modes, power and antennas it was tested with. An FCC ID on its own doesn't show that MeshCore's narrow mode, at the power and with the antenna you plan to use, is covered. Ask the manufacturer what its grant covers. The 910.525 MHz settings are a community preset, not an FCC-assigned channel. Part 15 devices also mustn't cause harmful interference and must accept any they receive (§15.5).

Licensed amateurs: 902–928 MHz is also the 33 cm amateur band, where Part 97 allows more power. But Part 97 bans messages encoded to hide their meaning (§97.113), and MeshCore encrypts its messages, so ordinary

MeshCore use belongs under Part 15. The same applies to UK amateurs: the encrypted mesh runs licence-exempt, not under the amateur licence.

This chapter is general information, not legal advice.

CHAPTER 4

Choosing your hardware

Almost every MeshCore board pairs a small processor with a Semtech LoRa radio chip. Which processor it uses matters more than anything else, because it decides battery life, how you update it and how you flash it.

The two processor families

	Nordic nRF52840	Espressif ESP32 (mostly ESP32-S3)
Power use	Very low. The best choice for battery and solar repeaters.	Higher. Fine on mains or USB power; needs a much bigger battery and panel for solar.
Bluetooth range	Good	Varies; the Heltec V3's small coil antenna only manages a few feet
Wi-Fi	None	Yes, so Wi-Fi companion builds are possible
Flashing	Web flasher, or drag-and-drop UF2 file	Web flasher, or esptool
Over-the-air updates	Bluetooth, with Nordic's nRF Device Firmware Update app	The board makes its own Wi-Fi hotspot and you upload the file in a browser
Examples	RAK4631 WisBlock, Heltec Mesh Node T114, Seeed T1000-E, Wio Tracker L1, XIAO nRF52840	Heltec WiFi LoRa 32 V3 and V4, LilyGo T-Deck and T-Beam, Station G2, XIAO ESP32-S3

The LoRa chip is usually the **SX1262**, which can put out up to 22 dBm (about 160 mW). Older boards with the **SX1276** top out at 20 dBm. The Seeed T1000-E uses the **LR1110**. All of them work with MeshCore when built for it.

Popular boards

Board	Chips	Notes	Good as
Heltec WiFi LoRa 32 V3	ESP32-S3, SX1262	Cheap and common, small OLED screen, U.FL/IPEX antenna socket. Short Bluetooth range from its coil antenna.	First companion, mains-powered repeater
Heltec WiFi LoRa 32 V4	ESP32-S3, SX1262 + amplifier	Heltec lists a 28 dBm high-power version and a 22 dBm version, plus a solar input and GNSS connector. On the amplified version the setting isn't the output.	Companion or repeater, with care over power
RAK WisBlock RAK4631 on a RAK19007 base	nRF52840, SX1262	Modular. The base has a Li-ion charger, a 5 V solar input and USB-C. Very low power; the usual choice for solar repeaters.	Solar repeater, companion
Heltec Mesh Node T114	nRF52840, SX1262	Low power, optional colour screen and GPS, solar charging. Heltec quotes 21 ± 1 dBm maximum.	Companion, solar repeater

Board	Chips	Notes	Good as
Seeed SenseCAP T1000-E	nRF52840, LR1110	Credit-card size, 700 mAh battery, IP65, GPS, magnetic charger. Internal antenna only, so range is modest.	Pocket companion
Seeed Wio Tracker L1 / L1 Pro	nRF52840, SX1262	OLED or e-ink screen, GPS; the Pro has a 2000 mAh battery and case. 5 V solar input on the L1.	Ready-made companion
LilyGo T-Deck	ESP32-S3, SX1262	Keyboard and screen. Messaging without a phone needs a stand-alone build (such as Ripple's) rather than the BLE companion firmware, which uses the phone app.	Stand-alone messenger
Station G2 (now discontinued)	ESP32-S3, SX1262 + 35 dBm amplifier	SMA socket, low-noise receive amplifier, USB-C PD or 9–19 V input. Far more power than UK rules allow at full output.	Experienced users only, after checking the setting-to-output figures and the rules
XIAO nRF52840 or ESP32-S3 + Wio-SX1262	either	Tiny and cheap; needs a case and antenna.	Builders

Check the current list in the MeshCore web flasher before you buy. The board, its version number and the firmware role must all be listed there.

> **Boards with power amplifiers**
>
> On boards with an extra amplifier (Heltec V4 high-power, Station G2, T-Beam 1W, E22-900M30S/M33S-based builds), the `set tx` value drives the amplifier, and the antenna gets much more. The MeshCore FAQ gives a 16 dBm setting on a Station G2 at 915 MHz as about 35 dBm of conducted output. The MeshCore FAQ warns that wrong settings can permanently damage some boards, and gives limits such as 19 dBm for the Ikoka E22-900M30S and 9 dBm for the E22-900M33S. In the UK, 27 dBm ERP is the legal ceiling, so these boards have to be run well below what they can do. Check the maker's figures for setting against output.

Buying tips

- **Buy the right band.** 868 MHz for the UK and Europe, 915 MHz for the USA. Many boards come in 433 MHz versions too, which won't work. A 915 MHz board may tune to 869 MHz but its filters and antenna are wrong for it.
- **Get an antenna for the same band**, with the right connector (chapter 10). Many cheap boards come with a poor antenna; a good one is the best upgrade you can make.
- **Never power a board without its antenna.** Transmitting into nothing can damage the radio, and a new board may transmit an advert as soon as it starts.
- **Check the battery connector.** Small JST-style plugs come wired both ways. Check the polarity marked on the board against the battery's wires before you plug it in (chapter 11).
- **Buy two.** Two radios always work with each other, so a pair lets you learn even before there's a repeater near you. Look at the MeshCore map (map.meshcore.io) and your local group first.

CHAPTER 5

Flashing a companion radio

Flashing means writing the MeshCore firmware onto the board. You do it once to start, and again for updates. It takes a few minutes in a web browser.

What you need

- A computer with **Chrome or Edge**. The web flasher uses Web Serial, which Firefox, Safari and phones don't support.
- A **USB data cable**. Many cables only charge; if the computer doesn't see the board, try another cable before anything else.
- The antenna fitted to the board.
- The **MeshCore app** by Liam Cottle for Android or iPhone, or the web app at app.meshcore.nz.

