

USER DOCUMENTATION

Welcome to the world of BroodMinder

None

None

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1. Home

2. Introduction

2.1 Welcome to the world of BroodMinder

If you're reading this, it's the start of a new adventure. You are now part of the precision beekeeper community. A community that uses information to improve bees' health. But also to improve everyone's practice, thanks to a deeper knowledge of the behaviour of colonies and their ecosystems.

2.2 Introduction to precision beekeeping

In precision beekeeping, the objective is to make the best use of all available data to provide the beekeeper with the right information at the right time. The beekeeper is informed in real time of all the events in their apiary. Those that are taking place at the moment, but also those to come. In this way, one can plan inspections in advance and knows in advance what to expect. The diagnosis is made before the journey to the apiary and completed by the inspection itself.

To achieve this goal, algorithms are our best friends. These are models that analyse the collected information and translate it into "beekeeping language".

Some resources on precision beekeeping:

- Precision beekeeping Wikipedia
- Precision beekeeping 101

2.3 Overview of the system

The Broodminder system consists of several components. With this very modular system, you can start simply and then expand the use according to your needs.

Here in a few words are the main components of the system.

BroodMinder Sensors

Weight, temperature, humidity sensors... A complete and at the same time modular range of devices that enable you to equip your hives according to your needs.



All the sensors transmit the information via Bluetooth and, of course, you can use your smartphone to collect this data. Simply download the BroodMinder Bees App from your favorite store (Apple or Android).

BroodMinder Bees App

The 4th generation app for your phone or tablet is called the "Bees" app and is available for iPhone or Android. This is the quickest and easiest way to start collecting data from the sensors. Use it in the apiary to locate the sensors and to take hive/apiary notes by either typing or speaking to the phone. With the app you can collect and review the data regardless of if the apiary has cellular or WiFi connectivity. The app will then automatically synchronize with MyBroodMinder.com, our cloud based analysis system. when internet becomes available.



MyBroodMinder.com

The data transmitted by your phone or by the hub arrives on the Mybroodminder.com portal. In this space, you can configure your apiary, your hives and assign your sensors to them. You can also visualize the raw data on fluid and interactive graphs. A New

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sensors and transmits them via the 3G/4G cellular network or WIFI to the cloud, where they are processed.



Hub

For those who want real-time data, the Hub is the solution. This autonomous box must be installed in the middle of the apiary. It automatically reads the information from all the

MyBroodMinder.c

2.4 And the adventure begins!

We hope that this first round makes you want to continue discovering the full potential of the system. Each brick that makes up the system has its own features and you will explore them in greater depth as you go along.

Hub

3. Quick Start Guide

We've done our best to make the installation and use of your BroodMinders intuitive and easy. Follow the process below to get to grips with all aspects of the solution (Sensors, App and Web...) and you'll have every chance of success.

Each step is described in detail later in this document.

AT HOME		
1.	\mathbb{T}	Install the App
2.	$\stackrel{\bigcirc}{\sim}$	Create your account
3.	(Power your devices
4.		Assign to a hive
5.	\Box	Make your first sync
6.		Power on Hub

AT YOUR APIARY		
7.		Install devices in hive
8.	()-()	Install your hub
9.	С	Update starting dates
10.	Q	View and explore

3.1 Before you start

Take note of the following best practices:

Set-up everything AT HOME

Make sure the system is functional before installing it in the apiary, then it will be less easy to set up.

ng your hives

Do what it takes to identify your hives, it will be much better. 1, 2, 3 A, B, C ... K254.

e our video library

Watch the video help "Quick Start with CS Kit"

Need help?

You can always contact us at support@broodminder.com.

3.2 START AT HOME



Download Broodminder Bees from your preferred store. Scan this QR code to be headed to it :





2. Create your account

Create your account into the Bees App. A single account for everything : App and Web MyBroodminder.

In BeesApp, on the Apiary tab, create your first apiary and your first hive, they will be needed for the next steps.



Download Broodminder Bees from your preferred store. Scan this QR code to be headed to it :





Create your account into the Bees App. A single account for everything : App and Web MyBroodminder.

In BeesApp, on the Apiary tab, create your first apiary and your first hive, they will be needed for the next steps.



In Bees you have several tabs that we will navigate :



Create your first apiary with ... > New apiary



Create your first hive with Hives > New hive

15:02 📩 🗇 生 🔹 🏩 🛱 💷 16% 🚊 🗊 First Apiary ... + New Hive å 👫 J Ø 8 Д 1 Create or select Hive Ð ((1) တ္ပ ø ଡ୍ଡି Manage Hives User Setting Apiaries

We can now move on to assign sensors to this newly created hive. But first we have to power on devices.

U 3. Activate your devices

In general all our devices have a pull strip. Older models (T2) might have a push button.



this:

With any device, pulling the tab should make the board blink. If you do not see any blink, push the batteries against the + contact. Sometimes the battery holder can be stiff and avoid the spring to push them through. (mostly for AA batteries)

Do not discard any plastic part. Keep them all in place.

Check that all seals are properly installed.

Verify that cable glands are tight too when appropriate.

Chderstand device model

All BroodMinder sensors have a 6-digit reference number in the form XX:XX:XX. The first two digits of this reference define the model:

• 41, 47 : T

- 42, 56 : TH
- 43, 57 : W
- 49 : W3 et W4
- 52 : SubHub
- 54 : Hub
- 58 : DIY

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• 63 : BeeDar

4. Assign devices to hives

First you need to claim the device by clicking on the green Claim button found in the Devices tab. This operation will associate each sensor you claim to your account . You will then be asked to attach the sensor to a hive. You can proceed or cancel and come back later via the menu

Attach each device to a hive.





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Move to another hive	
Apiary	
Select Apiary	
Hive	
Select Hive	
Location	
Select Position	
Start	
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Save	

Available device positions are

Position	typical use
Lower brood	TH or T into the lower brood box
Upper brood	TH or T into the upper brood box
Inner cover	TH or T under the cover
Scale under hive	full weight scales like W3, W4
Scale under hive (back)	half weight (bar) scales like W and W5
Beecounter	Beedar
Outside Hive	beekeeper's choice
Other	beekeeper's choice
Custom [1-7]	for research purposes (multiple devices)

Evice location is important

Carefully select position for internal sensors. Some metrics like brood are only computed if the device is assigned to the brood location.

Now return to the $\ensuremath{\mathbf{Apiaries}}$ tab to perform the first sync.

5. Make your first sync

Using BroodMinder Bees App there are multiple ways of syncing:

- Multi-Sync is at the top of the screen in the Apiaries tab. This syncs all devices at once and is a Premium feature.
- Single Sync is within the 3dots ... menus, either in Devices or in Apiaries tab

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You can only sync devices appearing in green (within bluetooth range)



Now look to your data using ... > Show Graph or ... > Show Details.



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On your first sync you probably do not see much data since there is only one or two samples.



6. Power-On your Hub

This stage is intended for those owning a Hub for real time monitoring. If you do not have a Hub, move to the next chapter. Remember from Hubs page that there are several hub versions:

- Broodminder-T91 Cellular Hub [solar, weather, naked]
- BroodMinder-Wifi Hub
- BroodMinder-Sub-Hub

6.1 Cellular Weather hub

- 1. Remove the orange silicon protection
- 2. Power ON the hub with the small black switch (use a pen tip to operate)



- 1. Color Leds will blink green, then blue, then green again
- 2. Check on Bees App that transmission has been established. Go to Devices tab > Hub ID > Show details > MBM last upload shall display current date/time.



1. Install orange protection again, starting from the USB side.



1. Insert the T91 within the weather shield with the USB face sidewise to avoid condensation deposition on this and the opposite face.



6.2 Cellular Solar hub

Follow the same process as above, with the difference that you will have to plug in the USB to the battery (we ship unpluged to avoid battery discharge during transport)

- 1. Unscrew the cover lid.
- 2. Insert the USB plug into the battery
- 3. Slide the power switch to the right



1. Hub will start and you can check data transmission using Bees App as described above.

3.3 NOW MOVE TO THE APIARY



7. Install devices in hives





Internal sensors

Install BroodMinder-T (model 47) and -TH (model 56) on the middle frame (usually no. 5), starting on the left-hand side as seen from the front of the hive. The identifier at the end of the tab should protrude so as to be visible from the front of the hive.



Scales

Place your BroodMinder-W scale preferably at the back of the hive. Make sure the hive is as level as possible. BroodMinder-W3 and W4 scales do not require precise levelling.



Beedar

The BeeDar is mounted on the front of the hive, centered on the hive axis. The height from the flight deck is just right to allow you to handle the entrance reducers without worry. Typically 5 to 7 cm above the floor.

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Beedar has a horizontal "view" angle of 85° and a vertical angle of 30°. You can hang it with two 4mm-diameter screws.

8. Install your hub

This stage is optional : only intended for those owning a Hub for real time monitoring.

As a general rule for any kind of hub you should know that overall range for Hub <=> internal devices is \sim 10 meters (30ft) - overall range for Hub <=> external devices is \sim 30-40 m

Important

• hubs should be located at least at 1.5m height from the ground (Cellular and Wifi reception damps A LOT when close to the ground)

avoid direct sun exposition



There are multiple ways to install the hub - solar versions can go on a pod or mural or even on hive



• other cell versions and SubHubs install nicely within the weather shield



Now check Connectivity - Check hub connectivity with Bees App (in the devices Tab > hub ID > ... > Show details) - You should have a Network signal greater than 20% to be comfort.

9. Update start date/time

To avoid having measurements from outside the hive, change the start date of the sensors. To do so, go to BeesApp > Apiaries > unfold the hives to see the sensors > "..." > Change the current position. Edit the start date/ time.

J 10. Explore and discover

Now you can also go to MyBroodMinder.com and explore your data.

Sign in with the same account you created on the Bees App.



In this interface you will be able to follow the brood levels, the weight gains and losses, configure your alerts or even the past and forecasted weather as well as the nectar-flow indexes and much more!

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Attention: Some data is computed daily and you will begin to see it from D+3 (D1 does not count because partial data, D2 will be the first complete day which will be posted the following day => D3)

4. Broodminder-BEES App

4.1 Overview

This section contains the nuts and bolts of using the app. There is a brief introductory video that you can also watch.

We have released a major update in June 2024 with numerous new features. We recommend exploring the app, reading the manual, and watching our videos to understand the extensive range of features available to you. Our development team are all beekeepers so we have added many features that we love and know you will love too.

- One touch reading of all sensors within range of the phone/tablet
- Apiaries tab displays weather and nectar flow conditions -NEW 2024
- Hives tab displays brood level, productivity, and internal conditions NEW 2024
- Powerful voice powered apiary and hive logbook with predefined tags
- Manage apiaries, hives, and device locations
- Set devices to battery saver mode with 5+ year battery life NEW 2024
- Tightly integrated with MyBroodMinder.com w/automatic sync for remote apiaries which have no internet (cellular) access.
- BroodMinder-SubHub support
- Real-time display of device signal levels
- Read composite device log and assign data to proper BroodMinder devices

Basic operation for a new user

- First Time
- Download BroodMinder-Bees from your app store
- Start the app and enter (or create) your MyBroodMinder.com user ID & password
- Create an Apiary and Hive using the MANAGE tab
- The DEVICES tab will automatically display all BroodMinder devices you own and all BroodMinder devices it detects close by
- Claim your devices and nssign your BroodMinder devices to a location within the hive
- Every Time
- Choose the MANAGE tab and press SYNC. Stored data will read and local and MyBroodMinder.com databases will be updated. NOTE: You can skip this step if you have a Cellular/WIFI/LoRa hub.
- Review your data with the Hives and Apiaries tabs
- Add hive and apiary notes during inspections
- If you do not have internet/cellular connection in your apiary, start the bees app when you return home and it will automatically sync data with MyBroodMinder.

4.2 APIARIES Tab

The Apiaries tab displays information about the selected apiary.



- 1. Notes from the last inspection are displayed in the upper left and expected nectar flow (based on the weathersource.com forecast) is displayed on the graph.
- 2. Note the "+" in the lower right corner. That will allow you to add notes about the apiary. Any place you see that "+" will take you to a new note for your logbook. There is more information about note taking below.
- 3. Weather log and forecast are shown in this screen.
- 4. Apiary notes can be reviewed here.
- 5. Alerts are displayed in the rightmost tab.

4.3 HIVES Tab

We've created the Hives tab to make it easy to quickly see the status of each of the hives in your apiary.



Your hives are listed across the top with the **brood level** and **daily change in weight** displayed. The heart displays the estimated fitness of the hive and the eventual number red dot in the upper right corner of the squared boxes indicates if there are any alerts to be reviewed.



Selecting any hive will bring all of its data to the graph below.

- 1. **Productivity** displays the change in weight after removing any beekeeper instigated changes such as adding or removing a super. Both the daily change (bars) and the cumulative change (dots) are displayed.
- 2. Brood is the estimated brood level determined from the hive internal temperature and external (weather) temperature.
- 3. Alerts make you aware of any items needing attention. Note that the alerts are set up and adjusted in MyBroodMinder under the Configure|Alerts section.



