

MANUAL

EFME

WIRELESS USB BASE STATION

Installation and user manual



Document	Version	Date	Applies to
Installation and user manual	V00x	10/2026	EFME USB base station

This manual describes the EFME USB base station: installation on the PC, the T24 Toolkit configuration software, pairing and configuring T24 modules, site survey and radio diagnostics, and fault finding.



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1 About this manual

This manual applies to the EFME USB base station. The base station is the radio interface between a Windows PC, laptop or tablet and the T24 telemetry modules. It is required to configure T24 modules with the T24 Toolkit software and to bring their data to a PC.

Display texts, key names and menu items are set in a fixed-width typeface, for example **MENU/OK**. Menu paths are written as menu › item. Software pages and buttons of the configuration software are written as they appear on the screen.

1.1 Notices

Notice	Meaning
Warning	Risk of injury or damage, or of losing the function of the system.
Important	Pay particular attention to the following instruction.
Note	Further information.

1.2 Product identification

Item	Description
Product	EFME wireless USB base station (dongle)
Compatible modules	T24 transmitters and receivers, for example octagon EFMC, EFMF (transmitters) and EFMG (large display)
Configuration software	T24 Toolkit for Windows (chapter 6)

2 Safety and conditions of use

Warning T24 products are not authorised for use in safety-critical applications where a failure of the product would reasonably be expected to cause severe personal injury or death.

2.1 Rules for correct use

- The enclosure is not weatherproof (IP50). Use the base station indoors or protect it from water.
- The case is not designed to be opened.
- Install the T24 Toolkit before plugging the base station in for the first time (section 4.1).

2.2 Radio

- The device contains a licence-exempt 2.4 GHz radio transceiver. The antenna is fitted inside the enclosure.
- Radio frequency exposure: the antenna must be installed so that a minimum separation distance of 5 cm is maintained between the antenna and all persons at all times, and the device must not be co-located or operated in conjunction with any other antenna or transmitter.
- Antennas with a gain exceeding 3 dBi are strictly prohibited for this radio.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

3 Product description

3.1 Overview

The EFME is a base station in a USB dongle enclosure for direct connection to laptops and tablets. It is powered from the USB port – no external supply and no cabling are needed. With the T24 Toolkit it is used to configure, calibrate and diagnose T24 modules over the air and to monitor their data.

3.2 Technical data

Item	Value
Interface	USB type A plug; USB HID device class, USB 2.0 full speed (12 Mbit/s)
Supply	from the USB bus: 4.875 ... 5.125 V DC (USB 2.0 specification)
Current	100 mA typical (device specification); the product information states below 100 mA
Address	fixed address 1 – one base station of this type per PC
Radio	2.4 GHz licence-exempt transceiver, DSSS, 15 channels, 10 mW (chapter 10)
Antenna	integrated chip antenna
Range	up to 500 m to a module with integrated antenna, up to 600 m to modules with 3 dBi antennas; open field (section 10.2)
Radio channels	one channel at a time; all modules to be received must be on the same channel
Throughput	around 200 messages per second per radio channel (section 5.8)
Degree of protection	IP50 (not weatherproof)
Operating temperature	–20 ... +55 °C
Storage temperature	–40 ... +85 °C
Humidity	max. 95 % RH, non-condensing
Dimensions	58 × 20.5 × 11 mm (L × W × H); enclosure without plug 46 mm long
Mounting	none – plugs into a USB port or into a USB extension cable

4 Installation

4.1 Software and driver

- Install the T24 Toolkit on the PC first (**setup.exe**); the drivers for the base station are installed with it.
- Then plug the base station into a USB port. It is powered by the USB bus.
- The connected host must support the USB HID device class and USB 2.0 full speed.

4.2 Position

- The antenna sits in the end of the enclosure opposite the USB connector. Keep this end free and away from metal parts.
- Some unshielded USB 3.0 ports produce broadband noise in the 2.4 GHz band. Symptoms are the inability to pair, reduced range or intermittent data reception. Plug the base station into a different USB 3.0 port, into a USB 2.0 port, or use a short USB 2.0 extension cable (USB A male to USB A female).
- Only one base station of this type can be connected to a PC at a time (fixed address 1).