Which companion firmware?

Firmware	Connects to	Choose it when
Companion Radio (BLE)	The phone app over Bluetooth	Almost always. This is the normal choice.
Companion Radio (USB)	The web app or a computer over a USB cable	A radio that stays plugged into a PC or Raspberry Pi
Wi-Fi companion	Over your Wi-Fi network	ESP32 only, and you compile it yourself with your network details

Using the web flasher

1. **Open flasher.meshcore.io** in Chrome or Edge, and plug the board into the computer.
2. **Pick your exact board**, including its version (a Heltec V3 isn't a V4), then **Companion Radio (BLE)** and the latest stable release.
3. **Put the board in bootloader mode if asked.** The flasher has an *Enter DFU mode* button for most boards. If that doesn't work, use the board's buttons: on many ESP32 boards, hold BOOT (PRG) while pressing RESET; on nRF52 boards, double-press RESET quickly; on a T-Deck, hold the trackball while switching on.
4. **Erase on the first install.** When moving from Meshtastic or other firmware, use *Erase Flash* first for a clean start. For a later update you can usually skip it, which keeps your settings (chapter 7).
5. **Flash**, choose the serial port when the browser asks, and wait. Don't unplug until it says it's finished. The board restarts into MeshCore.

> **The UF2 drag-and-drop method (nRF52 boards)**
>
> nRF52840 boards with the Adafruit-style bootloader can be flashed without the web flasher. Double-press RESET and the board appears as a USB drive. Download the `.uf2` file for your board and role from the flasher page and drag it onto the drive. The board copies it and restarts on its own. The drive's `INFO_UF2.TXT` file shows the bootloader version.

> **Moving from Meshtastic**
>
> Most boards sold "for Meshtastic" run MeshCore too. Erase and flash as above. Nothing is permanently changed: you can flash Meshtastic back later with its own web flasher.

Connecting the app

1. Turn on Bluetooth and give the app the **nearby devices** (Android) or Bluetooth (iPhone) permission.
2. Tap connect and choose your radio. Boards with a screen show a PIN to type in; boards without one use **123456** by default.
3. Open the radio settings and choose your preset: **EU/UK (Narrow)** or **USA/Canada (Recommended)**. Check that the frequency, bandwidth, spreading factor and coding rate in chapter 3 have stuck.
4. Set the **transmit power** for your antenna (chapter 3).
5. **Name your node**: short and recognisable, but not your address. Decide whether to include your position in adverts. You can leave it off or use a rough location.
6. Set the **default scope** and **path hash size** your local group uses. In the app these are in the experimental settings (app 1.43 or later).
7. Send an **advert**, then join your local channel and say hello. Try outdoors or at an upstairs window first.

> **Back up your identity**
>
> Your radio's private key is your identity on the mesh. Export your settings from the app before a factory reset or a full erase. Store the backup somewhere private: anyone with your key can send messages as you.

CHAPTER 6

Building and flashing a repeater

A well-placed repeater is the most useful thing you can add to a mesh. A badly placed one adds traffic and collisions without adding coverage, so plan it with your local group first.

Before you start

- **Talk to your local group.** Ask what's needed where, which scopes and path hash size to use, and what to name it.
- **Height beats power.** A repeater on a hill or a tall building with a clear view is worth far more than extra watts (chapter 13).
- **Choose low-power hardware** if it will run on battery or solar: an nRF52840 board such as a RAK4631 or T114.
- **Get permission** from whoever owns the roof, mast or land.

Flashing

Use the web flasher exactly as for a companion, but choose **Repeater** as the role. For nRF52 repeaters that will go somewhere hard to reach, install the **OTAFIX bootloader** first (chapter 7), so you can update over Bluetooth later and a failed update can recover.

First set-up over USB

A repeater has no chat app. You set it up by typing commands, either in the **console** on the web flasher page with the board plugged in, or with the configuration tool at **config.meshcore.io**. A typical UK set-up is shown below. Treat it as a template: change the values for your board, antenna and local group, type the commands one line at a time and wait for each reply, and send `advert` only after the board has restarted.

```
# identity and security
set name Hilltop-Rpt            # short, agreed with your group
password YourNewPassword        # default is "password"; up to 15 characters
set lat 53.800                  # optional, a rough position is fine
set lon -1.550

# radio (UK). USA: set radio 910.525,62.5,7,5
set radio 869.618,62.5,8,8
set tx <value>                  # board-specific: work it out (chapters 3 and 4)
set dutycycle 10                # UK 10% limit; "set af 9" before firmware 1.15

# local network settings: ask your group
set path.hash.mode 0            # hash size in its own adverts: 0/1/2 = 1/2/3 bytes
powersaving on                  # sleep between packets

reboot                          # radio changes need a restart
advert                          # after it restarts: announce it
```

Scope rules are set with the `region` commands. Groups usually give you the exact lines to paste, so follow theirs.

> **Change the admin password before it goes up**
>
> Anyone who knows the default password can log in over the air and change your repeater. Room servers also have a guest password; set it with `set guest.password`.

Managing it remotely

Once it's on air, a repeater shows up in your app's contacts when it adverts. Log in to it with the admin password, and you can see its status, battery, neighbours and statistics, and use a **Command Line** tab to send the same commands as over USB. That's also how you start an over-the-air update.

Useful repeater commands

Command	What it does
`ver` / `board`	Firmware version and board name
`get radio`	Shows frequency, bandwidth, SF and CR
`get tx` / `set tx 14`	Transmit power in dBm (needs a reboot)
`get dutycycle`	Airtime budget per hour (default 50%)
`neighbors`	Repeaters it has heard recently
`stats-radio`	Noise floor, signal levels, airtime (USB only)
`clock` / `clock sync`	Shows the time / sets it from your device
`advert`	Sends an advert now
`set flood.advert.interval 47`	Hours between flood adverts (3–168; default 47)
`set advert.interval 0`	Local (zero-hop) adverts every 60–240 minutes; 0 turns them off
`set owner.info text`	Contact details others can read (firmware 1.12+)
`set agc.reset.interval 4`	The FAQ's fix for an SX1262 that goes "deaf" over time
`start ota`	Starts an over-the-air update
`reboot`	Restarts it
`erase`	Factory reset, USB only. Destroys its identity

A newly flashed repeater sends a local advert every 2 minutes until you save any setting, so set it up promptly. Full list: docs.meshcore.io/cli_commands.