We have included in the Bees app and in MyBroodMinder powerful note taking features. Besides being a useful logbook to track your hives, the notes and tag selections are being used to drive our workflow engine that is under development. Soon we will be using workflows to track hive processes such as swarming and requeening.

1. Hive notes are shown here. Pressing the "+" in the lower right corner will bring up screen 2.

2. You can choose to add an apiary or a hive note.

3. Hive notes will allow you to add notes to one or multiple hives at a time. The tags below will be used for automatic workflow notifications (added soon).

Hint: The note function allows the use of your microphone for easy transcription.

4.4 MANAGE Tab

The MANAGE tab is where you will sync your entire apiary at once as well as move and configure devices. You must have a MyBroodMinder account (free or premium) since your apiary/hive configuration is stored there.



- 1. This screen shows the hives and current values of the sensors. Clicking on the hive will reveal more details about device numbers as shown for hive "Package" above. Note the Sync button at the top, this button will attempt to sync all of the devices in this apiary. You can see the status of the sync in image 2 right below the apiary name. In this case, the sync completed with 7 devices but was canceled before 8 of the 15 devices were completed.
- 2. The ... beside the apiary name allows you to create a new apiary or create new hives in this apiary.
- 3. The ... beside the Hive name allows you do do all the things show above.
- 4. To move a device to a different hive, click the beside device for example 43:e0:07 in image 1.

Hint: Sometimes it works better to sync Hive-by-Hive if they are far apart. You can choose Sync with the ... for each hive. Start the hives close to the phone, you don't have to wait for each hive to finish before starting the next one. Then move the phone to a new position close to the remaining hives and sync again. If you tap on the sync status that appear near the top, it will show more details about exactly where it is in the synchronizing process.

4.5 DEVICES Tab

The DEVICES tab gives you full control of BroodMinder devices which are:

- In your device inventory on MyBroodMinder.com
- and/or seen by your phone via Bluetooth.
- If the device is new, a CLAIM DEVICE button will appear to take ownership
- If the device is owned by somebody else, that will also show on this screen
- Watch the icon to the left of the device, it will indicate "Nearby" when you are withing Bluetooth range
- If the device is "Nearby" it will display the current temperature/battery/weight/etc
- Tap any "!" and the app will inform you of an issue such as low battery or firmware update needed

You can Sync individual devices from this page by pressing the ... beside the device.



Hint: Image 3 show the filter button and it is awesome. It will limit what is shown on this list. For example if you select Nearby, it will show only those device where the phone sees the BroodMinder. Then if you refresh the screen (pull down in iOS or Android) it will clear the list and then fill it back in as it see the Bluetooth signal from each BroodMinder. This is a great way to verify your BroodMinder is operating.

4.6 USER SETTINGS Tab

The settings tab allows you to customize your Bees app. It will display the users account as well as a few items which can be modified.

Note that if we wish to update the firmware in your devices the "Show available firmware updates" must be selected. This toggle defaults to off unless a mandatory update is required. You can update your older devices in order to utilize the new (2024) battery saver features discussed below.



4.7 Battery Saver

We recommend watching the video and reading these notes to fully understand battery saver.

You can extend the sensor battery life to 5+ years in two ways.

- If you have a hub (SubHub, Cell, WiFi, or LoRa), you can set your devices to reduce advertising. This will add a year to your T2 and -TH2 devices and 5+ years to your -W devices.
- Since swarms only happen during daylight hours and during part of the year, several years of battery life can be gained by reducing the detection time.

Note: If your devices are 5 years old or newer, you can update the firmware in the device using the Bees app. To enable updates, select "Show available firmware updates" in the User Settings screen.

- 1. Choose "Enable/Disable Battery Saver" to manage this option.
- 2. Once on the Battery Saver Screen, the Bees app will search for any BroodMinder devices that it can control. Note that you must be within Bluetooth range to configure the device. It will only display devices with firmware which supports battery saver. To see all of your devices within range, press "Include Ineligible".
- 3. Setup will let you adjust Battery Saver settings to best suit your purposes. Note that an estimated life for different BroodMinder devices is calculated and displayed based on your settings. Select "Hub Present" if you own a hub and set when you want to detect swarms.
- 4. Once the setting are adjusted, return to screen 2 and press "Enable/Update". As the devices are configured, the icons to the left will indicate battery and/or scheduling enabled (green with check).
- 5. To turn off battery saver features, press "Disable". NOTE: It may take up to 10 minutes to shift devices from hub mode to normal because the devices "sleep" for 9.5 minutes between advertising.

Here are more details for the interested student.

BroodMinder -T2 and -TH2 devices transmit their current condition via "advertising pulses" every 5 seconds. Transmitting this data 24/7 is the major energy use for the system. If you have a hub in the apiary, it "listens" for these pulses every 10 minutes. If

the data is only changing once per hour, then we only need to have the devices advertise for 10 minutes per hour extending battery life for 12-13 months.

The -T2 and -TH2 read data every 60 seconds and watch for temperature events (swarms). This is the next largest energy consumption. When not detecting events, one hour sampling is adequate. So, by limiting the time one minute data is collected to the time swarms are likely, we can extend the life much longer. For example, battery life for T2/Th2 is 5.6 years if we only detect from May-August and from 9am to 4pm and have a hub present.

BeeDars also benefit from limiting swarm detection. While watching for swarms, the radar samples for 30 seconds in order to get an average and more accurate value. at night we can reduce this to 3 seconds and still see activity, but save a lot of energy.

Our weight scale devices transmit adverting pulses every one second. With a hub available, we reduce that to every 5 seconds and extend the battery life from 2 to 8 years for the -W and from 5 to 20 years for the W3.

4.8 SubHub Devices

SubHub devices are a bit special since they are listening to all of your nearby BroodMinder devices. When you press the three dots by a SubHub, this menu pops up



SubHub Details

This page is where you control the SubHub. You can sync all of the data and you can view live data from here. See the next pages for more detail

SubHub Details

This page is where you control the SubHub. You can sync all of the data and you can view live data from here. See the next pages for more detail



means you should see them all show up here if your close enough. It will also show any Bluetooth Low Energy (BLE) device in range if you uncheck the BroodMinder Devices Only box

-	oaminaer Devic	les Only	Uncheck this to see non-BroodMinder devices
Signal	Device	Timestamp	
34% 74% 72%	47:00:00 49:02:11 49:02:19 57:00:01	9:45:25 AM 9:45:26 AM 9:45:26 AM	The Timestamp will update every time it sees the device
78% 88%	57:02:C7 57:02:F4	9:45:27 AM 9:45:27 AM	Every time you start/stop it clears the list
		/	
		/	
		/	

SubHub Show All Devices

When you set up your SubHub, you can use this display to know exactly which devices your SubHub sees. All BroodMinders advertise every 5 or every 1 second. That **Hint**: This is an especially useful page to use when optimizing the position of your SubHub. It is handy even if you do not sync with your phone. You will see what devices are being extended to your remote hub device.

5. MyBroodMinder Version 5

5.1 Overview Quick Tour

There are many great features available in MyBroodMinder to view and analyze your data. Please note that there is a lot of context help by either hovering your cursor over an item or clicking the ? next to an item.

We have updated the video library for Version 5.

The quick tour is pretty long. There are a lot of useful features. Let's start by describing the functions available to you.

The best way to learn is to read this guide while looking at your MyBroodMinder account.

Note that some features are for MyBroodMinder premium users. The feature breakdown is here. We discuss more about Free and Premium at the end of this chapter.



HIVES

Home Screen

=	richm@pa-qus.com								
K ft Home		Hives					Apiaries		
New Configure	Name	Date	Rees	Brood	Weight	Productivity	Alerts	Notes	Навич
Multi-Select 🛞	MyAplary > My First Hive	Wed 31						8° 15°	0

Here you will find a quick glanceable view of all the hives that you own. Hives are shown here if you have sensors currently assigned in the hive. Learn more about device assignment and configuration here.

	н	ives				Apiaries		0
Name	Date	Fitness	Brood	Weight	Productivity	Alerts	Notes	History
Gelos > <u>R1</u>	Yesterday		68%	28.35 kg	-0.24 kg			Ð
Gelos > <u>R2</u>	Yesterday		76%	32.34 kg	-0.24 kg			Ð
Gelos > <u>R5</u>	Yesterday		51%	31.84 kg	-0.01 kg	ß		\$
	Sat 22	•	53%	31.9 kg	-0.14 kg	A h h		
	Fri 21	•	54%	32.12 kg	0.58 kg	h		
	Thu 20	•	56%	31.5 kg	-0.99 kg	A		
	Thu 20						P	
	Wed 19	•	58%	32.54 kg	0.08 kg	h		
	Tue 18	•	61%	32.35 kg	0.01 kg	Ro		

At a glance information shown here:

- Fitness Daily hive fitness state, learn more here
- Brood Daily brood level, learn more here
- Weight Daily hive weight
- Productivity Daily hive productivity, learn more here
- Alerts
- Notes

Click the History icon on the right to view this data for the last 7 days for each hive.

APIARIES

Here you will find a quick glanceable view of all the apiaries that you own. Apiaries are shown if they have hives with currently assigned sensors. Learn more about apiary, hive, and device assignment and configuration here.

Hives										Apiaries								
Gelos																		
Foraging Idx	19	24	88	74	100		46	44	32	73	100	100	100		47	79	100	
Nectar Idx			20	25	32		9	8	3	24	44	49	52		11	20	31	
Notes																		
Alerts	1																	
Weather	\bigcirc	\bigcirc	\bigcirc	\bigcirc	\bigcirc	Ģ	Ģ	\bigcirc	¢		\bigcirc		¢	Ģ	\bigcirc	\bigcirc	\bigcirc	
Min Temp	5	5	7	9	8	9	9	8	12	12	12	13	14	12	9	11	10	
Max Temp	16	16	21	20	23	15	18	18	17	20	24	24	24	14	18	20	22	
Wind	13	8	12	15	17	12	22	18	12	11	10	10	23	21	12	13	14	
Rain						8	11		8		1		5	15	2			
Mo	n 17	We	d 19	Fri	21	Su	n 23	Tue	e 25	Thu	u 27	Sat	29	Ma	n 1	We	d 3	

At a glance information shown here:

- Foraging Index learn more here
- Nectar-Flow Index learn more here
- Notes
- Alerts
- Other basic weather readings

Left Sidebar - Choose which hives to view

The left sidebar is your key to navigating your apiaries and hives as well as apiaries shared with you by your friends. There is a lot of functionality built into this menu. Explore by clicking around.


- \bullet Clicking on > opens up hives in the apiary and devices in the hives
- Hovering over a BroodMinder device will display the ID number
- ...
- Apiary Edit apiary info and location, add hives, share with friends, add apiary notes
- Hive Edit hive information, color of graph trace, move to new apiary, add BroodMinder devices, get link to BeeCounted.org, add hive notes
- Device Edit device name, adjust/move device location
- Multi-Select is a powerful feature that lets you overlay data from many different hives and apiaries. If you want to focus on one hive at a time, turn it off.
- When you click on an Apiary, it will display the hives in the apiary and bring up the data in the main window. Click it a second time and it removes the data from the view.
- Clicking a second apiary will add the hives to the view. Notice that the hives which are displayed are underlined. The color of the underline is the color of the graph line for that hive.
- Clicking a hive will toggle it to display or not display.
- The small X to the right of Multi-Select will clear all of the hive displays.

Dashboard - Choose how to display the data

The buttons at the top of the view window let you chose how to display your information. We provide some standard views that we believe are useful. You can also add custom view to include many new analysis features.

- New
 Configure
 Calendar Weather MyQuebboard +
- Classic
- Calendar
- Weather
- You can create your own custom displays using the +
- Sensor readings
- Weather
- Analysis
- Maps and images
- Note The v to the right of the notes section will expand the text of all of the notes within the timeframe shown. There are many powerful note features discussed below.
- to the right of the dashboard buttons
- Create sharable link This is a powerful feature. Once you get the display looking like you like it, you can create a browser link to share with anybody, even if they do not have a MyBroodMinder account. You can choose a fixed timeframe to share, or a variable timeframe such as the last 2 weeks. When you share it this way, it will always bring up the newest 2 weeks of data. You can also add a description which will display at the top of the graph.
- Download You can download the BroodMinder data, the weather data, and/or the notes to a CSV (Comma Separated Variable) file.
- Notice all the BroodMinder IDs of devices in the graph are identified at the very bottom of the view. If you click one, it will take you do the data graph for that device. In that view you will see all of the data for that device no matter where it has been installed.

ä

Graph Controls



controls available to get your reports looking just right.

- Time Range Using the dropdown menu at the top, Last 7 days , you can chose the duration of the display
- Change the height of each individual graph using the = on the left of the window between the graphs.
- Turn individual graph lines on/off by clicking the legend below the dates
- Highlight the line of a graph by placing the cursor directly over if. The other graph lines will dim.
- Tools to the right of the graph
- Zoom time scale click the horizontal tool, then drag the cursor over the region of interest while holding the left mouse button. Un-zoom by clicking the tool again.
- Zoom vertical click the vertical tool, then drag the cursor over the region of interest while holding the left mouse button. Un-zoom by clicking the tool again.
- Clicking the yellow hive tool will hide/unhide hive notes
- Clicking the red hive tool will hide/unhide the apiary notes
- Clicking the bell tool will hide/unhide the alerts

Adding Notes

There are powerful new note capabilities in both MyBroodMinder and the Bees app. You can use the Bees app to add notes in the field, and then edit or add additional notes when you review them in MyBroodMinder.