5 Basic principles of the T24 radio system

A few radio settings and concepts have to be understood to configure, deploy, optimise and troubleshoot a T24 telemetry system.

5.1 Transmitters and receivers

All T24 modules are transceivers, but they mainly work either as a transmitter or as a receiver. Transmitters are the sensor modules: they measure load, strain, voltage, temperature and so on and send messages with the measured value and status information at a user-defined rate. Receivers use these messages to display, analyse or process them – handheld displays, large displays, output modules – and can control the transmitters, for example send them to sleep or wake them. A PC and a base station are only required to configure the modules, although they can also be part of a data collection system. Once configured, the modules work autonomously.

5.2 Radio channel and group key

Two modules can only communicate if they share the same radio settings:

Setting	Meaning
Radio channel	The frequency the radio works on. The T24 band is divided into 15 channels (1 ... 15). Modules must be on the same channel to exchange messages.
Group key	Isolates groups of modules on the same channel: no module can affect another or see its messages unless both have the same group key. Defined by the user, up to 15 alphanumeric characters. Group keys were introduced with radio firmware v3.0 (March 2015); to work together with older modules that do not support them, the group key must be blank.

5.3 ID and data tag

- Every module has a unique 6-character hexadecimal ID allocated at the factory, for example **FF1234**. The ID is used to configure the module.
- A transmitter does not send its ID with its measurement messages. It identifies them with a data tag: a 4-character hexadecimal number, set at the factory to the last four characters of the ID and changeable by the user. Receivers and software select the messages they use by this data tag.
- Because of this, a transmitter can be replaced without reconfiguring the receivers: configure the replacement with the same data tag, radio channel and group key.

5.4 Operating modes of a transmitter, sleep and wake

Mode	Behaviour
Normal	Takes a reading, sends a message and enters a very low power state until the next reading.
Configuration	Pauses sending and disables the low power state so that the module can be configured; entered by pairing. Normal operation resumes afterwards.
Sleep	The module is sent to sleep by another module, or goes to sleep by itself when its messages are no longer used. It can be woken on demand by other modules or by software via a base station.

Transmitters have a sleep delay (in seconds). Most receivers and the T24 software send stay-awake messages, usually every 5 seconds, while they receive messages from a transmitter. If no stay-awake message arrives within the sleep delay, the transmitter goes to sleep. The sleep delay should therefore be at least 10 seconds; it can be set up to one hour where the receiver may be out of range for a while. Values between 30 and 300 seconds are usual. A sleep delay of zero disables the function: the transmitter then only sleeps when told to.

5.5 Pairing

Pairing finds out and matches the radio settings (channel and group key) of two modules, without any visible clue of what those settings are. It is triggered by removing and re-applying the power of the module to be paired, so no physical access to its electronics is needed.

- Pairing from the T24 Toolkit: remove power from the module, click **Pair** in the software and re-apply power. The base station adopts the radio settings of the module and puts it into configuration mode; the settings of the module are not changed.
- Pairing from a receiver: some receivers pair to a transmitter without a PC. The transmitter is set to the radio settings of the receiver, and the receiver learns its ID and data tag. The transmitter continues in normal mode with the altered radio settings.
- Soft pairing: where the power of a module cannot be reached, the T24 Toolkit can connect if the radio channel, group key and ID of the module are known. This works well with receivers; transmitters with a transmission interval of more than 5 seconds may be difficult to soft pair, and in high traffic or high noise environments it may not work reliably – then power cycle pairing is the only option.

5.6 Setting several modules to the same radio settings

When the T24 Toolkit pairs to a module, the base station adopts the radio channel and group key of that module. To give a set of modules the same group key, either pair to each one in turn and set its radio channel and group key, or configure the base station itself (hold the shift key and click **Pair** on the Home page), set it to the required radio settings and then use the tool on the Radio Settings Advanced page to pull each module of the set to the settings of the base station.