Installation checklist

- Antenna fitted, connectors tight and weatherproofed (chapter 10).
- Radio settings, power, duty cycle, scopes and password checked with `get` commands.
- Tested on the bench, then from where it will live, with a companion some distance away.
- Enclosure rated IP65 or better, with a breather vent or desiccant (chapter 12).
- Owner info set, and the local group told it's live.

CHAPTER 7

Keeping firmware up to date

MeshCore moves quickly, and new features often need every repeater in an area to be updated. You can update a board by USB, or over the air while it stays on its mast.

Good habits

- **Check what you're running** with `ver`, or in the app.
- **Read the release notes** and check with your group, especially for repeaters.
- **Export a backup** of companion settings before updating.
- **Update one repeater first**, check it, then do the rest.
- **Check your settings afterwards**, especially the radio settings: some radios have come back up on another region's preset after an update.

Updating by USB

Use the web flasher as before, choosing the same board and role and the new version. Skip *Erase Flash* to keep your settings and identity. On ESP32 boards, flashing the full "merged" firmware file (for example with esptool) also overwrites the bootloader and the Bluetooth pairing list, so you may need to pair your phone again afterwards. nRF52 boards can also be updated by dragging the new `.uf2` file onto the board's USB drive.

Over the air: nRF52 boards

nRF52 boards update over Bluetooth from a phone near the repeater. Install the **OTAFIX bootloader** first: it's a MeshCore-maintained fork of the Adafruit bootloader that goes back into update mode when it finds the main firmware is invalid, for example after an interrupted update, and makes updates faster. You install it once, by USB, by dragging its `update-….uf2` file onto the board's USB drive. The flasher links to it.

1. Install Nordic's **nRF Device Firmware Update** app (nRF DFU) on your phone.
2. Download the **.zip** firmware file for your board and role from the flasher to your phone.
3. In the MeshCore app, log in to the repeater as admin, open the Command Line and send `start ota`. Wait for `OK`.
4. In nRF DFU's settings, turn on packet receipt notifications and set the number of packets: the FAQ suggests 10 for RAK boards and 8 for the T114.
5. Choose the zip file, choose the repeater (turn on force scanning if it doesn't appear) and tap **Upload**.
6. If it fails, turn Bluetooth off and on, restart the phone, or forget and re-pair the board, and try again.

Over the air: ESP32 boards

1. Download the **non-merged** `.bin` file for your board and role.
2. Log in to the repeater as admin and send `start ota`.
3. The repeater starts a Wi-Fi hotspot called **MeshCore OTA**. Connect your phone or laptop to it.
4. Open **http://192.168.4.1/update** in a browser and upload the file. The board restarts on the new firmware.

Companions can be updated over the air too, from firmware 1.15 onwards. Wi-Fi and Bluetooth only reach a few tens of metres, so for a repeater on a mast you need to be near it, not just somewhere on the mesh.

> **If an update goes wrong**
>
> Don't panic. If an update is interrupted, the OTAFIX bootloader should find the firmware invalid and wait in update mode, so you can try again. Otherwise bring the board back to a computer and flash it by USB, using the bootloader buttons if needed. From firmware 1.7, nRF52 boards also have a rescue mode: hold the user button within 8 seconds of power-on, then use the flasher's console.

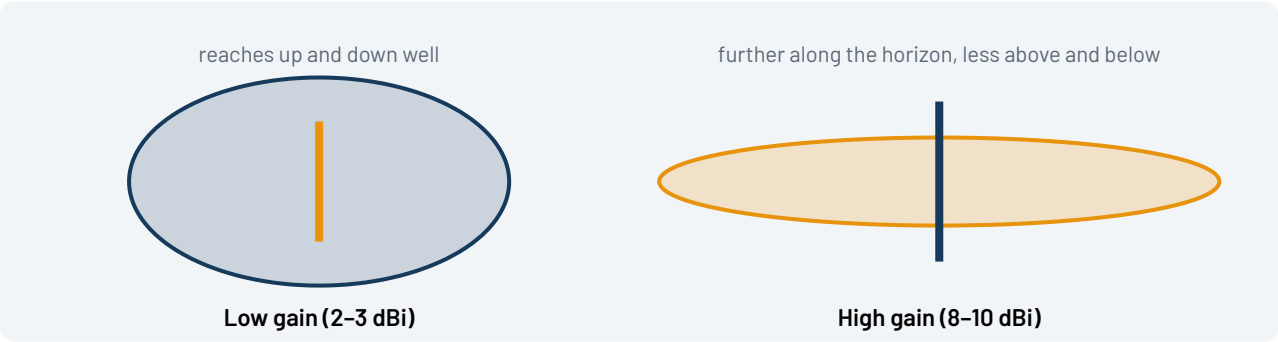
CHAPTER 8

Antennas

The antenna, and where you put it, decides your range far more than the radio does. A good antenna in a high place beats extra power every time, and it works on receive too.

The basics

- **Match the band.** An antenna is cut for a range of frequencies. Use one made for 868 MHz in the UK or 915 MHz in the USA. A quarter wavelength is about 86 mm at 869.6 MHz and 82 mm at 910.5 MHz, so the two look alike but aren't interchangeable for best results.
- **Vertical polarisation.** Everyone on the mesh uses vertical antennas. A horizontal antenna talking to a vertical one can lose a large part of the signal, so mount yours upright and hold handhelds upright.
- **Gain isn't free power.** An antenna can't make power; it squeezes it into a flatter pattern. A high-gain collinear sends more towards the horizon and less up and down, which is great on flat ground or a hilltop. It can be worse for reaching nodes close below a high site.
- **Gain counts towards your legal power** (chapter 3). If you fit a bigger antenna, recheck your setting.



Side view of radiation patterns. Gain reshapes the pattern; it doesn't add power.