5.2 Managing

New

Note that we recommend setting up your apiaries, hives, and devices using the Bees app. The Bees app makes it easier to assign the devices.



The most simple way to add a note is to double click on a graph at the time you want to add a note. An editor will pop up. You can enter text and you can also add tags. Once you save the note it will show up on the graph as a hive tool.

You can also add a note for the entire apiary such as Performed OA treatment on all hives. Do this by clicking the ... to the right of the apiary in the side bar and choosing add note. This note will display in all hives.

New

Note that we recommend setting up your apiaries, hives, and devices using the Bees app. The Bees app makes it easier to assign the devices.

<	🔒 Home	
	🛨 New 🌼 Confi	gure
	Apiary	⊗
	▶ 📋 Hive	•••
	Device	•••
	။ Custom Dashboard	 ×
	🗸 🥒 Apiary Note	•••
	Hive Note	
	Russialis	
	-×	

Apiary

When you add a new apiary to your setup you will name it and give it a location. We only track location by zip/postal code in order to preserve privacy. You can also set a default color for the graphs related to this apiary. This color will be used for the weather display of this apiary

Hive

It is easiest to add the hive using the ... to the right of the apiary. This automatically enters the apiary as the location. When you add a hive, you can give a name and a color for the graphs related to this hive.

Device

it is easiest to add the devices using the \ldots to the right of the hive. This automatically enters the apiary and hive as the location. You will need to select the location of the

device in the hive. You can not have two devices in one location. We include several custom locations if you want to do your own thing.

Custom Dashboard

You can create a number of custom dashboards. You can drag any or all of more than a dozen widgets and place them in your preferred order. This allows you to create reports exactly how you would like them. (Amanda and Lorenzo did a great job on this feature.)

Apiary Note

Apiary notes are assigned to all hives in an apiary. You will notice that the choices for tags are different than for hives. These notes will show up on the graph with the red hive tool.

Hive Note

Hive notes are not shared across an apiary. I suppose this is pretty obvious. Once you create a note, it can not be assigned to a different hive. These notes will show up on the graph with the yellow hive tool.

Configure

Once you have apiaries/hives/devices added, you may need to move or delete them. All of this can be accomplished in the Configure screen.

	≡ MyBrood	richm@pa-qus.com	:	
<	A Home	Configure		
	New Configure Multi-Select	Apiaries		~
	~ MyApiary …	Hives		~
	> My First Hive ···· > 🔅 Weather ····	Devices		~
	 중 54:00:12 ✓ Walnut bank 2023 [≜] 	Hubs		~
	Georgian Italians Russians	Third Party Devices		~
	🔅 Weather	Public Links		~
	New Features	Dashboards		~
	Support	Alerts		~
	BeeCounted	My Subscriptions		~

Apiaries

Here you can update your apiary. You can also set it to hide which will remove it from your Left Sidebar but keep the data. Deleting the apiary will remove all traces of it. Both of these changes can not be reversed.

You can also add a local source of weather information in the apiary. By default, we retrieve weather information from weathersource.com based on your postal code. You can replace this with a BroodMinder device that is in your apiary. You can use any of our devices which broadcast temperature and/or humidity values.

Hives

Hives can be configured and moved between apiaries, set inactive (data remains), or deleted (data is destroyed). From this menu you can also display which and when BroodMinder devices were installed and removed.

Devices

The devices section will display every BroodMinder device that you own. Note that you can sort this list by clicking the headings and you can filter the list to display only certain types. You can also download a CSV file that lists every device shown. This can be handy for taking care of inventory and battery replacement.

If you sell your device or give it to another beekeeper, you will need to delete it from your account. We only allow one owner of a device at a time for data management reasons.

If you reach out to support, we can rename your device (the "mac address") and then you can keep the data.

Hubs

If you own hubs, they will show up here. Hubs will send any data they receive from any apiary, but if you want the hub to show up in the Left Sidebar correctly, you must assign it to the proper apiary.

This is also where you manage and assign tokens which are required for real-time updates. See the Managing tokens section for more information on this.

Third Party Devices

Third party devices are sensors that are not made by BroodMinder. Currently we support YoLink sensors. They are managed in this section similar to the Devices section. See the Third Party section of this manual for more information.

Public Links

The public links feature is a powerful feature of MyBroodMinder. Once you start making them it can be difficult to keep track of them. You can do that here. You can change the notes and graph timeframe of the link.

Dashboards

Version 5 is all about dashboards and this is where you control them. You can hide any dashboard and/or duplicate and modify them quite easily.

Alerts

There are almost 30 events from hives, devices, & weather that can trigger an alert. In this section you can adjust the thresholds of these alerts and disable any that you do not want to see. It is important to note that you must enable the Alert Summary Email (at the top of this section) to enable alerts.

My Subscriptions

We wish everything was free, but we want to stay in business and keep paying our bills, so we ask for and appreciate your help. The more advance features, the ones that take a lot of programming work, come at a cost. Here is where you can keep track of your contributions to sustaining the effort.

5.3 Sharing

From MyBroodMinder you have many options to share your hives with other beekeepers and friends:

With another user

 you can share an Apiary (in the Apiary ... > share) with another Mybroodminder user simply enter his/her account email. Acces is granted per apiary, in read only mode. They will see apiary and hives but not devices.

With another user

• you can share an Apiary (in the Apiary ... > share) with another Mybroodminder user simply enter his/her account email. Acces is granted per apiary, in read only mode. They will see apiary and hives but not devices.



× Gelos Sharing
Share apiary to MyBroodMinder user
MyBroodMinder Users 🛛 🕂
Enter Email mynewbeekeeper@friends.com Share
× · · · · · · · · · · · ×
Share apiary to other sites BeeCounted.org
Hives shared to other sites 🗸 🗸

On beecounted

 you can also share an apiary beecounted.org (in the Apiary ... > share, see above). By default, all free acounts are sharing on beecounted.



With an URL

 you can share a dashboard (in the Dashboards ... > share): this produces an URL and anyone having it will see your dashboard. You can post it on social networks too. When creating the url you will notice that you have some choices : which hives to share, what time frame, frozen or continuous etc..



Educational Dashboards

 And Last but not least, there's a fourth and the most classy way to share your hive : Educational
 Dashboards This is a big screen mode for associations, schools or corporations that are willing to display their bees to colleagues and fellows. Send us an email to support@broodminder.com to know more about this service.



Educational Dashboards are fun!

5.4 Models & algorithms

In this section, we will discuss the more technical aspects of Mellisphera's way of functioning. We will thus present the different models - BFIT, BFORCE, BWEIGHT - as well as the WEATHER sources and ALERTS.

Colony Health - BFit

BFIT for Bee Fitness is the algorithm that informs the beekeeper of each hive's condition. We use benchmarks such as the time of the season and the surrounding hive state in order to define a "nominal" state. Then we position each hive in relation to this reference.

The color code is the following:

color	meaning
Green	Healthy
Orange	Disturbed (declining or with abnormal events)
Red	In trouble
Black	Dead
White	No data or no weather

BFit is based on algorithms that collect events. The 'Learning' algorithm learns from previous events to preserve, or not, future events. Afterwards, it classifies the detected events between those affecting the hive state and the others.

BFit also takes into account the results from BForce. In this way, it can determine the difference between the current hive dynamics and a theoretical brood dynamics that is constantly changing. These theoretical dynamics are regularly updated. It also takes into account the different regions of the world to provide relevant information according to latitude or climate.

Brood level - BForce

Note on Brood Levels

Brood is estimated using internal temperature measurements and other parameters (T2 or TH sensor required). Brood levels are given in percentages. Familiarize yourself with these values in your hives. As a starting point, in a 10-frame hive, 90% brood could mean 9 frames, 80% 8 frames, etc. However, this varies with hive configuration, so learn what these percentages mean for your bees.

Brood development is a key factor for bee colonies. The aim of BForce is to provide an indication of the brood level in the hive on a range of 0 to 100%.

When the colony is at its full capacity, it reaches a stable state of 35° C. This state is associated with 100% brood. This means that the hive is strong.

On the contrary, when there is no brood, the bees do not need to regulate the cluster temperature. In this case, the hive internal temperature will roughly follow the ambient temperature. If this is the case, there will be 0% brood.

Between these two extreme points, we can imagine a lot of intermediate situations.



In order to illustrate this, here are the hourly measurements on two hives from the same apiary. The first is represented in red and the second in grey. Each hive has a very different condition. The red one has an internal temperature close to 25°C/30°C - following the same fluctuations as the external temperature (dotted lines) while the grey one is situated in the famous 'Optimal Brood Zone' with a constant temperature of 35°C.

In this example, the grey hive has a high proportion of brood, contrary to the red one. **BForce correlates this colony characteristic and translates the raw temperature measurement into standardized and understandable information**. The model takes a range of parameters into account to optimally estimate the brood level.

- hive internal temperature
- ambient temperature
- evolution of surrounding colonies
- season, latitude & climate
- other events identified in the hive

BForce is also a **strengthening tool in swarm detection**. In fact, when a swarm has been detected by one of our Machine Learning tools, the brood is impacted by the queen loss and thus the interruption of egg-laying. With BForce, we can classify the different swarms detected.

Comprehensive results

Brood calendars & charts show the daily progress of the brood in each hive. The values vary from 0% (no brood) to 100% (complete brood). Generally, 10% is one brood frame, 40% 4 frames, etc. Depending on your practice and the hive model used (Langstroth, Dadant) you might have to adjust these values. Therefore, **hives with a brood level higher than 80% generally produce honey**. You can visualize the season's history at a glance. The egg laying stops and restarts are clearly visible.



Brood calendar

You can also compare several hives with each other, whatever their apiary.



Annual brood - same hive compared with two others

With practice, we can identify several events on these graphs. We can identify when the egg-laying starts & stops, of course. But we can also detect swarms, bad weather periods that have impacted brood production, the effect of Asian hornets, etc.



Two hive path over a season, with some events

Productivity - BWeight

Having flowers does not necessarily imply nectar - and thus resources for bees. Indeed, many factors condition the occurence of a honeydew: the ambient temperature and humidity, the last rains and their intensity, the root depth for plants such as rapeseed or sunflower. Honeydews are therefore not acquired nor easy to identify. However, understanding them is a basic need for every beekeeper.

A weight sensor installed under a hive provides detailed information on weight gain and loss. However, this information takes into account several factors that are not necessarily related to productivity.

First of all, during the day, weight variations depend on the resources brought in or consumed. But they also depend on the bees' movements: during the day, they are more or less numerous to come out to forage.



In red: when bees get out of the hive In blue: when they bring back nectar In black: dehydration

This is why the hive weight graph shows some "bumps". A bump every day, as you can see in the graph below. On the chart, you can also see sudden weight variations, related to the beekeeper's interventions.



With these facts, we can see that **for a proper productivity evaluation, we must only consider the weight variations coming exclusively from the bees' production**. In this way, external events must be ignored: feeding, swarming, addition/withdrawal of suppers, beekeeper interventions, unexplained loss or gain. The BWeight algorithm makes it easy to identify these distinct events and to exclude them from the productivity calculation.

Gross weight history with beekeeper's interventions in blue

5.5 Weather

For each apiary, several information are presented from several sources:

- apiary weather: typically temperature, hygrometry, rainfall and wind.
- Foraging and Nectar Flow Indexes (see below)
- sources from which these values are derived or computed

The weather data displayed in this space is derived from two main sources:

- 1. By default, they come from WeatherSource. This service provides real-time weather conditions for a given location defined by its country/postal code. The service also includes a 10-day forecast. The current day is indicated by the vertical dotted line. All users have access to this source.
- 2. When the user has defined a local weather source, the data measured by this personal source is also displayed.



On top of the raw weather data we have developed an algorithm translating this information into beekeeping specific metrics. The result takes the form of two indices on a scale of 0-100%:

- Foraging Index (FI): evaluates the atmospheric conditions for bees to forage. This index considers the outside temperature, the hygrometry, rain and wind.
- Nectar Flow Index (NFI) : evaluates the atmospheric conditions for the nectarification of the flowers. Here too, several factors are analyzed in relation to the nectar flow conditions. 0% means that the conditions for honeyflow are not met, 100% that it is damn great. But beware, depending on your climate zone, 100% may never be reached and you will have to be satisfied with lower rates! To validate the forecast range, this algorithm has been developed with apiaries located in various climatic zones (temperate, cold, very cold, tropical...); We ensure you that in some cases it can reach 100% ③

The 10-day weather forecast allows to project these indices over a week and a half. These foraging and nectarflow forecasts are helpful for the beekeeper to identify the relevance of certain actions.