5.7 Asynchronous operation and logging

Transmitters send at a fixed interval, timed from when they were powered on or woken, regardless of whether anything is listening; the measurements of different transmitters are not synchronised. Logging software stores the last value received from each transmitter when a log is recorded. With 10 transmitters at 333 ms message interval, the recorded values are only known to lie within 333 ms of each other. If a set of readings must lie within a certain time of each other, that time is the maximum message interval to set; the log interval of the software should always be greater than the transmitter message interval.

5.8 Bandwidth

Each radio channel can carry a finite number of messages; modules on the same channel share it, even with different group keys. A message takes around 3 ms, which would allow at most 300 messages per second; in practice the limit is around 200 messages per second per radio channel. As the number of transmitters increases, more messages collide and are lost. For example, 2 modules may transmit 100 times per second, or 100 modules once per second. Modules that do not need to communicate with each other can be put on separate channels.

5.9 Repeaters and repeater subgroups

A repeater retransmits messages to increase the range or to get around obstacles. It must use the same radio channel and group key as the modules it repeats. Because a repeater doubles the radio traffic, all modules have a repeater subgroup setting (default 0): a repeater repeats messages from all modules whose subgroup is 0 or matches its own; a repeater with subgroup 0 repeats all. Changing it is normally only necessary when the bandwidth is very full.

6 The T24 Toolkit

The T24 modules are configured with the T24 Toolkit, a Windows application that is free of charge. A base station, for example the USB base station EFME, is required as the radio link between the PC and the modules. Install the software by running **setup.exe** and following the prompts.

- All items that can be changed or interacted with are shown in green. Click a green item to open a dialog window (slider, text box or list) and enter the new value.
- Double-clicking the icon in the top left of the window copies a screenshot of the current page to the clipboard.

Important Do not pair to multiple modules with multiple instances of the toolkit at the same time.

6.1 Connecting to the base station

On the start page select the interface type of the connected base station; for a USB base station no further settings are needed. The base station address is usually 1. Click **Home** to start communication. If no communication can be established, the toolkit stays on this page: check that the base station is powered and connected correctly.

6.2 Home page: connecting to a module

With communication to the base station established, pair to the module to be configured:

- Remove power from the module.
- Click **Pair** in the toolkit.
- Re-apply power to the module within 10 seconds.

If the connection succeeds, the toolkit changes to the Information page; if pairing fails, try again. Pairing does not change the radio settings of the module – the base station adopts those of the module. While the toolkit is connected, the module usually stops its normal transmission of messages.

- To configure the base station itself, hold the shift key and click **Pair**.
- If the power supply of the module cannot be reached, click the **Click Here** link at the bottom of the page and follow the prompts (soft pairing).

6.3 Information

Shows information about the connected module. A name can be entered to recognise the module later. The features supported by the module are shown as icons – coloured if supported, greyed out if not: protected calibration, group key support (and whether a group key is configured), listing of sleeping modules (base stations only), extended range radio (introduced 2015) and version 4.0 radio (better performance in hostile RF environments).

6.4 Battery and radio levels

Shows the radio signal levels at the base station and at the remote module, and the battery voltage of battery powered modules. The battery level at which a transmitter reports low battery can be set here (at 2.1 V the module stops working); below this level the bar turns orange. **Advanced** shows the details of the received radio packets:

Value	Meaning
LQI	Link quality indicator, 0 ... 100. Communication is achieved within this range; towards zero it may become intermittent.
RSSI	Received signal level, from about -30 (good signal) to -98 (weak signal).
CV	Correlation value, how well the signal can be decoded: 55 (poor) ... 110 (excellent).

6.5 Radio settings

Item	Function
Channel	Radio channel 1 ... 15, default 1. The spectrum analyser helps to find a clean channel.
Group Key	Only visible on modules that support group keys. Only modules with identical group keys can communicate; blank for operation together with older modules.
Reset Module Only	Enabled after a change. New radio settings only take effect after a reset or power cycle; this button makes the module adopt them while the base station stays on the existing settings, then returns to the Home page.
Reset Module and Base Station	Enabled after a change. Module and base station adopt the new settings and the connection is re-established.