Antenna types

Type	Typical gain	Notes	Best for
Internal PCB or FPC antenna	0–2 dBi	Built into trackers and some boards. Convenient, modest range.	Pocket use
Stubby or rubber-duck whip	2–3 dBi	Screws onto the radio. Quality varies a lot; many cheap ones are poorly tuned.	Handheld companions

Type	Typical gain	Notes	Best for
Quarter-wave ground plane	≈2 dBi	A vertical element with radials, easy to build. Good all-round pattern.	Home base, DIY
Half-wave dipole	2.15 dBi	The reference antenna for ERP. Needs a choke or balun on its feed.	DIY, testing
Fibreglass collinear	3–10 dBi	Weatherproof, mast-mounted, usually N-type. The usual repeater antenna; 5–6 dBi is a good all-rounder.	Repeaters, home base
Magnetic-mount whip	2–5 dBi	The car roof acts as the ground plane.	Vehicles
Yagi	8–14 dBi	Directional; must be aimed. Mind the power limit.	Point-to-point links between sites

Checking an antenna

Cheap antennas are often tuned for the wrong band or not at all. If you have a NanoVNA or an SWR meter that covers 900 MHz, check that the lowest SWR falls on your frequency and is below about 2:1 across the 62.5 kHz you use. A home-made antenna can be trimmed to frequency the same way. For most people, an antenna from a known supplier with a data sheet is the safer route.

Placement and mounting

- **Get it high and clear.** Above the roofline, away from metal, gutters, solar panels and other antennas. A loft is better than a room, and outside is better than a loft. Metal roofs and foil-backed insulation block signals.
- **Keep it vertical** and away from your body on handhelds. A radio in a pocket loses a lot.
- **Short feeder.** Put the radio near the antenna and run power to it, rather than a long run of coax (chapter 9).
- **Lightning and static.** An outdoor mast should be earthed, and coax entering a building should go through a surge arrester. Follow the rules for masts and earthing where you live, and don't put up antennas near power lines.

CHAPTER 9

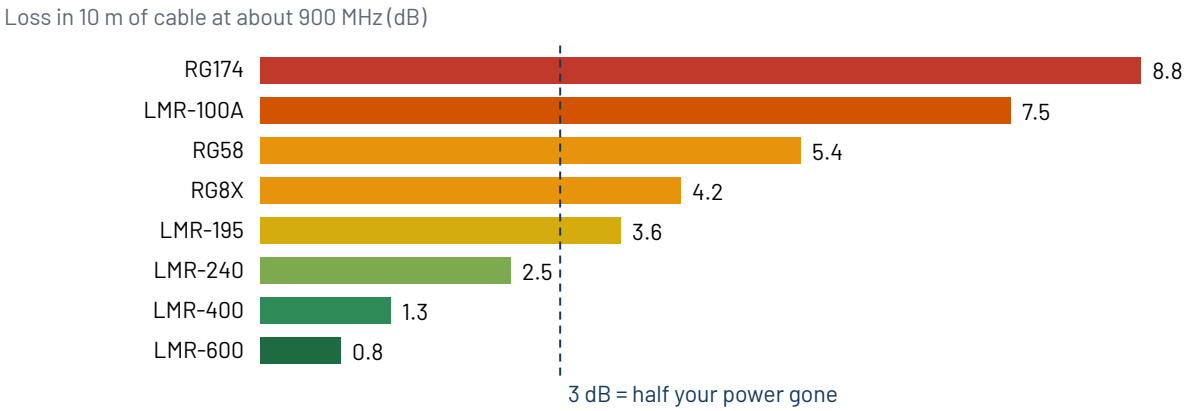
Coax cable and loss

At 869 and 915 MHz, coax loses signal quickly, and the loss works both ways: on transmit and on receive. A few metres of thin cable can throw away half your signal.

Loss is measured in decibels. Every 3 dB loss halves the power, and 10 dB leaves a tenth. The table gives typical loss per metre at around 900 MHz, from manufacturers' data, and what's left after different lengths.

Cable	Diameter	dB per m	1 m	3 m	5 m	10 m	Power left after 10 m
RG174 (pigtails)	2.8 mm	0.88	0.9	2.6	4.4	8.8	13%
RG316 (pigtails)	2.5 mm	0.86	0.9	2.6	4.3	8.6	14%
LMR-100A	2.8 mm	0.75	0.7	2.2	3.7	7.5	18%
RG58	5 mm	0.54	0.5	1.6	2.7	5.4	29%
RG8X (mini-8)	6.1 mm	0.42	0.4	1.3	2.1	4.2	38%
LMR-195	5 mm	0.36	0.4	1.1	1.8	3.6	43%
RG213	10.3 mm	0.26	0.3	0.8	1.3	2.6	55%
LMR-240	6.1 mm	0.25	0.2	0.7	1.2	2.5	56%
LMR-400	10.3 mm	0.13	0.1	0.4	0.6	1.3	74%
LMR-600	15 mm	0.08	0.1	0.2	0.4	0.8	83%

LMR, RG58, RG8X and RG213 figures are 900 MHz values from the Times Microwave coax selection guide, converted to dB per metre. RG174 and RG316 are 1 GHz figures from a cable supplier's data sheet, slightly pessimistic at 869 MHz. Real cable varies by maker; add about 0.1–0.2 dB for each connector or adapter.



Thin cable is fine for a few centimetres inside a case, not for runs up a mast.

Rules of thumb

- **Keep it short.** The best feeder is no feeder: mount the radio in a box at the antenna and run power, not RF, up the mast. Size the power cable so the radio still gets enough voltage during transmit peaks; USB cables have their own length limits.
- **Under 1 m:** RG316 or RG174 pigtails are fine.
- **1 to 5 m:** LMR-240 or similar.
- **Longer runs:** LMR-400 or better, or move the radio.

- **Count adapters.** Every adapter and joint adds loss and a place for water to get in.
- **Cable loss lowers your ERP**, so in the UK it can let you use a higher setting, but it costs you the same on receive. Better antenna, shorter cable is always the better trade.