Practical use of the Nectar Flow Index (NFI)

Understanding and utilizing the Nectar Flow Index (NFI) can significantly enhance your beekeeping practices. Here's a guide on how to practically apply the NFI:

1. Monitor Local Blooming Plants: Keep track of the types of plants in your area and their blooming periods. The NFI is only useful if there are plants in bloom.

2. Understand Plant-Specific NFI Thresholds: Different plants have varying NFI thresholds for nectar release. For instance:

a. Rapeseed: Nectar flow generally starts at an NFI > 7 because of the cooler early-season conditions.

b. Sunflower: Nectar flow typically begins at an NFI > 30 during the warmer summer months.

3. Observe and Record: Regularly observe your hives and note when bees start to gather nectar from different plants. Record the NFI readings corresponding to these observations. Over time, you'll identify specific NFI thresholds for various plants in your area.

4. Make Informed Decisions: Use your observations and recorded data to make informed decisions about hive management. For example, if the NFI indicates that nectar flow is likely but your bees are not active, check for other factors such as plants blooming, hive health or local microclimate conditions.

Plan hive movements or resource supplementation based on anticipated nectar flows.

By effectively integrating the NFI into your beekeeping routine, you can optimize nectar collection and overall hive productivity.

5.6 MyBroodMinder-Free vs MyBroodMinder-Premium

We offer both a free and a premium service. We have attempted to establish an equitable and economical system for our wide variety of users.

Our team is self funded and continues to make extraordinary efforts to create and refine the BroodMinder eco-system. That said, we realize the our customers are the ones that will decide if our services are worth the effort.

If you do not desire the premium features, it is still possible to read and analyze your BroodMinder devices.

BroodMinder-Free approach

- Create a MyBroodMinder account
- You will be allowed a maximum of 5 hives.
- If you have additional sensors they are still supported, but can not be assigned to additional hives.
- Devices are read and transferred to MyBroodMinder with the Bees app using the "Devices" tab
- Data/graphs are viewed in MyBroodMinder by clicking on the link in the "Configure | Devices" tab
- You can name devices to reflect their location if you wish
- Note that this approach will also work if you have a paid account to read additional sensors beyond your subscription level.

6. Sensors

6.1 Sensor range

Before getting started let's get familiar with the different devices we will deal with. Every device has a specific ID like for example '56:01:3f' the first two figures (56) are the model ID. In this case 56 corresponds to a Broodminder-TH device.





<section-header></section-header>	Model	Name	Description supports. Tough as nails
<image/>	49	Scale DIY	A do-it-yourself kit for DIY beekeepers.
	63	BeeDar	A Radar to track bee activity during the day.
	52	SubHub	The subHub is both a data hub and a transmission relay.

Product	Model	Name	Description
Rate and a second secon			
<image/>	60	Hub Wifi	Ideal if your hives are close to a Wifi network.
	54	Hub 4G	Optimal connectivity with multi- operator SIM card.

Product	Model	Name	Description
	54	Hub 4G Weather	Two in one: Data transmission AND weather station (temperature, humidity and pressure)
	54	Hub 4G Solar	Endless autonomy with this version boosted with a solar kit.



6.2 Installing your BroodMinder

The Citizen Science Package contains two Broodminder-TH (temperature and humidity) or T2 (temperature only) Devices and a Broodminder-W hive scale. Here is where you install these devices:

The first BroodMinder -TH (**T**emperature and **H**umidity) is placed on top of the frames in the upper brood box. Insert centered from the back of the hive as far as it will go with the tab sticking out.

The second BroodMinder-TH or -T2 is placed on top of the frames in the lower brood box. Insert centered from the back of the hive as far as it will go with the tab sticking out.

Support the back of the hive with an auxiliary support

Place the Hive Scale under the front of the hive with the Device ID label facing to the right as seen from the back. Install on the shady side of the hive.



6.3 Routine Maintenance

There is not much routine maintenance that is required. Please note that if your batteries are lasting less than 6 months, something is wrong and you should contact support@broodminder.com for replacement or refurbishment.

Spring

We have a video talking about spring maintenance on the support page at mybroodminder.com/resources. In the spring, it is a good time to clean up your devices. You can use 91% or better Isopropyl or Ethyl Alcohol, it will not harm the electronics.

You can place the wrappers in the freezer and then propolis will break off more easily.

Ensure that the scale wrapper is not cracked, that will allow rain to harm the sensors. You can seal any cracks with packing tape.

We also have replacem ent wrappers for all the devices on our website at Broodminder.com.

We also offer Refresh service where we replace the housings and batteries and test the devices. This is a very good option every couple of years to ensure that your devices are operating properly. There is more information at broodminder.com/collections/service-warranty/products/ refresh-broodminder-t2

Winter Service check-list

For peace of mind and greater efficiency, we recommend servicing all of your devices at the end of each season. Starting the next season with empty memory devices, loaded batteries and updated firmware will put all the chances on your side.

If you would like us to do this for you go to BroodMinder-Refresh at BroodMinder.com. We will clean, test, add new batteries and housings. If something fails testing, then we will contact you and offer you a refurbished device at 50% the cost of a new device.

Prepare hardware

✓rder some CR2032 batteries to have enough stock

Note

Forget your supermarket and low cost sites where you won't have any quality guarantee. Order a batch of batteries in dedicated shops to get a fair price (about 0,50). Farnell

 \bigcirc ollect all your devices and bring them at home, you want to work comfortable

•Jake a full sync of all your devices with the Apiary App to catch any sample that the hub eventually missed (leave your phone syncing and charging and go for a coffee or two)



T2 Maintenance

Change the battery as described in the video



Start the device



vpgrade firmware as needed



TH Maintenance

Change the battery as described in the video



©pgrade firmware as needed (see above)

W Maintenance

In ange the battery as described in the video using the provided tool to remove the battery



Pull the battery carefully from one side of the holder while pushing the circuit board against the wooden part. This will avoid tou also pull the board out of the scale or breake the holder under too much pressure

Once you're done place the small tool carefully into its original location and avoid any interference if it hosts between the two amovible parts of the scale.

Hub Maintenance

©harge the battery to its maximum using a phone charger with a micro-usb cable



ि।stall any available firmware updates (Broodminder Cell App will tell you)

@fter upgrading the Cell Hub check you have the right APN either hologram or matooma.m2m (into Configure > Diagnostics > Cell Network > Custom APN)

Arning

Remember the battery (older white style, not the new silver battery) has two modes **Always on** and **Auto off** : in the apiary it has to be **Always on**.



6.4 Device Firmware Updates

From time to time we make updates to improve the operation of our sensors. BroodMinder devices use OTA (Over The Air) firmware updates and are very simple to perform.

This procedure works with the following models (model is the first 2 characters of the ID, for example 47:12:34 is model 47)

Model 47,49, 51, 52, 56, 57, 58, 59, 60, & 63

Basic Process

- Update Bees App
- Find and select Update Icon for the device in Bees App
- Press "Update Firmware" or "Sync and Update Firmware"
- Wait and watch for 2-3 minutes
- Verify

Bees App Update

Before beginning the firmware update, be certain to visit the Android Play Store or Apple App Store and update your Bees App. The app will contain the most current version of firmware for all of our devices.

Notification Icon

When you open the Bees App, you may see a symbol beside you device or in the details page. We will show both locations in the images below.



Updating the device

Press the symbol and you will be presented with an update page shown below.



Now you have a choice. There is backup data stored on your BroodMinder device. Updating firmware will place the device in "Factory New" state which removes any backup data. Note: All data that you have already retrieved is safe.

1) If all of you data is up to date on MyBroodMinder, you can "Update firmware without sync". 2) If you are not certain, you can sync and then update. This will take longer since we read the entire data log before updating.

The update process will take 2-3 minutes.



Verify

Once complete, you should see the firmware update icon is removed and the current version is updated.

If it did not update correctly, remove the batteries for 1 minute, replace the batteries and retry the update.

Verify

If you are still having difficulty contact us at support@broodminder.com.



7. BroodMinder TH & T



7.1 Broodminder TH (56)

This sensor measures in-hive temperature and humidity and will also watch for temperature events such as swarms. Based on those informations we will be computing Brood level, hive fitness and a set of specific alerts (hotter and colder limits, excessive humidity...).

The first BroodMinder-TH was released in 2016. It was model 42 and was evolved into TH2 back in 2019. The SwarmMinder (see below) version TH2SM was introduced in May of 2020 evolving to model 56. In 2023 it was evolved to TH3 which is the current version distributed.

Installation

All Broodminder-TH device IDs start with 56 so they should be easy to recognize. The normal placement of the sensor is on top of the frame near the middle of the hive box of interest. This position is chosen for several reasons:

- Heat rises, therefore the sensor will feel the heat of the brood below.
- The brood tends towards the middle of the hive and then surrounds the brood with pollen and honey. Placing the temperature sensor here has the best chance of sensing the brood.
- Using this standardized position allows for cross-hive comparisons across the world.

If you are in a cold climate and you overwinter in more than two boxes, then you may want to move the sensors up to under the inner cover. This is because as the cluster moves above a sensor, that sensor tends to sense the outside temperature (since heat rises).

By placing the Broodminder-TH sensor right below the inner cover, you will sense the heat of the entire hive. Condensation is very likely when it reaches 100% and you may want to inspect the hive and take appropriate action if necessary. Note: Relative humidity (RH) depends both on moisture in the air and temperature. As temperature goes down, RH goes up. A good example is when RH = 100% outside dew forms. The same thing will happen in your hive.

If you move the Broodminder-TH to the top, then you may want to move the other Broodminder-TH to right below the top box. That way you will see as the cluster moves up past this box.

As a final note, the Broodminder-TH is thin enough that if you want to experiment with different positions such as between the frames you can. We would love to know how this works for you and what you learn.

Whatever position you choose, you can add a tag to the data using the Broodminder app. We'll talk about doing that in a later chapter.

Note

Do not forget to adjust the actual date/time you installed the device in hive. It is necessary to start with clean data from the onset, otherwise (if you powered on a few days before) the brood estimation will start with the data from your livingroom!

SwarmMinder

SwarmMinder is a special feature of BroodMinder TH and T. The device is scaning for sudden thermal variations. It enters a decision loop that depending on how in-hive conditions evolve, might end-up trigering a Themperature Event.

See below the details of this feature.

Maintenance

The CR2032 battery is replaceable by opening the wrapper. It should last more than a year and we recommend replacement each fall before the low temperatures of winter.

If your plastic wrapper gets used by time, you can order new ones and replace them during your winter service.

7.2 Broodminder-T (47)

The BroodMinder-T (**Temperature**) is a cost reduced version of the BroodMinder-TH. It will sense the hive temperature which will indicate brood rearing during the season and winter survival during the winter. We will be computing Brood level, hive fitness and a set of specific alerts (hotter and colder limits..)

BroodMinder-T was introduced in 2019 as model 41 and evolved to the SwarmMinder version BroodMinder-T2SM in May of 2020 becoming model 47.

Installation

All BroodMinder-T device IDs start with 47 so they should be easy to recognize. However, they exist in 2 versions :

- Broodminder-T2 with a button (until febr. 2023),
- Broodminder-T3 without button (from febr. 2023 ahead).

For the version with no button, just remove the "remove before use" tag and it will run automatically.

The button version (T2) is a little more complicated. to turn on the BroodMinder-T2, press the button for 10 seconds. **The LED will flash 10 times to indicate success.**

Arning

IF YOU DON'T HOLD THE BUTTON LONG ENOUGH, YOUR T2 WILL SHUT DOWN AFTER ABOUT 10 SECONDS.

If you ever want to know if the -T2 is operating, press the button again, and the LED will flash momentarily to indicate the battery is fine and the device is operating.



The normal placement of the sensor is on top of the frame near the middle of the hive box of interest. See the TH section above for the full explanation.

Note

Do not forget to adjust the actual date/time you installed the device in hive. It is necessary to start with clean data from the onset, otherwise (if you powered on a few days before, the brood estimation will start with the data from your livingroom!)

SwarmMinder

Broodminder-T model 47 also operates with SwarmMinder. Find all the details in the paragraph below.

Maintenance

BroodMinder-T2 : To change the battery, simply cut the tape on three sides around the circuit board. Then swing the board out and replace the battery with a new CR2032. Be sure to seal the circuit board again using packing tape.

7.3 SwarmMinder Details

Swarm Thermoregulation

It is well known that during a swarm event there is a lack of thermoregulation from the colony and that this is reflected by a temperature overshoot like the ones displayed in the following picture:



Fig. 2 – Summary of temperature dynamics during registered swarming events normalised by the moment of maximal temperature (time point zero).

And here is an actual swarm trace:



We can note the temperature peak in the afternoon of May 31st. This peak is detected by SwarmMinder and the SM state code jumps from 25 to 42. At the same time the weight drops down due to bees leaving the hive.

If you want to turn off the T2, you simply have to push long on the button and it will power off. You can double check by pushing again short : the led should not flash.

SwarmMinder algorithm

To capture those events, every SM device (T or TH) is reading temperature once per minute. Then it compares current and prior values looking for specific changes. It watches for a minimum temperature change to be obtained. Once achieved, it watches for a temperature increase of at least 1°C from 30 minutes prior. That increase must continue for between 2 and 20 minutes and be followed by a temperature decrease.