When the radio settings of a base station are changed, the two reset buttons are not shown; the change takes effect immediately.

6.6 Radio settings advanced

- **Repeater Subgroup:** default 0, which lets all repeaters repeat messages from this module.
- Remote module radio settings tool: sets a batch of modules to the radio settings of the base station. Usually reached by pairing to the base station (shift + **Pair**). Remove power from the remote module, click the **Click Here** link, re-apply power. The toolkit stays paired as before; only the remote module changes its radio settings.

6.7 Save and restore

Save writes all configuration information of the connected module, including calibration data, to a file with the extension **.tcf**. **Restore** loads such a file into the connected module and overwrites all configuration information including user calibration data.

7 Configuring the base station

Usually the base station does not need to be configured: when the toolkit pairs to a module, the base station is set automatically to the radio settings of that module. Configure it directly if you want to communicate with the modules using your own software, or to soft pair to a module.

- Start the T24 Toolkit with the base station plugged in.
- On the Home page hold the shift key and click **Pair**.

Page	Item	Function
Radio Settings	Channel	radio channel 1 ... 15, default 1; the spectrum analyser helps to find a clean channel
	Group Key	only modules with identical group keys can communicate; blank for operation with older modules without group keys
Advanced	Waker Duration	duration in seconds of a wake attempt sent to a module via the base station; normally not to be changed

Changes to the radio settings of the base station take effect immediately.

8 Site survey and radio diagnostics

8.1 Spectrum analyser

Shows the radio signal levels detected across all channels. Use it for a site survey before installation or to diagnose poor communication, and choose a quiet channel. 16 channels are shown; the modules use channels 1 ... 15, channel 16 is reserved for pairing negotiation.

Trace	Meaning
Real-time detected signal (white)	Where other radios are operating at this moment. T24 works alongside other transmissions, but quiet channels are preferable.
Peak detected signal (shaded)	Builds up a picture of where the traffic has the highest power.
Minimum detected signal (red)	Important: in a quiet RF environment it is not visible. Where it shows, there is broadband noise or very high traffic. As long as it stays below the CCA threshold of the radios in use, they still operate; avoid channels with a high minimum level.
Band noise floor	Lowest level across the band, usually off the bottom of the chart. If visible, it indicates underlying problems in the environment.
CCA thresholds	Radio v3.x and below do not transmit above their threshold (orange dotted line); v4.0 radios have a revised threshold for high-noise environments; v5.0 radios adapt their threshold to the tracked noise floor.

Levels above -95 start to reduce the maximum achievable range. A double-click on the chart resets the peak and minimum calculation.

Note Some unshielded USB 3.0 ports of PCs emit broadband noise in the 2.4 GHz band. It reduces the range of a base station placed close to such a port and can prevent pairing. Use a USB port away from USB 3.0 ports, or a short USB 2.0 extension cable.

8.2 Channel monitor

Lists the messages received from transmitters: data tag, number of messages, transmission rate, link quality, value and error messages. Some base stations also list sleeping modules, shown with their ID instead of a data tag. The base station must be on the same radio channel and have the same group key as the transmitters.

Item	Function
Radio channel tabs	Change the radio channel of the base station.
Clear List	Clear all detected messages from the list.
Wake All	Wake all modules on the current radio channel with matching group key.
Start Logging	Log the received data to a CSV file: data tag, elapsed ms, value.
View Last Log	Open the last logged file in the application associated with CSV files.
Move Group Channel	Visible if the base station has a group key. Moves all detected transmitters and all other modules on the same channel and group key (for example handheld displays) to a new channel; they are woken first, then the base station follows. Receivers are not listed – make sure they are available to be woken.
View Real-Time RSSI	Base stations with radio firmware 4.1 or later: real-time RSSI (white) and the allocated CCA threshold (red). A module can transmit when the RSSI is below the red trace.

The text below the real-time chart assesses the suitability of the channel, from critical to excellent. A channel assessed as excellent for its background noise can still be unsuitable because of too much traffic.