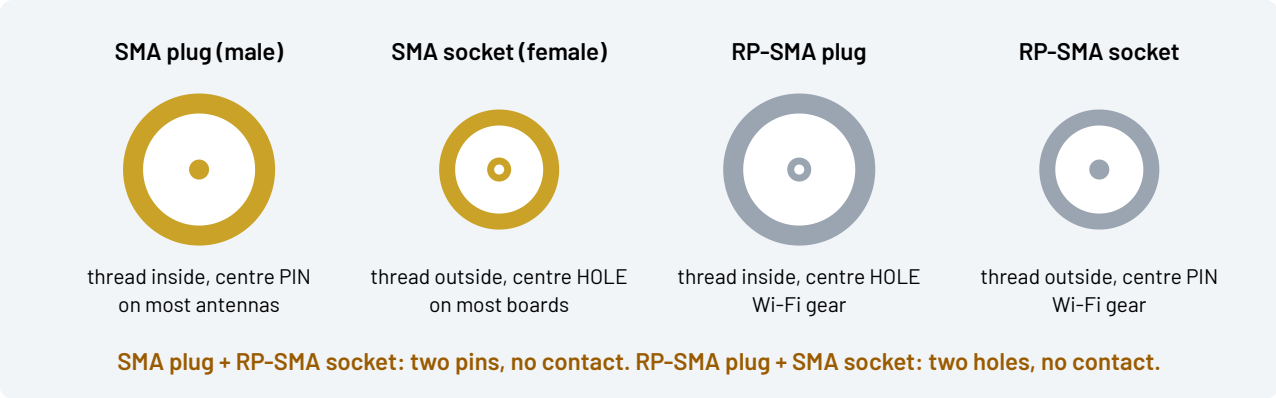
Worked example. A repeater with 10 m of RG58 up a mast to a 5.8 dBi collinear loses 5.4 dB in the cable. Moving the radio to the top of the mast, with a 30 cm pigtail, saves about 5 dB each way. That's more than tripling the power reaching the antenna, and the same gain on every signal it receives.

CHAPTER 10

Connectors: U.FL, SMA, RP-SMA and N

Most "it doesn't work" problems with a new antenna are connector problems: the wrong gender, the wrong polarity, or a loose or wet joint.

Connector	Where you'll find it	Points to know
U.FL / IPEX (MHF1)	On the board itself: Heltec, RAK, T114 and others	Tiny push-on socket for a pigtail. Hirose rates U.FL for only about 30 connections, so fit it once and leave it. Press straight down; lever it off with a proper tool, never by pulling the cable.
SMA	The usual antenna socket on boards, pigtails and small antennas	Threaded, small, good to well beyond 6 GHz. Tighten by hand plus a small nip with an 8 mm (5/16") spanner. Don't overtighten.
RP-SMA	Wi-Fi routers and their antennas	Same thread as SMA, but the centre pin is swapped between plug and socket. It screws onto SMA but the centre doesn't connect, so you get almost nothing. Avoid it unless your board uses it.
N-type	Mast antennas, fibreglass collinears, thick coax	Big, robust and low-loss. The right choice outdoors and for LMR-400. Still needs weatherproofing.



Describe each connector by its body (plug with a nut, or jack with an outer thread) and its centre contact (pin or socket). On SMA the plug has the pin; on RP-SMA the plug has the socket. Check the centre contacts before you screw two connectors together.

Adapters and pigtails

- A short **U.FL to SMA bulkhead pigtail** is the normal way to bring a board's antenna out through a case wall. Keep it short and use RG316 or RG178.
- **SMA to N adapters** join a small board to a mast antenna or thick coax. Use one good adapter rather than a chain of them, and support the weight so it doesn't strain the board's socket.

- Thick coax like LMR-400 should never hang off a board's SMA socket. Use a short flexible jumper to take the strain.

Weatherproofing outdoor joints

1. Tighten the connector properly first.
2. Wrap with self-amalgamating tape, stretching it as you go, from below the joint to above it so water runs off.
3. Cover with a layer of good PVC tape to protect it from UV.
4. Leave a drip loop in the cable so water runs off before reaching the connector, and point bulkhead connectors downwards where you can.

Water in a connector raises the loss slowly over months, so a repeater that gets gradually worse often has a wet joint.

CHAPTER 11

Batteries

Almost all MeshCore boards are built for a single lithium-ion cell. Getting the chemistry, connector and temperature right matters, both for your radio and for safety.

Battery types

Type	Nominal	Full charge	Use with MeshCore boards
Li-ion 18650 or 21700 cell	3.6–3.7 V	4.2 V	Ideal. Robust, cheap, high capacity (about 2500–3500 mAh for good 18650s). Use protected cells or a holder with protection, from a reputable brand.
LiPo pouch	3.7 V	4.2 V	Same chemistry in a flat pack. Fits small cases; easily damaged, so pad and protect it. Swelling means replace it.
LiFePO4 (lithium iron phosphate)	3.2 V	3.6–3.65 V	Long life and safer chemistry, but **not** for boards with a built-in Li-ion charger, which charge to 4.2 V. Use it only with a charger made for LiFePO4 and a board that runs from about 3.0–3.6 V.
NiMH / alkaline	1.2–1.5 V per cell	–	Not suitable for the battery connector. Never connect non-rechargeable cells to a charging input.
USB power bank	5 V out	–	Easy for portable use. Many switch off when the load is very small, which a sleeping nRF52 board can cause.

> **Check the connector polarity**
>
> Battery plugs (JST PH 2.0 mm, 1.25 mm and similar) are made with the red wire on either side. Plugging a reversed battery into a board can destroy it instantly. Compare the + and – marks on the board with the battery's wires before you connect, and swap the pins in the plug if needed. Never cut both wires at once.

Built-in chargers

Most boards charge a Li-ion cell from USB, and some from a solar input. For example, RAK's data sheet for the RAK19007 base gives a 4.2 V charge voltage, a 350 mA charge current, a 3.3–4.3 V battery range and a 5.5 V absolute maximum on the solar input. A 350 mA charger takes many hours to fill a large pack. That's fine for a repeater topping up all day, but worth knowing if you expect a big battery to recharge overnight from USB.