Any time the sensor sees a 2°C (4°F) increase in temperature (when brood is present) then the sensor records the 30 minutes before and 40 minutes after with 1 minute resolution and sets a flag indicating a Temperature Event has occurred. See the data interpretation section for more information.

Note

SwarmMinder delivers Temperature Events and not Swarm events because so far the events trigering might be from different sources, and not only swarms. Other SM triggers might be:

- a pre-swarm some days before
- a beekeeper inspection (exposing the internal sensor to teh sun)
- a very steep ambient temperature variation and/or a low insulated hive

SwarmMinder events display

SwarmMinder events are displayed at 3 different levels:

 At hive level you will only be notified of Temperature Events (ie. SM triggered). Those events are materialized by red needdles displayed on the temperature curve. And you can choose wether you want to see them or not clicking on the corresponding icon available on the right side menu bar.



1. At the device level you have the hole series of SM codes displayed on the graph. It is called SM State



1. This same data is displayed on the respective table and of course can be exported to csv, just in case you would like to play a bit more with it.

Data Editor Zoom chart or click point to filter readings below.										
Select readings to remove in table below										
Remove	Epoch	Timestamp	Sample	Rssi	Source	Battery	Temp	SM State		
	1687435836	22/06/2023 14:10	4911	44	WFC	77%	32.38	25		
	1687432313	22/06/2023 13:11	4910	60	WFC	76%	31.15	25		
	1687428636	22/06/2023 12:10	4909	60	WFC	75%	29.94	25		
	1687425113	22/06/2023 11:11	4908	54	WFC	74%	29.52	25		
	1687421512	22/06/2023 10:11	4907	50	WFC	74%	28.85	25		
	1687417835	22/06/2023 09:10	4906	64	WFC	74%	28.75	25		
	1687414311	22/06/2023 08:11	4905	54	WFC	74%	28.44	25		

Sampling the event

As described above, the sensor is scanning every minute and if the event is detected it will keep record of the temperatures associated with it.

For those having a hub in the apiary, the trigger will be automatically detected by the hub and sent through email or SMS to the beekeeper. However the hub is not harvesting the minute information. it only takes a few points of the trace. When you do a sync with the Bees App the whole timeseries is collected and sent to the cloud.

The chart below clearly shows what are the samples sent through the hub (red dots) and the full series collected by BeesApp (green dots).



Note

There might be some slight time shift between the samples collected by the hub and those from Bees App. This is due to the fact that the timestamp set by the Hub and the BeesApp can be different.

SwarmMinder State Codes (Models 47, 56)

The following numeric codes (base 10) will be displayed in the SM State value.

SWM_STATE_STOPPED

00 SM Stopped 01 Initialization complete - stopped 02 Stopped: by STOP request

SWM_STATE_CHECKING

- 20 Start checking for swarm event
- 21 Buffering temperature data 22 Temperature < Hive Base Temp (32.5C, 90.5F)
- 22 Temperature < Hive Base Temp (32.5C, 90. 25 Buffered Hive Temp < Hive Base Temp</p>
- 29 SWARM EVENT DETECTED

SWM_STATE_LOGGING

```
40 Swarm Event Detected - start logging
41 Still logging swarm data
```

SWM_STATE_WAITING

60 Swarm Event logging complete- start waiting - swarm detection 61 Swarm Event logging complete- still waiting

lifo

The temperature event trigger will only operate if the device position is assigned to the upper or lower brood box. Since the algorithm is really only meant for brood areas, this prevent spurious triggers when the SwarmMinder devices are located elsewhere.

Note

It is important to note that not all Temperature Events are swarms. In some cases it can be the consequence of other actions like for example 1/ your own inspection or 2/ a very thin and uninsulated roof that does not protect the hive from overheating at the sun => you should think on insulating.. 3/ the colony preparing for swarming the days before it actually does.

We are still learning on all the different circumstances and patterns that might happen. If you want to contribute to build this knowledge and share your experience with us, feel free to drop us an email to support.

8. BroodMinder W



8.1 Broodminder-W (57)

The Broodminder-W (Weight) is a single-bar hive scale that goes under the hive. It is an excellent tool to track nectar flows as for following winther ressource consumption.

The first W was released in 2017, it was model 43 and lasted for 5 years unitil in 2022 was released the W+ scale under model 57 improving bluetooth range and battery life.

Installation

There is an extensive writeup about positioning the scale in appendix A. That is a good thing to read, but if you are in a hurry, here are the basics.

Arning

the most typical error source is inadequate support under the scale. This can result in strange behavior as the hive flexes as it expands and contracts due to sun, rain, temperature, etc. Providing a flat support will improve results. An easy fix is to place a ¾" plywood sheet (or equivalent) under the scales.

ADDITIONAL NOTE

If all you want to see is honey flow, good support is not required. You will just have to ignore the daily fluctuations. You will still be able to observe the overall change in weight.

Place the scale in the shade

The Broodminder-W has a temperature sensor inside which reads the local temperature. For the temperature to be accurate, it should be shaded from direct sun. This temperature is also used to compensate the weight sensors so avoiding the temperature spike created by direct sunshine will improve performance.

Being in the shade will also extend the housing life. We use UV resistant plastic, but in the direct sun even that will become degraded. If this happens, you can order a new housing on Broodminder.com.

Get the Broodminder-W level

We have done our best to make installation simple. However, you need to pay attention to a couple of things.

Make sure the hive is level. This doesn't mean "crazy level" but if your hive looks like the Leaning Tower of Pisa, then you won't get good results. 2x4's and shims are your friends. By using a few 2x4's and shims creatively, you can level almost anything! We also find that screwing the 2x4's together makes life better and more stable.

After you install the Broodminder -W, look at the end of it. Through the plastic cover, (remember... install it with the plastic cover), you will see the upper wooden piece and the lower aluminum piece. Make sure that they do not touch. This will ensure that all the weight is sitting on the two little buttons on top of the aluminum base and not somewhere else.

Typical installation, not as accurate

Using the typical installation, you will see small changes to the hive however, the absolute accuracy will not be as good. For improved accuracy, see the recommendations of the next section.

The Broodminder-W is designed to measure ½ of the hive weight. To do this, we want you to support one side of the hive (front or back, left or right) with a 2x4 or similar However, we recommend that you use a piece of 2" angle for the support. By orienting it so that the point of the angle iron is up, it gives a very precise pivot point. You should be able get this at your local hardware store. Aluminum is extra nice because it won't rust. A great place to get just what you need for less than \$5 each is Speedy Metals (1/8" {A} x 2" {B} x 2" {C} Angle 6061-T6 Aluminum, Extruded).]

The Broodminder-W is placed under the opposite side.

There is a nice explanation of the math and physics involved in Appendix A, however it boils down to this. **Do your best to place the support and the scale directly under the wall of the hive body.** That will give good results.

Better installation, more accurate

A better way to install will require a few modifications to your bottom board. You will make a couple of small cuts that will be used to accommodate precise and repeatable placement of the scale and support.

First off, we recommend that you use a piece of 2" angle for the support. By orienting it so that the point of the angle iron is up, it gives a very precise pivot point. You should be able get this at your local hardware store. Aluminum is extra nice because it won't rust. A great place to get just what you need for less than \$5 each is Speedy Metals (1/8" {A} x 2" {B} x 2" {C} Angle 6061-T6 Aluminum, Extruded).

Now we want to make the cuts in the bottom board. For this setup we recommend using front and back supports and not side to side. That given, you must choose whether to place the Broodminder-W under the front of the hive, or the back of the hive.

In general, it is better to place the Broodminder-W out of the sun. This is because the sun will heat the scale and give you a false reading of the outside temperature. Placing it in the shady side of the scale avoids this problem. It will also make the housing last longer.

Next you will cut the bottom board. For the angle iron side, you will cut a groove the width of your saw blade that the point of the angle will fit in. For the scale side, you will cut a notch 3/16" deep that ends 1" inside the center of the hive body wall. See the images below.





Maintenance

Model 43 :

The CR2032 battery is replaceable. It should last more than a year and we recommend replacement each fall before the low temperatures of winter.

If you find that your scale sucks the batteries, contact support. There is maybe a workarround you can make yourself.

Model 57 : You will have to replace the two AAA batteries. They should last about 2 years.

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You can order a new housing on Broodminder.com.

9. Overview



Broodminder-W3 (49) This scale is a full hive scale that you can build yourself. It is the entry point to the DIY (Do It Yourself) in Broodminder.

It is available in 3 versions

- 1. Fully assembled
- 2. Partially-assembled & calibrated
- 3. Parts kit

The BroodMinder-W3 uses 4 force sensors to weigh the entire hive and sits on top of the bottom board for fast, convenient installation.

- 200kg (400lb) total hive weight measurement
- 0.01 pound (5 gram) resolution
- 4 Temperature compensated weight sensors. (4 @ 70cm (30") lead length)
- Stores weight once per hour for 5 years (user configurable)
- Replaceable 2xAA batteries last 5 years
- 16.5" x 20" x 2.25" Pine construction (assembled version only)

The "Fully assembled scale" is ready to place under the hive.

The "Partially assembled, calibrated, fixed feet" version contains all of the parts needed to assemble a hive scale except for the 2x4 support pieces. All of the soldering and electronics are assembled and calibrated in our workshops in Wisconsin/France.

Also a swivel foot version of that kit "Partially assembled, calibrated, wooden support, swivel feet"

We now have a "Partially assembled, calibrated, Apimaye swivel feet" version which works well for Apimaye hives. Watch the video here to understand the differences.

The "Parts kit, unassembled, uncalibrated" version contains all of the parts needed to assemble a hive scale except for the 2x4 support pieces. Soldering and calibration are required as described in the following user guide sections.

- 1. Board Assembly
- 2. Mechanical Assembly
- 3. Scale calibration

We know this can raise questions, feel free to reach out.

If you are thinking on another scale architecture that would better fit your needs, check the BroodMinder-DIY section for deeper considerations.

10. W3 and DIY circuit board assembly

What follows explains how to assemble the hive scale boards wheter if they are for the BroodMinder-W3 model or for the BroodMinder-DIY.

Important

If you purchased a **W3 Unassembled-Calibrated** scale, all your electronics work is already done and you can jump straight to the next section : Scale Assembly

Arning

During the assembly process it is important to avoid putting any strain on the connections of the wires to the sensors directly, as if the connection breaks the sensors become UNREPAIRABLE. If it ends up being the case that the connections are broken you will have to request a new sensor(s) to be shipped to you.

When working with the wires, it is recommended to use two points of contact as shown in the pictures below to avoid the connections being strained directly.

This is the most common problem with this kit, so please keep this in the front of your mind when constructing this kit.



10.1 Get started with the circuit board

We are working here with the XLR2-L board. This is a multi purpose board and that's why there are so many components missing. Although for scales you only need the "-L" version shown below.



10.2 Prepare the board

• tin all 16 pads on a flat surface



 \bullet solder the battery holder on the BAT2 slot (+ goes with the square pad)


10.3 Prepare the load cells

Now with a permanent marker note the load cell position : J1, J2, J3, J4.



Remember :

	Left	Right
Rear	J4	J2
Front	J3	J1



Now cut a slit on the rubber grummit. tape the 4 wires together for each sensor and pull them with a hemostat or pliers.



Drill a hole in the box with a 1/2in (12mm) bit. Route the wires through the hole and solder on the board pads following the color order Black-Green-White-Red as shown in the picture below

Note

Make sure that before you solder the connections onto the board that the wires have been pulled through the grummit and that the grummit has been slotted into the electronics box.

If you solder the connections before the grummit has been slotted into the electronics box then you will have to un-solder all the connections otherwise the electronics box will not close correctly.

Note

Take care to associate each loadcell with its coresponding pad J[1-4] (This will be printed on the board in small text next to each pad).



10.4 Mount the scale feet

To mount the feet, simply take the screw so that it is orientated as in the image below then screw on the top piece until tight.

Note

Be sure to use Loctite or a similar product on the screws to prevent them from coming loose over time. If this step is skipped it can cause the feet to become loose and cause the sensor to read inaccurate data.



10.5 Mount the scale structure

Go to next chapter : W3 Scale Assembly

11. BroodMinder-W3 Kit Guide

11.1 Overview

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If you acquired a W3 uncalibrated-unassembled model you should first start with the Circuit board assembly about how to assemble (solder) board with loadcells.

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We suggest that you watch the videos from Section $\ensuremath{\text{DIY}/\text{W3}}$ in the video Library.

The first section of this document demonstrates the **fixed feet** version followed by the **swivel feet** version. There is also an appendix to explain modification for Fixed to Swivel W3.