9 Fault finding

Observation	What to check
The toolkit stays on the start page	No communication with the base station: is it plugged in, was the toolkit (with the driver) installed before the first plug-in, is the interface type set correctly?
Pairing fails	Try again. Re-apply the power of the module within 10 seconds of clicking Pair . Check for USB 3.0 noise (section 4.2).
Soft pairing does not connect	Radio channel, group key and ID of the module must be known and set. Transmitters with an interval above 5 s and busy or noisy channels make soft pairing unreliable – use power cycle pairing.

Observation	What to check
The channel monitor stays empty	The base station must be on the same radio channel and have the same group key as the transmitters. Wake the modules with Wake All .
Poor range or intermittent data	USB 3.0 port nearby, base station shielded by the PC or the user, obstacles in the line of sight. Check the spectrum analyser and the link quality (LQI, RSSI, CV).
Group key not available	Modules built before 2015 do not support group keys; leave the group key blank when they are used together with newer modules.
Unexpected behaviour while configuring	Do not pair to multiple modules with multiple instances of the toolkit at the same time.

10 Radio, antenna and range

10.1 Radio specification

Item	Value
Licence	licence exempt
Radio type	transceiver (2-way)
Frequency	2.4000 ... 2.4835 GHz
Channels	15 (DSSS)
Modulation	MS (QPSK)
Data rate	250 kbit/s
Transmit power	10 mW
Antenna	integrated chip antenna (1.3 dBi) in the end of the enclosure opposite the USB connector

10.2 Range

Maximum range in an open field site between this device and the other module, depending on the antenna of the other module. The base station itself has the integrated chip antenna.

Antenna of the other module	Range
Integrated chip antenna (1.3 dBi), e.g. EFME	500 m
Internal 3 dBi inverted-F antenna, e.g. EFMC, EFMD, EFMG	600 m
External ½-wave dipole antenna (1.1 or 2.2 dBi)	400 m
External 3 dBi surface-mount antenna (IP69K)	600 m

Tests conducted in an open field site with the transmitter at the top of a 3 m pole; the receiver was mounted 1.5 m above the ground.

10.3 Installation guidelines

Radio performance at 2.4 GHz depends strongly on the environment. Any structure within the operating region of the radios has three effects:

Effect	Consequence
Obscuration	An obstruction masks the line of sight between the radios: reduced range.
Distorted radiation pattern	Structures or objects near the antenna distort the coverage: reduced range and link quality.
Reflection	Signals arrive by an indirect path: reduced range or poor link quality.

- Maintain line of sight between the modules and keep objects or structures at least one metre away from the antennas wherever possible.
- A small increase or reduction of the antenna height often improves reception.
- Under water the range is only about 100 mm, depending on the packet rate.

Note The range of the USB base station may be reduced because of its close proximity to the computer and the user. Where necessary, use a USB extension cable to move it away from the PC.

11 Approvals and declaration of conformity

Region	Conformity
Europe	CE
USA	FCC, FCC ID: VHARA24
Canada	IC, IC: 7224A-RA24

11.1 Europe (CE)

The equipment complies with the EMC Directive 2014/30/EU and with the essential requirements and other relevant provisions of the Radio Equipment Directive 2014/53/EU; valid for the European Community, Switzerland, Norway, Iceland and Liechtenstein.

The EU declaration of conformity for the T24 telemetry product range (date of issue 16 October 2017) covers:

Directive	Harmonised standards
2014/35/EU Low Voltage	EN 61010-1:2010
2014/30/EU EMC	EN 61326-1:2013 · EN 61326-2-3:2013
2011/65/EU RoHS	–
2014/53/EU Radio Equipment	EN 300328 V2.1.1

The declaration of conformity is available from octagon on request. The CE marking, FCC ID and IC number are printed on the label of the device.

11.2 Canada (IC)

IC: 7224A-RA24. This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To comply with Industry Canada RF radiation exposure limits for general population, the antenna(s) used for this transmitter must be installed such that a minimum separation distance of 5 cm is maintained between the radiator (antenna) and all persons at all times and must not be co-located or operating in conjunction with any other antenna or transmitter.

11.3 USA (FCC)

FCC ID: VHARA24.

- This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.