Temperature

- **Never charge lithium cells below 0 °C.** This applies to LiFePO4 too. Charging when frozen plates lithium metal inside the cell, which damages it permanently and can make it unsafe. Simple board chargers don't check. Seeed's T1000-E, for example, specifies charging only between 0 and 45 °C.
- **Heat ages cells fast.** A sealed box in full sun can get far hotter than the air. Shade it, use a light-coloured box and keep the battery away from the warmest part.
- **Cold reduces capacity** for a while. Allow 20% or more extra for winter.

How long will it last?

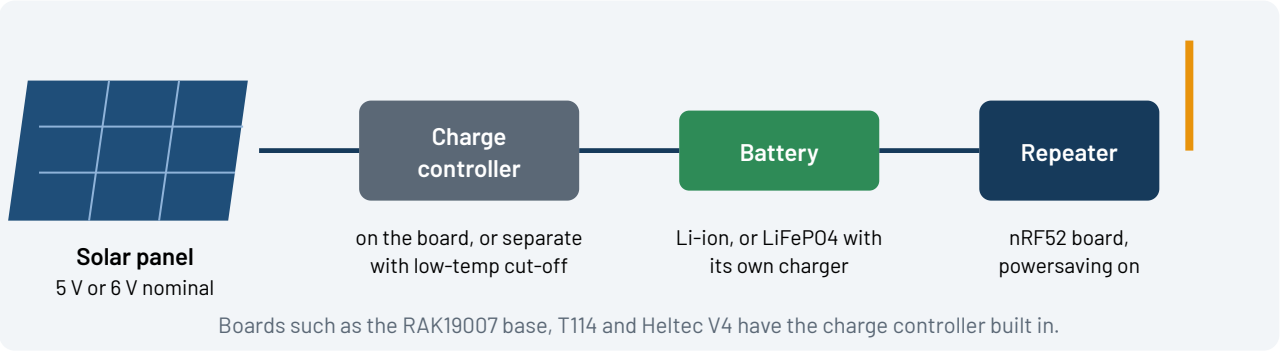
Battery life in hours = usable capacity in mAh ÷ average current in mA. A 3000 mAh cell running a board that averages 50 mA lasts about 60 hours; the same cell on a board averaging 10 mA lasts over 12 days. That's why low-power boards and power saving matter so much (chapter 12).

The best way to know your board's average current is to measure it at the battery, over a day or more of normal traffic. A USB power meter only measures what goes in through the USB socket, including any battery charging, so it only gives a fair figure with the battery disconnected or full. Alternatively, work in average power and allow for the voltage and the losses in the board's regulators.

CHAPTER 12

Solar-powered repeaters

A solar repeater can sit on a hill for years with no mains supply. The trick is to design for the darkest weeks of winter, not for a sunny June day.



The parts of a solar repeater. Everything except the panel and antenna goes in a weatherproof box.

Step 1: work out the daily energy

Measure, or estimate, your repeater's **average** current, including the time it spends transmitting. Then:

daily energy (Wh) = average current (A) × 3.7 V × 24 h

Board type	Average current used here	Energy per day
nRF52840 repeater with power saving (RAK4631, T114)	about 10 mA (estimate)	0.9 Wh
ESP32 repeater without power saving (Heltec V3)	about 50 mA (estimate)	4.4 Wh

These are planning figures, not measurements of a particular board. NoDak Mesh's repeater guide quotes RAK's data sheet as 17 mA for the RAK4631 receiving continuously; power saving lets it sleep between packets. Testers of MeshCore's ESP32 power-saving code reported drops from about 38 mA to 6.5 mA on an ESP32-C6, and about 9 mA on a XIAO ESP32-S3 once asleep. Measure yours, at the battery, with typical traffic (chapter 11).

Turn power saving on with `powersaving on`. On nRF52 boards it takes effect straight away; on ESP32 boards the repeater starts sleeping about two minutes after boot.

Step 2: find your winter sun

A panel's daily output in watt-hours is roughly its rated watts × the "peak sun hours" for the day. These are December figures from PVGIS, the European Commission's solar database, for a south-facing panel tilted at 60° (55° and 50° for the southern US cities), over 2014 to 2023:

Place	December average	Worst December	June average
London	1.57	0.90	4.50
Manchester	1.20	0.93	4.05
Glasgow	0.90	0.67	4.03
Inverness	0.70	0.39	3.97
Seattle	1.81	1.26	–
Chicago	2.73	2.31	–
Denver	5.54	4.93	–
Dallas	4.36	3.00	–

Inputs: PVGIS 5.3 monthly radiation tool, panel facing due south (azimuth 0°). London 51.50, –0.12; Manchester 53.48, –2.24; Glasgow 55.86, –4.25; Inverness 57.48, –4.22 (all 60° tilt); Seattle 47.61, –122.33 (60°); Chicago 41.88, –87.63 (55°); Denver 39.74, –104.99 (55°); Dallas 32.78, –96.80 (50°). "Worst December" is the lowest of the ten December monthly averages from 2014 to 2023, divided by 31. Figures are kWh per square metre per day on the tilted panel, which equals peak sun hours. UK figures use PVGIS-SARAH3 satellite data; US figures use the coarser PVGIS-ERA5 data. Run PVGIS (UK) or NREL's PVWatts (US) for your own site. A steep tilt catches more of the low winter sun and sheds snow.

A UK December gives a panel around a third of its June output, and in a bad December in northern Scotland about a tenth. Monthly averages also hide runs of dark, overcast days, which is what the battery is for.

Step 3: size the panel

panel watts = daily energy × 1.5 ÷ 0.75 ÷ (peak sun hours × 0.8)

× 1.5 adds margin to refill the battery after dull days; ÷ 0.75 allows for charger and wiring losses; × 0.8 allows for dirt, angle and shading.

Place (worst December)	nRF52, 10 mA	ESP32, 50 mA
London	2.5 W	12 W
Manchester	2.4 W	12 W
Glasgow	3.3 W	17 W

Place (worst December)	nRF52, 10 mA	ESP32, 50 mA
Inverness	5.7 W	29 W
Seattle	1.8 W	9 W
Chicago	1.0 W	5 W

These are sizing estimates and minimums. Even the worst monthly average hides runs of several dark days in a row, which is what the battery has to cover. In practice, a **5–6 W panel** is a sensible choice for a low-power nRF52 repeater in most of England, and **10 W** for Scotland, high ground or a partly shaded site. An ESP32 repeater needs four to five times as much, which is why low-power boards are the usual choice for solar.