11.2 BroodMinder-W3 Assembly - FIXED FEET

Hardware



Reference	Item Description	Qty	5	3
А	Phillips Flat Head # 7 x 5/8"	2	3	
В	#8x4" Drywall Screw (W3PA & W3UA)	3	4	
С	#3 3/4 Phil Brass Flat Wood Screw	16	3x20	he frame (Fixed Feet) everything is where it secure the boards to
D	Load Cell Custom Support	4	Note	
Е	Spline Material	1		ed to use a 5/32th drill holes before drilling in er may result in strippi
F	Electronics Assembly	1		ent the nail from being
user provided	16.5 Inch Pine 2x4 (adjust for hive width)	2	430x40x60	
user provided	15-16 Inch Pine 2x4	1	420x40x60	

- The length of the end boards should be enough to span the width of your beehive. We typically make them about 16.25"-16.50" long for a typical 10 frame Langstroth hive. The length of the connecting board is not critical but should be around 16".
- Cut saw kerfs (1,2,3) as shown in the picture below. They should be around 0.4" -0.75" deep. These will hold the wires from the sensors.
- Cut kerf 4 for the wires to reach the electronics box. (see picture farther down).
- Test fit the spline and widen the kerfs if necessary.
- Remove the broad area (marked 5) with a chisel so that when the 2x4 tips it does not pinch the wire.



	everything is where it needs to be, use 3 secure the boards together.
e	
	ed to use a 5/32th drill bit or similar for holes before drilling in the nails. A 1/8th er may result in stripping the nail when ent the nail from being fully drilled into

Prepare the frame members

• Cut your 2x4s to length.



To assemble your frame, make sure you have a flat surface and ensure your pieces are square. Follow the picture above for the correct orientation of the boards.

Make sure not to completely drill in the side with one screw so that the board can pivot.

Attach the electronics box

Make sure the box is located center in the frame with the hole opening as shown. There should be a slight gap between the edge of the frame and the box as shown. Use (2) "A" screws which screw into the top right and bottom left of the electronics box.



Sensor Mounting

Position sensors marked 1-4 as shown with mounts "D" as shown.



Use 4 "C" screws per sensor. Make sure that before you drill in the sensors to the wood that you put the load cell custom support () between the sensor and the wood to allow for the sensor to read correctly. If the mount is not installed, it can cause the sensors to record incorrect information.



IMPORTANT: Do not fully tighten these screws. Bending the senor will create a measurement error. Tighten then back off $\frac{1}{2}$ turn.

Wire Routing

Once the sensors have been mounted, you can run the wires through the groves cut in the wood.

To deal with any extra wire:

- Unmount the circuit board from the electronics box by removing the two screws on either end of the board.
- Pull the slack wire through the grummit and fold it so that it sits behind the circuit board.
- Remember not to put any stress directly on the connections for the wires if possible, as that has a high chance to cause the connections to come loose or disconnect entirely.
- Remount the circuit board to the electronics box with the same two screws.

Once the wiring has been routed properly and any slack has been pulled into the back of the electronics box, you can secure/protect the wires using the spline material "E".

It is recommended to use a flat object to gently push the spline material into the groves so that they do not stick out (this does not take much force, gently tapping with a hammer works well). Once the spline material is in place, it can then be secured to the wood using staples to ensure it doesnt come loose or fall out in the future.

Note

Be careful when stapling not to have a staple go directly through the spline material as that may cut the wires to the sensors.





Finish and Enjoy

Now you can remove the battery tab and replace the lid on the electronics box and enjoy your new BroodMinder beehive scale.



11.3 BroodMinder-W3 Assembly - SWIVEL FEET

Hardware



Item Description	Qty
(Picture A) Phillips Flat Head # 7 x 5/8"	2
(Picture B) #8x4" Drywall Screw (W3PA & W3UA)	3
(Picture C) #10 ¾" SS Round Head Screw	4
(Picture D) Load Cell Custom Support	4
(Picture E) Swivel Feet	4
(Picture F) Spline Material	1
(Picture G) Electronics Assembly	1
16.5 Inch Pine 2x4 (User provided) (16.5 inch or adjust for hive width)	2
15-16 Inch Pine 2x4 (User provided)	1

Prepare the frame members

- Cut your 2x4s to length.
- The length of the end boards should be enough to span the width of your beehive. We typically make them about 16.25"-16.50" long for a typical 10 frame Langstroth hive. The length of the connecting board is not critical but should be around 16".

- Cut saw kerfs (1,2,3) as shown in the picture below. They should be around 0.4" -0.75" deep. These will hold the wires from the sensors.
- Cut kerf 4 for the wires to reach the electronics box. (see picture farther down).
- Test fit the spline and widen the kerfs if necessary.
- Remove the broad area (marked 5) with a chisel so that when the 2x4 tips it does not pinch the wire.
- Drill qty 4, $^{3\!4''}$ holes. The centers should be $^{3\!4''}$ from the edge and $^{3\!4''}$ deep



Screw together the frame

Once you're sure everything is where it needs to be, use 3 letter B screws to secure the boards together.



To assemble your frame, make sure you have a flat surface and ensure your pieces are square. Follow the picture above for the correct orientation of the boards. Leave the side with 1 screw very slightly loose so that the board may pivot.

Attach the electronics box

Make sure the box is located center in the frame with the hole opening as shown. There should be a slight gap between the edge of the frame and the box as shown. Use (2) "A" screws.





Sensor Mounting



Use 1 "C" screws per sensor.



Wire Routing

Tuck the wires into grooves and secure with spline material "E". To secure spline material press into groove with flat object, this allows wires to move in the bottom of groove. Do not create stress on the wires. Remove (2) circuit board mounting screws. Pull the slack wire into electronics box and fold wire behind circuit board, reinstall mounting screws. Secure spline material with staples.





Finish and Enjoy

Now you can remove the battery tab and replace the lid on the electronics box and enjoy your new BroodMinder beehive scale.





If you acquired a W3 uncalibrated-unassembled model you still need to calibrate your scale. Jump to the Scale calibration section

11.4 Appendix: Update fixed feet W3 scales to swivel feet

If you have an Apimaye hive, you may want to upgrade your W3 to include the swivel feet mounting.

This is quite easy except for one step. Removing the fixed feet from the W3 kit is quite difficult because there is no screw head to grab and the feet are fixed with permanent Loctite.

We have tried removing them here at Bees on Main and boy... they are difficult.

Therefore, we recommend modifying the load cell holder and using the load cells with fixed feet. The modification is needed so that the foot reaches the ground.

All that you must do is remove the skirt that captures the swivel foot.





11.5 Appendix: W3 Unassembled-Uncalibrated parts

Here are all the parts for a W3 scale H model type :

(only missing the Spline material)



12. W3 and DIY circuit board calibration

What follow will explain you how to calibrate the hive scales BroodMinder-W3 model or for the BroodMinder-DIY

Calibration (DIY and W3UA Only)

You will now calibrate your scale using the Bees App.

Watch the video to get you started :



The excel sheet for calibration is available here. You will need to make a copy in your own drive (File > make a copy)

You will find the calibration screen in the Bees App at Devices Tab > [Device name] > ... > Show details > ... > Troubleshooting > Calibrate Scale

	17-15	
〈 49:06:1A	49:06:1A	
J1 Weight:6.62 kg	3	
-17000	Offset -26723	Set
J2 Weight:6.97 k	3	
-17000	Offset 34097	Set
J3 Weight:3.34 k	g	
-17000	28658	Set
J4 Weight:8.31 k	9	
Divisor -17000	-42758	Set
Scale all channel	3	
Percent 100	_	Set
Set divisor for all	channels	
32000	_	Set
Connected Total \	Veight: 25.24 kg Sar	nple: 11
	Taxa All	

Your objective is to find the actual four Divisors. A good divisor starting point is :

- 32000 for 50kg load cells
- -17000 for 100kg load cells (note the negative divisor)
- -9000 for 200kg load cells (note the negative divisor)

ф

You do not need to take care of Offsets. They are automatically computed on Tare.

Ар

Basically what is happening here is we are using linear algebra to solve the simultaneous equations generated by the first 5 positions. After zeroing the sensors, there 4 weights and 4 variables (slopes). Through the magic of mathematics, we get the answers.

13. BroodMinder W4



13.1 Broodminder-W4 (49)

Note

W4 scale is only available in Europe.

BroodMinder-W4 is a professional grade hive scale specially designed for migratory beekeeping. It is a rugged, lightweight and high precision scale that can be installed in any kind of configuration. Insensitive to hive leveling or centering with its 4 x 100kg high precision load cells, it mounts easily on wooden or metal pallets.

As for any other of our hive scale models, W4 will accurately measure the slightest changes in beehive weight, allowing to detect nectar-flow startup and intensity. It also improves colony overwintering and spring growth management and gives precise description of foragers activity during the day.

Recommended for migratory beekeepers to improve colony management while reducing time spent and transportation costs.

Installation

The W4 bars are 50cm long. You tipically can mount them longitudinal to the hive (left/right) but also transversal (front/rear). It all depends on your preferences and constraints. The acuracy remains unchanged.



This scale is specially designed for migratory beekeepers. The aluminum structure is 4 mm thick and features grooved surfaces on the top and bottom to prevent the hive from slipping.



For those using Nicot(r) bottoms, the scale takes advantage of their features. The grooves are fitting the bottom, actually holding the hive from any slip.



Theres also the possibility to mount centering pins on the scale using the pre-positionned mark for drilling (see picture above).



Mounting on pallets

If you are migrating your hives, you do not even need to remove the hive, you can let it installed. For this you will have to attach the scale to your pallets.

• On wooden pallets simply drill two holes on thhe bottom bar and screw them to the pallet



• on metal pallets, you can drill and use a pin



Then you can securely handle and lift your pallets.



Once on your truck, you can strap without fear. The maximum nominal weight for this scale is 400kg. Straping will raise the load to 150-200 kg.



14. BroodMinder BeeDar



New in 2023, the BroodMinder-BeeDar is an activity monitor for your hive.

- Radar is used to detect the number of flying bees. The radar emits from the square, green and gold sensor. This should be approximately over the entrance.
- Audio is used to detect the overall sound level of the hive. The audio sensor is mounted to the back of the box and couples to your beehive by screwing the BroodMinder-BeeDar to your hive box which then acts a bit like a guitar.

14.1 Background

The BeeDar was invented by Dr. Herb Aumann from the University of Maine and Main Biosensors LLC. There is a nice academic paper about it here.

https://www.researchgate.net/publication/349017653_Janus_A_Combined_Radar_and_Vibration_Sensor_for_Beehive_Monitoring

The BeeDar senses motion and is tuned to be particularly sensitive to bees. When it collects data, it will record the motion for 30 seconds and then take the average. By default this will happen every 15 minutes. Data is transferred to MyBroodMinder just like every other BroodMinder device.

14.2 Installation

- Remove the BeeDar lid and remove the 2 loose flat screws.
- Pull out the "Remove Before Use" tag. The LED on the circuit board should flash for several seconds. If it doesn't, then you might need to remove the one screw which holds the circuit board, take out the board and check the batteries. (Sometimes a part of the tag can rip and remain under the battery terminal.)
- Screw the BeeDar to your hive using the flat head screws and the holes that are in the upper right and lower left of the BeeDar.

• Replace the lid and tighten the screws making certain that the gasket is in place correctly.

The sensitivity of the BeeDar is a fan beam emanating from the radar sensor. The box should be mounded level and do not point it up by tipping the box backwards (such as on an angled landing board). This will do a good job of sensing rain falling which is not the goal.

Note

The BeeDar Audio will not work as well with a plastic hive as with a wooden hive due to the acoustic properties of plastic.

15. BroodMinder Do It Yourself Guide

15.1 Why DIY ?

We realize that many of our users are curious and want to invent things. Our DIY kit allows that creativity without the need to write 8 years of software.

The DIY is the raw circuit board that we use in the BroodMinder-W2. We hope that this board allows many home crafters to create wonderful devices to monitor the hives. Be sure to share your designs with us and we will share them with the world.

- Proven design
- 5-year battery life
- No software to write
- Works with most standard load cells
- Integrates into the vast BroodMinder ecosystem
- Utilizes a 4 channel 24-bit load cell IC (TI ADS1234)
- Data is available by BLE advertising
- Stored data is readable by BroodMinder apps

In order to utilize the BroodMinder-DIY, you will need to add your own load cells. The board should work with most load cell available, but beware, there are many bad choices. For example, if you try to use normal "bathroom scales" load cells, you will find that they have tremendous "creep". Under load, the output values can change 50% overnight.

We are offering you here some proven concepts that you could adopt or inspire from. There are different categories you can explore

Multiscales



Multiscales are architectures of a single scale for multiple hives.

Multiscale1 and Multiscale2 are single and double loadcell architectures that allow for 4 scales onto a single board.

Retrofit

Retrofit cases for those that would own an old scale or from other vendor, that is not working anymore and are willing to bring it back to life into the BroodMinder ecosystem.

15.2 Getting started

Hardware

The starting point is getting a BroodMinder board. Here the choice is straight forward : there's a unique model of board for scales and we call it XLR:



Then you'll need a set of loadcells you have a choice of your loadcells depending on the architecture you target : 50, 100 and 200kg are the most common. On the display below you have the 'flat' 50kg side by side with the 'beam' 200kg type.



Center hole of 50KG load cell is 5mm diameter

We are happy to provide you with either type. If you get your own, be sure that they are temperature compensated and have very low creep. The resistance of the 200KG load cell is roughly 300 ohms per leg. For the 50KG load cells it is around 750 ohms.

Then you will be assembling the boards and the loadcells into the architecture of your choice (more about this further). Achieving that point, weather is your enemy, so you will also want a box and cable glands. we recommend the following available from Digikey.com

- Hammond 1554C, fits circuit board nicely \$10.00
- \bullet Hammond 1555C, with ears fits circuit board nicely \$10.00
- Jacob Gmbh 50.007 PA7035 cable gland PG-7 \$0.70

Electronics & Wiring



Most load cells seem to use this color scheme for the wires. If that is the case, then wire them like this.

Black, Green, White, Red (from top to bottom).



The outputs are in the middle. If things are mixed up, usually it will be corrected during calibration.



Note

The board does not sport much in the way of electrical protection. We have found that in our configuration this is fine and we want to save as much cost as possible for our users. You may need or want to add additional protection circuits. We leave that to you.

Warning

THE ABSOLUTE MAXIMUM VOLTAGE FOR THE DIY BOARD IS 3.8 VOLTS DC!

A final note, (stepping up on soap box), I (Rich Morris) hate connectors. They are almost always the first thing to fail. Personally, I try to solder everything but your milage may vary. (stepping down now)



Note

On the next figure you will find our circuitry. You may wonder why we share this... The truth is, the circuit doesn't get you very far. It requires lots and lots (and lots) of software to hold this all together. We hope the circuit helps you if you need it or want to learn more.



Calibration

Once you have your scale built, you will want to calibrate it. You do this by setting the scale factor for each ADC channel which are stored in flash memory in the processor.

We have now built new features into the Bees app for doing calibration. See the video here for more information.

A check the board model!

The DIY board is a model 58. If you have something different (e.g. 57:xx:xx) call us and we will work it out. The ID should start with 58!

Single-loadcell scale

- 1. Open the Bees App calibration screen Devices Tab > [Device
 name] > ... > Show details > ... > Troubleshooting >
 Calibrate Scale
- 2. Enter a starting point Divisors in the channels you're willing to calibrate (eg. -9000)
- 3. Push on the Tare button to set the weight to zero
- 4. Load the scale with a known weight and read the output on the screen.

The divisors are the values that convert the raw readings of the ADC to weight. 31,000 is a good starting place for the small load cells. The larger ones are more like 11,000. It is a simple matter to set the divisor to a value, then do a test weight. And then adjust the divisor appropriately.

Example

Real Weight = 30.0, Divisor = 31,000, BRM-58 readout is 20.0

Change the divisor to 31000 * 20.0 / 30.0 = 20,666 and the weight should correctly read 30.0

Ър

if you are NOT using a channel, set the divisor to 0 and it will always read 0 weight.

Four-loadcell scale

If you are using 4 loadcells together into a single scale, then you should follow the same procedure as for W3 Calibration described here

16. Build your custom Multiscale-1

Multiscale-1 is a multi hive scale that uses single load cells for each hive. The classical setup is a 4-hive stand with combined with 4x200kg loadcells and a single XLR board.



Above is an example build on a hive stand is available from BetterBee

Another similar set-up consisting on a 3 hive slots with single 200kg loadcell and plywood plate is described in the pictures below



Model	Pros	Cons
Multiscale1	Most accurate architecture, a single load cell is individually calibrated on a dedicated circuit board channel.	It rocks and it rolls. Having a single path to transfer all the stresses, results in an architecture that is not extremely stable. Once you touch the hive, it all starts to roll. Some bees do not like it and get agressive.

17. Build your custom Multiscale-2



The Multiscale2 system utilizes a single XLR board and two 100 kg load cells per hive, enabling independent weight measurement for up to four hives.

This cost-effective design benefits from using a single electronics board, with one channel allocated per hive (up to four). Compared to the Multiscale 1, this setup offers a more stable structure with significantly less rocking. However, because the two load cells are combined into a single channel, every twin cells are calibrated as a whole rather than calibrating each cell individually. While this could slightly reduce accuracy, our experience shows that the results remain highly accurate while gaining on stand stability compared to single-load cell structures.

17.1 Mechanical part

In the example below we're displaying a 3-hive scale stand.



We're using W4 bars as top support and 100kg loadcells (one at the front and another at the rear). They are hooked to the wooden structure with an L shaped 5mm aluminium profile.

The rounting of the cables to the board needs an extra lead that is soldered using a Control line, $4 \ge 0.14 \text{ mm}^2$, shielded, 25 m coil.

Model	Pros	Cons
Multiscale2	A very good compromise among accuracy and stability	Two load cells sharing a single channel result in a slight loss of accuracy, but using high-quality load cells helps minimize these differences.

18. Retrofit a SolutionBee scale



It is easy to take an old broken hive scale and convert it to a BroodMinder enable scale. Here is an example.

Note

This is not the same wiring as our load cells (colors are different).



- 1. Cut the load cell wire to length
- 2. Carefully tin the leads. Old wire may be difficult to tin, use plenty of flux if this is the case.
- 3. Determine the wiring. In our example, this is the wiring of the load cell
- 4. Connect to the board. In our case, from the top
- a. Green Exc J1(1)
- b. Red Sig(-) J1(2)
- c. White Sig(+) J1(3)
- d. Black + Shield Gnd J1(4) or J2(4)



5. Connect pins 2, 3, & 4 of the unused channels (Gnd)



- 6. I do not recommend using a connector. I tried and the corrosion was a big problem. It worked for a while and then the calibration was way off.
- 7. Stabilize the wire with a tie wrap and cut a hole in the case (Bud Industries PN-1322-CMB 11.20 or Hammond 1591CSFLBK 5.50)

8. Ensure the box is sealed, silicone caulk works well if you use the cheaper Hammond box.



9. If the box is tucked up in good spot, you might be able to get away with mounting without sealing the cable entry. Be certain to have a drip loop so that rain doesn't drip inside.



10. The BLE chip will work better if it is oriented so the circuit board is away from the metal frame.

Good luck, let us know how it goes.

19. Retrofit a "Label-Abeille" Scale



Follow these instructions to bring back to life the hive scales from "Label-Abeille®". The objective is to replace the old board with a BroodMinder-XLR board.

19.1 Mechanical part

Put the scale upside down and rmove the lower yellow cover Then open the "head" black box placed on the Loadcell screws side (reference "S" in te picture below).



In the box remove the "A" board and the "B" harness. Unscrew the "C" harness from the board. This is the one coming from the load-cell to be soldered on the new XLR board.


Now cut the central plot with a cutter to leave space to the XLR board



Like this



Now prepare the XLR board. We will only use chanel J3. Therefore we bridge channels J1,J2 and J4



Solder the battery holder on this side (side is important to be able to have the batteries accessible once the casing will be mounted again.)



Now solder the cables on the J3 channel.

- The sequence is Black-Green-White-Red
- RED goes onto the square pad.
- Big Black is the shield wire. You can hook it to the scale structure if you wish.
- This loadcell has two other cables (yellow/blue) for voltage feedback (long wiring for industrial applications) : they are not needed here.



Now install batteries. You should see a blinking led.





Now you can place it in the box as shown



Take care batteries end up aligned with the box opening!



Now open BroodMinder-Bees on your phone and go to the Devices tab to find the scale. Check battery level, etc.

And you're done with the mechanical part!



Now let's move to calibration

19.2 Calibration

To calibrate the scale follow the process below. If you need help, you'll find more details in this page

Open Bees App, move to Devices tab > locate the scale ID > ... > show details > ... (top right) > Troubleshooting > Calibrate scale

🖬 Free 🗢	12:02			🖬 l Free 🗢		12:02					
🗸 Back	58:01:CF			🗸 Back		58:01:CF			•••		
1y 6m	30d 14d	7d	3d	24 h	1y	6m	30d	14d	7d	3d	24h
Sync View Realtime											
Set Rate				T							
Clear Device Log			П			View	Debu	g Log			
Troubleshooting			7			View	/ Read	lings			
Delete Local Data						(Calik	orate S	Scale	D	
Cancel				Pluoto	oth Cia	(Cance	I			

Now follow the process :

- 1. Place the scale on the up-right position.
- 2. With empty scale weight: Hit the button Tare Scale (bottom button)
- 3. Now insert Divisor = 0 for ALL chanels (bottom of the screen)
- 4. Now enter Divisor = -9000 for chanel J3 (NEGATIVE starting value)
- 5. NOTE : you $\mathbf{do} \ \mathbf{not}$ have to worry about Offsets

🖬 Free 🗢	11:58						
〈 58:01:CF	58:01:CF						
J1 Weight: 0 kg							
Divisor 0	Offset 118	Set					
J2 Weight: 0 kg							
Divisor O	Offset 132	Set					
J3 Weight: 0 kg							
Divisor 9000	Offset -187	Set					
J4 Weight: 0 kg							
Divisor O	Offset 132	Set					
Scale all channels							
Percent 100	_	Set					
J4 Set							
Total Weight: 0 kg Sample: 44							
Tare All							

- 1. Place a known weight on the scale > check "J3 Weight" displayed on the app > modify the divisor iteratively to find the actual weight on the display
- 2. Once you found the right divisor save and quit this interface

You are done, congratulations !

19.3 Troubleshooting

More often than not, the problem is simply wiring. Start by measuring between the load cell leads. You should see hundreds of ohms, not 0 and not infinity. Also be aware that we use plated through holes. If you drill them out (like Lorenzo did), the pads will no longer conduct from the top of the board to the bottom. You can solve this by solder jumper wires with the schematic as a guide.







20. Yolik devices

You can attach devices from Yolink to MyBroodMinder.com

The only think you'll need to do in order to hook them is to enter the device ID number in Mybroodminder > Configure > Third party devices

21. Introduction to BroodMinder Hubs

All BroodMinder sensors transmit data via Bluetooth. There are several ways to collect the data :

- 1. Via your smartphone (see the Bees App section of the manual) or via a hub.
- 2. We use hubs to monitor and send data to the cloud automatically every hour so that you can see your current hive status anywhere there is internet available. You can picture a bicycle wheel where your BroodMinder devices are the spokes and the hub listens to all of them and sends their data to the cloud. We also have special cases for swarming. It will send a text or email notification within 10 minutes of the event.

We offer serveral technologies for data transmission. Depending on your use case, there might be one that fits better than the others.

- BroodMinder-T91 Naked Cell Hub Cellular hub must be recharged every 6-14 months
- BroodMinder-T91 Solar Cell Hub Cellular hub, solar powered, never needs recharging
- BroodMinder-WIFI WIFI hub for apiaries with good WIFI avaiable
- BroodMinder-LoRa LoRa hub providing long range coverage solution for specific needs.
- BroodMinder-SubHub This is a hub with no WIFI or Cellular. It can be used in remote locations to collect all sensor data into one device which makes downloading data to your cell phone very fast. It can also be used to connect remote (50-400 meters) hives to a shared BroodMinder-T91.

All of these hubs are monitored and set up using the BroodMinder Bees App.

All of the hubs sample the BroodMinder devices every 10 minutes.

We are happy to help you configure your system. The variety of apiary locations and installations is vast and it can be confusing to get everything working correctly. We have made these tools to be flexible and work in most situations, everywhere from downtown New York City to the rural Yukon Territory or the Pyrenées mountains.

21.1 BroodMinder Hub Firmware Update

From time to time we make updates to improve the operation of our sensors. BroodMinder devices use OTA (Over The Air) firmware updates and are very simple to perform.

Updating BroodMinder-T91 Cell hub

- Check current hub firmware installed with Bees App (see below)
- Trigger the upgrade (see below)
- Cycle power
- When the hub restarts it will go through a green then a blue light for 5 sec
- During that blue light, press the central button to trigger the upgrade
- Wait and watch for 2-3 minutes.
- The hub will reboot automatically
- Verify with Bees App that the firmware has upgraded

You're done.

Check the hub Firmware

Open Bees App and find your hub in the Devices tab. Go to the ... menu in front of it and hit Show Details.

Now you see the current firmware version of your hub.



Trigger the upgrade

Cycle power and when the led becomes blue, push briefly the central button. The upgrade is now triggered. Wait for 2 minutes until it is installed and restarted

WATCH THE VIDEO



Note

During the upgrade the hub pulls the new version over the air. You need to be on a cell covered zone to upgrade your hub.

Verify

Once complete, you should see the updated firmware version in the Hub details page (as you made it before)

Need help?

If you are still having difficulty contact us at support@broodminder.com

22. BroodMinder-Cell T91



22.1 BroodMinder-T91 Cell Hub (BRM-54)

The BroodMinder-T91 Cell Hub is based on the Nordic "Thingy 91".

You will find an installation video here.

Installation is super easy because we set everything up before shipping.