> **Match the panel voltage to the input**
>
> Board solar inputs are made for small "5 V" panels. RAK gives 5.5 V as the absolute maximum for the RAK19007, and Seeed says not to exceed 5 V on the Wio Tracker L1. A panel's open-circuit voltage is well above its rating, and higher still in cold weather, so a "6 V" panel can exceed these limits. Check the board's data sheet, and use a separate charge controller for larger panels. A built-in charger also limits how much a big panel can put in (350 mA on the RAK19007); a bigger panel still helps on dull days, when it's the light that's short, not the charger.

Step 4: size the battery

capacity (Ah) = average current (A) × 24 × days without sun ÷ 0.8 ÷ 0.8

÷ 0.8 because you shouldn't run lithium flat; ÷ 0.8 again for winter cold.

- **nRF52 at 10 mA, 7 days' autonomy:** about 2.6 Ah, so a 3000–3500 mAh protected 18650 cell, or a protected pack of about 6 Ah for comfort.
- **ESP32 at 50 mA, 7 days:** about 13 Ah, which means a ready-made protected pack of that size.

For a first build, buy a protected Li-ion pack made up by a reputable supplier, with the voltage and connector your board needs, rather than wiring loose cells together. Loose cells with damaged wrappers or no protection can overheat or catch fire.

Step 5: the enclosure

- **IP65 or better**, sized for the board, battery and any charge controller, with cable glands for every cable.
- **Condensation is the main enemy.** A breather vent with a waterproof membrane lets the box breathe without letting rain in; a desiccant pack helps. A sealed box with no vent pumps damp air in and out as it heats and cools.
- **Shade and colour.** A white or grey box in shade runs much cooler than a dark box in the sun. Mount it under the panel if you can.
- **Antenna outside the box** on a bulkhead connector, or a short, good cable. Antennas inside metal boxes don't work.
- **Cold.** For an unattended outdoor repeater, use a charger or battery management system that stops charging outside the battery maker's temperature limits (usually 0–45 °C). A simple charger without a temperature sensor will keep charging below freezing, which damages the cells.

Before it goes up

Run the complete repeater, panel, battery, box and all, in the garden for a couple of weeks, ideally through some grey weather. Watch the battery voltage in the app each day. If it falls over several days, add panel or battery now, not after you've climbed the hill.

CHAPTER 13

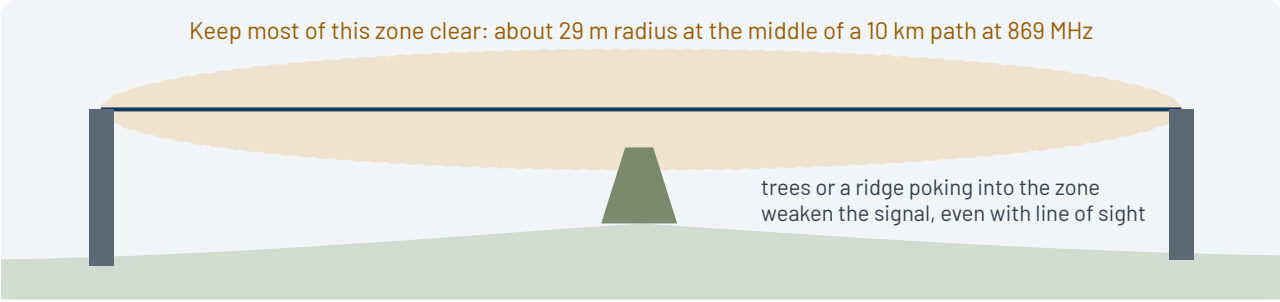
Range, line of sight and planning

At these frequencies, radio waves travel in nearly straight lines. Hills and buildings block them, and the curve of the Earth sets the horizon. Height is what gets you past both.

Why height matters most

The distance to the radio horizon, with normal atmospheric bending, is about $4.12 \times (\sqrt{h_1} + \sqrt{h_2})$ km, with antenna heights in metres. A companion at 2 m talking to a repeater 30 m up has a horizon of about 28 km; two repeaters each 30 m up, about 45 km. That's over smooth ground. Hills and buildings in between come first.

The Fresnel zone



Seeing the other end isn't quite enough. The signal travels in a fat zone around the direct line.

Radio energy fills an ellipse-shaped region around the direct line between the antennas. If ground, trees or roofs intrude on much of it, the signal weakens even though the ends can see each other. Its radius at the middle of the path is about $17.3 \times \sqrt{(d \div (4\,f))}$ metres, with d in km and f in GHz: about 21 m for a 5 km path at 869 MHz, 29 m for 10 km and 42 m for 20 km. Try to keep at least 60% of it clear.

Link budget, roughly

LoRa can decode signals below the noise. A rough receiver sensitivity is $-174 + 10 \log_{10}(\text{bandwidth in Hz}) + \text{noise figure} + \text{the decoding limit for the spreading factor}$. With 62.5 kHz, a 6 dB noise figure and Semtech's SX1262 limits, that comes to about **–130 dBm at SF8** (UK) and **–127.5 dBm at SF7** (USA). Treat these as estimates: real radios, local noise and interference all make a difference, and an urban noise floor can cost you many dB.

The UK settings use SF8 with coding rate 4/8: slower, but more robust than the US settings. As an example, a 60-character channel message from a node with an 8-character name, with a scope and no hops yet in its path, is an 89-byte packet. With MeshCore's 32-symbol preamble, explicit header and CRC, that takes about 0.9 seconds to send on UK settings and about 0.36 seconds on US settings. Longer messages and longer paths take longer.

Planning tools

- **map.meshcore.io** shows nodes that share their position, so you can see where repeaters are.
- **Path profile and coverage tools** (such as HeyWhatsThat, or the Radio Mobile program) draw terrain between two points or estimate coverage from a site.
- **Field testing** beats any model. Walk or drive with a companion, note where messages get heard repeats, and ask others to report what they hear.