- We recommend you test everything before you take it to your apiary.
- You will get an email from BroodMinder when we ship the hub. If you don't then check your junk email folder, or contact us. The email has instructions on connecting the hub to your account. There are two cases.
- If there is a link in the email, then click it and you will be guided to connect the hub to your account and claim the one year token which is included with purchase.
- If there is not a link, then we assigned it to your account before shipping.
- ${\ensuremath{\cdot}}$ When you get your hub, turn it on. There is a slide switch



- Go to MyBroodMinder.com, choose Configure and expand the Hubs section. This is where you can manage your hub.
- Click on the Manage icon to assign or move it to an apiary.
- You must also assign a token. A token is a virtual coin that we use to pay for the 24/7 upload service. You should receive 1 year service with the hub. If you did not, then contact us at support@broodminder.com.
- After you see it working you can move it to your apiary.
- If you have a solar T91, then ensure that the gasket is seated correctly when you replace the lid. Also make certain that the solar panel is facing towards the sun for most of the day.
- If you have a naked T91, then ensure that it is in a weatherproof housing of some sort. We recommend the Lacrosse Solar Shield. We also recommend that you place the T91 in the mesh bag we include. This will keep out small bugs (such as earwigs) which are attracted to the slight warmth.

Solar version

Life long powered version

Solar version

Life long powered version



Weather version

•

Use the Weather shield to protect the T91



Extended range

If you have issues with the cell network coverage, maybe an antenne can help improve the situation in your apiary.

We might have several solutions for you : contact us at support@broodminder.com.

One of them is this External Antenna kit. The antenna plugs into the connector marked "LTE" on the Thingy91.



- Place the connector through the plastic mounting bracket
- Push the connector into the Thingy91 jack.
- Secure the bracket with the screw that we included.



23. BroodMinder-WiFi



If you have good WIFI in your apiary, BroodMinder-WiFi should work for you. We recommend setting this up where there is strong WIFI and a nice work area prior to placing in your apiary.

You will find an installation video here

Arning

Broodminder-WiFi is only compatible with 2.4GHz networks. It will not find, nor connect to 5GHz or mixed 2.4+5GHz networks

23.1 Installation

- We recommend you test everything before you take it to your apiary.
- You will get an email from BroodMinder when we ship the hub. If you don't then check your junk email folder, or contact us. The email has instructions on connecting the hub to your account. There are two cases.
- If there is a link in the email, then click it and you will be guided to connect the hub to your account and claim the one year token which is included with purchase.
- If there is not a link, then we assigned it to your account before shipping.

- Remove the cover and pull out the "Remove before use" tabs. The LED should flash for a few seconds.
- Now start up the Bees App on your phone or tablet and choose the Devices page. You should see the BroodMinder-WIFI show up on the list.
- Press the Claim Device button and follow the prompts to add it to your inventory.



- Click the ... to the right of the WIFI hub and choose Show Details
- \bullet Choose the \ldots at the top right corner and select <code>Configure Wifi</code>
- \bullet Now you can $\mbox{ Scan}$ and search for WIFI networks that the hub can see.
- After scanning, select your preferred hub
- Enter the password
- Save the hub will now connect to your WIFI network
- Once connected, you can press the Upload Now button to send data immediately.
- You can also send data by pressing the button near the LED on the BroodMinder-WIFI circuit board.

• Go to MyBroodMinder.com to see the results (results shown beloware from a hub running for > 1 week)

9:34		all 🗢 🖿	9:05			
🗸 Back	60:00:99	•••	< 60:00:99	60:00:99		
Firmware: 1.22 MBM Last Upload: Never Battery: 100% Temperature: 79.8°F RSSI: -34				Upload Now		
			Scan BeesOnMain-2G 🗸			
			Password			
				Save		
					Done	
Viev	v Debug Log			Custom		
Configure Wifi			Bees	OnMain-2G_2GEXT		
			B	eesOnMain-2G		
	Cancel		Sr Mys	Next_Gen DectrumSetup-E1		



24. BroodMinder-SubHub



24.1 BroodMinder-SubHub (BRM-52)

The video , BroodMinder-ASP (Apiary Starter Pack) Installation shows how this works together.

Installation is simple. Open the box and pull out the battery tabs and the -SubHub is running. You will see it show up in the phone app with an ID beginning with 52:. Once running, it will listen for other BroodMinder devices and add their data to it's internal log. The cool part is that the -SubHub will now advertise (send out) that data to be received by a BroodMinder-CELL, or a BroodMinder app.

Due to power constraints, the BroodMinder-WiFi does not operate with the BroodMinder-SubHub.

If you are watching with a BroodMinder app, you will see your devices show up on the list. Each device is advertised for 5 seconds, rolling through all the known devices one after the other. You will see them marked in the device list as coming via the - SubHub.

The BroodMinder-Bees app is the best tool to interact with your -SubHub. You can use it to setup and also to retrieve stored data.

You can also take an old cell phone, connect it to your local WiFi (or with a cell subscription) and run the BroodMinder Apiary app in Hub Mode. It will push the sensor data to MyBroodMinder.com every 10 minutes. Since the phone can be plugged into the wall for power it becomes very simple. Note that to do this you must have a BroodMinder-Premium account.

We have seen better performance with iOS (Apple) phones or tablets. Some of the older Android devices work find, but some have problems with Bluetooth locking up.

If your apiary spans a long distance, you can employ multiple -SubHubs, one for each group of hives. They do not daisy chain, but they work directly to the central -CELL or app.

24.2 Brief Explanation

It is a Bluetooth range extender and a high speed data vault in a box about the size of a TV remote.

The BroodMinder-SubHub will listen for all your BroodMinder devices and retransmit them using its long range transmitter. This means you can 'hear' your BroodMinder devices over 1000 feet (330 meters) away.

Secondly, the -SubHub stores all of this data, and you can read the data using our new turbo-transfer protocol (releasing spring 2021). You can read a month's worth of data from 50 devices in 2 minutes.

And finally, it also records the temperature of itself, allowing you to see your apiaries micro-climate, or even place it inside a swarm box to see when bees move in.

24.3 Why does the BroodMinder-SubHub exist?

It's all about maximizing the value of hive monitoring. From the data our citizen scientists have been collecting over the last six years, we have learned that internal temperature tells us the most. We have learned to detect brood rearing, swarms, hive strength, and mating flights. And this is only the start.

Fortunately, temperature is cheap and easy to measure. However, that data only does good if you can get it to the beekeeper. The -SubHub makes that easier. Here are a couple of scenarios:

Scenario 1

Setting: Your BroodMinder enabled hives are 500 feet (150m) from a building with power and you have an old cell phone.

Configuration: Put the -SubHub in the middle of your hives and the cell phone in the building. Run the apiary app in hub mode.

Outcome: Your hive data will be sent up every 10 minutes. In the event of a swarm, you will receive an email or text message as soon as it is detected.

Scenario 2

Setting: This apiary is remote and there is no power nearby. You are already set up with a BroodMinder-Hub, however some of your hives or swarm traps are 700 feet away

Configuration: Put the -SubHub near the hives. Since the -SubHub also measures temperature, you can place it inside the swarm trap to detect when bees move in. You can have multiple -SubHubs feeding the BroodMinder-CELL hub if you wish. **Outcome:** More of your apiary can be monitored with minimal cost. Temperature increase in swarm traps will show on MyBroodMinder.com when bees move in.

Scenario 3

Setting: This apiary is remote and there is no power and no cell tower nearby.

Configuration: Put the -SubHub near the hives. It will record data from all the nearby BroodMinders.

Outcome: When you visit your apiary, you can read all of the the data from all of the hives, typically in less than a minute. You will be able to view this data with the new BroodMinder-Bees app in a manner similar to MyBroodMinder. Then you can send the data to MyBroodMinder when you arrive back in civilization.





24.4 Range Testing

If you are going a long distance, we have a few hints for you.

1) The -SubHub's radio waves are directional. The batteries block the antenna. This means that the -SubHub circuit board should be on the side of the -Hub or phone receiving the data. 2) You can use the BroodMinder-Bees app to do your testing. Please watch the video BroodMinder-ASP (Apiary Starter Pack) Installation for the best information on this. 3) A super way to test the range is using an app and your phone. Nordic Semiconductor has an app called "nRF Connect" for both iOS and Android. It is the best Bluetooth app out there. Here are a couple of usage notes.

- a. Go to Settings > Scanner > Scanner Timeout >> set to Never
- b. Start scanning in the Scanner tab at the bottom of the app
- c. BroodMinder sensors will be named by their ID (e.g. 57:01:01)

d. Press the up arrow beside No Filter and put a : in the Name field and flip the switch beside it. This will only show devices with a : (such as BroodMinder devices.). You can also limit it to a specific device this way.

e. Now select the RSSI Graph and you will see each time the phone gets an update from the BroodMinder.

f. There are many other great options in the program to explore if you like this sort of thing.

As a general note, detecting advertisements does not mean that you can connect to a device. Connections require stronger signals. This means that if you want to download the log, or update firmware, you may need at least a 40-50% signal level.

Good luck, we are very excited about the BroodMinder-SubHub and hope it will be of use to you.

24.5 How did you do all of this magic?

It wasn't easy. Our team has been working on the BroodMinder-SubHub and MyBroodMinder ecosystem for over a year. That time was split between solving the technical challenges and making the system flexible and easy to use. We feel it is a game changer and that you will love it.

For the folks that love all of the technical details, here they are.

The -SubHub is using the same circuitry that our BroodMinder-W2 uses. It uses a Silicon Labs, long range Bluetooth Low Energy (BLE) module. We have measured the advertising range of the module with an iPhone 11 at greater than 1000 feet. We got usable data at 1700 feet.

By using 4 AA batteries, we have much more power to play with. This enables us to listen for BroodMinder devices for 20 seconds every ten minutes with anticipated battery life greater than a year.

There is a one megabyte memory added to store the log data. This allows us to store 35,000 records or roughly data from 100 devices for two weeks (or less devices for longer, you can do the math). The -SubHub has the capacity to keep track of 128 BroodMinder devices at one time.

The data will be read using BLE SPP (Serial Port Profile). We have timed transferring the entire 35,000 record log to take about 120 seconds using iOS and less than that for new Android devices (longer for phones 4 or 5 years old). The new BroodMinder-Bees app supports this high speed transfer.

The final piece is in Advertising the data from the -SubHub. As mentioned above, the -SubHub listens for new data for 20 seconds every 10 minutes. It then modifies it's BLE advertisement packet to 'mock' all of the BroodMinder devices it heard. The -SubHub advertises a different device every 5 seconds thus allowing data from 12 BroodMinders to be sent every minute which means over 100 devices in 10 minutes.

We have established these parameters in order that the batteries last at least a year. While they will be adjustable for special circumstances, we feel that the standard setup will cover 99% of the cases.

That is basically how it works. Of course there are many, many details in making the pieces fit together seamlessly and to be supported by the equipment in the field. And, as always, during deployment we will be watching closely.

If you have a CELL device, the subhub will amplify the data sent from the devices and extend the normal 10-15 foot range up to 300-500 feet (depending on obstacles in the way). Multiple subhubs can be located in the apiary to ensure complete coverage.

Good luck, we are very excited about the BroodMinder-SubHub and hope it will be of use to you.

25. BroodMinder-LoRa



25.1 BroodMinder-LoRa (BRM-65)

LoRa (Long Range) and LoRaWAN (Long Range Wide Area Network) are technologies designed for low-power, long-range wireless communication.

- LoRa is a physical layer (or radio modulation) that enables long-range, low-power communication between devices. It uses a spread-spectrum technique to achieve high sensitivity and range, allowing devices to communicate over several kilometers with minimal energy consumption.
- LoRaWAN is a network protocol built on top of LoRa. It defines the communication protocol and system architecture for a network of LoRa devices. LoRaWAN manages how data is transmitted over the network, including encryption, data rates, and network management. It facilitates communication between end-devices (sensors, actuators) and network gateways, which then connect to a central server or cloud application.

In summary, LoRa provides the physical layer for long-range communication, while LoRaWAN provides the network protocol and management to support scalable, low-power, wide-area networks.

25.2 LoRa Hub

The LoRa hub is working very similar to all other Cell or wifi hubs. It is tracking all the devices and sends any new data to the cloud every 10 minutes. The major difference is that instead of using a cellular network, it will use the radio frequency 915Mhz (US) and 868MHz (EU) dedicated to LoRa.



25.3 LoRa Gateway (BRM-66)



At the other end of the emitter there should be a receiver. Depending on your location it could roam through different networks. Although you can also install a gateway that will be hooked to the internet.

This means that custom networks can be build using the pair Hub/Gateway to address specific configurations in zones with poor cellular coverage for example.

The distance between the gateway and the Hub can range from hundreds of meters to actually kilometers. In an area with little geographical relief the range can go up to 10-15km (20-30Mi).

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If you are considering this technology for your apiary, please contact us and we will advice the solution that could best fit your needs.

26. BroodMinder-Cell 3G (BRM-44 & BRM-50)

The 3G Cell hubs have been under operation since 2018. In some countries like USA they have been disconnected but they are still delivering a good service in many other places. What is described below is a troubleshooting guide for Cell Hub models 44 and 50.

These hubs are not configurable with the Broodminder Bees app. You must install the Broodminder Cell App Android, iOS to manage the settings.



26.1 Install the SIM Card

Here are the steps to install the SIM card:

- 1. Unplug the 3G 'Clic' circuit board.
- 2. Open the SIM metal holder: slide it upward through the antenna with your thumb, then pull it up and remove the SIM.
- $\ensuremath{\mathsf{3.}}$ Insert the SIM card in the right position.



4. Pull down and slide down to lock.