CHAPTER 14

Being a good neighbour on the mesh

Everyone in an area shares one narrow radio channel. A few habits keep it working for everybody.

- **Keep tests short and few.** One "test from Leeds" is plenty; repeated pings on a public channel cost everyone airtime.
- **Don't over-advertise.** Send an advert when you join or move, not every few minutes. Leave repeater advert intervals at the defaults unless your group asks otherwise.
- **Set your scope** so local chatter stays local.
- **Coordinate repeaters.** Two repeaters covering the same patch double the traffic for no gain. Ask before you put one up, and give it a sensible name and owner info.
- **Use the right power.** More isn't better on a shared mesh: it just widens the area your transmissions take up. In the UK it may also be illegal.
- **Think about privacy.** Don't put your home address in your node name, and think before sharing an exact position. Your node name and timings are visible to anyone.
- **Keep your firmware reasonably current**, especially on repeaters, so the network can use new features.
- **Remember it's not an emergency service.** In an emergency call 999 or 112 in the UK, 911 in the US.

CHAPTER 15

When it doesn't work

Problem	Things to check
Computer won't see the board to flash it	Another USB cable (many only charge), another port, the bootloader buttons, and that no other program has the serial port open. Use Chrome or Edge.
App can't find the radio	Bluetooth and nearby-device permissions, that you flashed the BLE companion firmware (not USB), and that no other phone is connected to it. Restart both before resetting anything. On a Heltec V3, hold the phone close.
Nothing heard at all	All four radio settings, especially after flashing or an update; the antenna is fitted and for the right band; try outdoors or higher up. Check the map for nearby repeaters.
You hear others, but get no replies	Your scope, transmit power and antenna. A distant repeater you can hear may not hear your smaller radio.
Channel messages go nowhere	The exact hashtag spelling or the private key, and your scope.

Problem	Things to check
Direct messages don't deliver	That you've both saved each other as contacts. Then reset the path so the next message floods.
Repeater goes "deaf" after a while	`set agc.reset.interval 4`, as the FAQ suggests. Check for nearby interference and a wet connector.
Range got worse over months	Water in a connector or coax, a loosened antenna, or a dying battery. Check the battery voltage history.
Solar repeater dies in winter	Panel too small or shaded, battery too small or too cold to charge, or power saving off. See chapter 12.
Board reboots under load	A weak USB supply or cable; use 1 A or more. On battery, a worn or too-small cell.
Over-the-air update fails	Get closer, toggle Bluetooth, restart the phone, re-pair. Use the right file: .zip for nRF52, non-merged .bin for ESP32.

CHAPTER 16

Quick reference and glossary

UK settings

```
EU/UK (Narrow)
869.618 MHz · 62.5 kHz · SF8 · CR8
set radio 869.618,62.5,8,8
set dutycycle 10
500 mW ERP (27 dBm) maximum
```

US settings

```
USA/Canada (Recommended)
910.525 MHz · 62.5 kHz · SF7 · CR5
set radio 910.525,62.5,7,5
Power: within the device's
FCC authorization
```

Useful addresses

meshcore.io	Project home, links to everything
flasher.meshcore.io	Web flasher (Chrome or Edge)
docs.meshcore.io	Documentation, FAQ and command reference
app.meshcore.nz	Web app for USB companions
config.meshcore.io	Repeater and room server configuration tool
map.meshcore.io	Map of nodes that share their position
shackwiki.com/meshcore-uk/ and /meshcore-usa/	Power and airtime checker

Glossary

Advert A broadcast announcing a node's name, key and, optionally, position.

Airtime Time spent transmitting. Limited to 10% an hour in the UK.

BLE Bluetooth Low Energy, the link between phone and companion.

Bootloader Small program that loads new firmware; DFU mode puts the board into it.

Companion Your personal MeshCore radio. Doesn't repeat.

CR	Coding rate: how much error correction each packet carries.
dBi / dBd	Antenna gain compared with an ideal point source / a dipole. dBd = dBi – 2.15.
dBm	Power compared with 1 mW. 20 dBm = 100 mW, 27 dBm = 500 mW, 30 dBm = 1 W.
Direct routing	Sending along a known path instead of flooding.
Duty cycle	Share of time a radio may transmit.
EIRP / ERP	Radiated power compared with an isotropic antenna / a dipole. ERP = EIRP – 2.15 dB.
Flood	A message every repeater passes on once.
LoRa	Semtech's long-range, low-data-rate radio modulation.
nRF52840 / ESP32	The two processor families used on most boards.
OTA	Over the air: updating firmware without a cable.
Path hash	A repeater's 1–3 byte ID, added to packets it passes on.
Repeater	Fixed node that relays packets for others.
Room server	Node that stores posts for members to read later.
Scope	Region name that tells repeaters how far to carry a flood.
SF	Spreading factor. Higher is slower but reaches further.
UF2	Firmware file you drag onto an nRF52 board's USB drive.

CHAPTER 17

Sources

Checked in November 2026. MeshCore changes quickly, so check the current documentation and your local group.

MeshCore

- MeshCore README and licence: github.com/meshcore-dev/MeshCore
- MeshCore FAQ: docs.meshcore.io/faq (firmware types, supported hardware, flashing, OTA updates, passwords, power warnings)
- MeshCore CLI command reference: docs.meshcore.io/cli_commands
- "Installing the OTAFix Bootloader", MeshCore blog, 6 April 2026: blog.meshcore.io/2026/04/06/otafix-bootloader
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- Heltec, WiFi LoRa 32 V4 and Mesh Node T114 pages: wiki.heltec.org
- Seeed Studio, T1000-E and Wio Tracker L1 pages: wiki.seeedstudio.com
- Meshtastic hardware pages for the Station G2: meshtastic.org/docs/hardware
- Hirose U.FL series specification (mating cycles)

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- Times Microwave coax selection guide (LMR, RG58, RG8X, RG213 attenuation): rfparts.com
- Koax24 RG174 and RG316 comparison (attenuation at 1 GHz): blog.koax24.de
- European Commission JRC, PVGIS 5.3 monthly radiation, 2014–2023: re.jrc.ec.europa.eu/pvg_tools
- Semtech SX1262 data sheet (demodulator SNR limits by spreading factor)

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