KERT_AE® Quick-Start Guide for Version 4

The first part of this document is based on the delivery status and describes how to charge the batteries, to connect the computer with the AE devices, to update the firmware, to register the devices and to set up the browser. *Table 1* lists the most important application criteria for all available items. Not every part is required for a specific measurement configuration. AE measurements are already possible with an ISM type sensor and a smartphone. Various measurement situations and the necessary settings are then dealt with in detail.

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Table 1 **List of possible system components**

	Sensor Type ISM *Power supply:* Li-Ion, FeLiPO4 or USP-C *Data transfer:* Bluetooth LE or a proprietary protocol
	Sensor Type SPE *Power supply and Data transfer:* Single Pair Ethernet cable
	Sensor Type ISM *Power supply:* Li-Ion, FeLiPO4, SPE cable or USP-C *Data transfer:* Single Pair Ethernet, Bluetooth LE or a proprietary ISM protocol
	Mid Device Only necessary for the sensor type SPE. Recommended for sensor type DUAL and measurement setups with more than eight sensors or when extremely high event rates are expected.
	USB-C charging cable Only necessary for the sensor type ISM.
	Single pair Ethernet cable Only necessary for the sensor types SPE and DUAL.
	Desktop, Notebook, Tablet or Smartphone Minimum requirements: ◆ Bluetooth 4.2. ◆ Browser version (Chrome 85, Chrome Android 85, Edge 85, Opera 71). Requirements for advanced features: ◆ Bluetooth 5.2. ◆ Dual WiFi 2.4 and 5 GHz.
	USB C power adapter or bank The KERT devices detect USB BC1.2, SDP, CDP, DCP and HVDCP
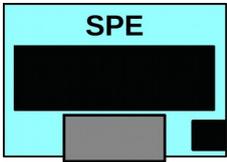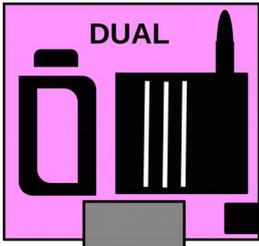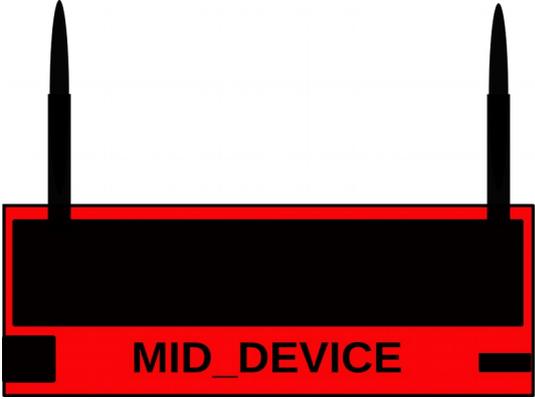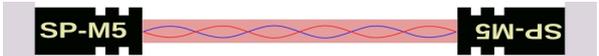
1. Before the first measurement

1.1 Visual inspection of all devices

⚠ Before each use, it is absolutely necessary that all devices are checked for mechanical damage. There is a risk of explosion for damaged devices. This applies in particular to the Li-ion batteries. LiFePO4 batteries are more robust. Leaking cells can damage the sensor element and the electronics, hier too. The voltage generation for the test signals can also pose a risk if the housing is defective.

1.2 Charge the batteries

In general, all KERT_AE® devices detect power sources of types USB BC1.2, SDP, CDP, DCP and HVDCP. The sensors require 900 mA at 5V and can also be charged via standard USB 3. A 45 Watt USB Type-C source using Power Delivery is strongly recommended for rapid charging of Mid Devices. When charging for the first time, the status is indicated by the dual LED:

Blink Code	Description
red	Charching, connection not possible.
red/green	Charging, connection allowed.
green	Fully charged, connection allowed.

All other signals are error messages (see 5. Troubleshooting). The leds turn off when the device is connected to the KERT_AE® web application. The charging is then displayed on the **Status Log**.

1.2.1 Charging schematic without Mid Device

ISM and DUAL type sensors can be charged as follows:
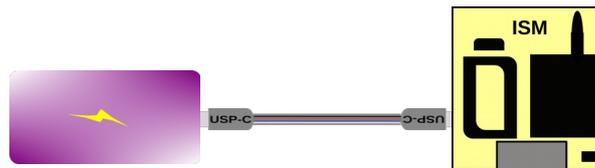
1.2.2 Charging schematic with Mid Device

Mid Devices and SPE or DUAL type sensors can be charged as follows:
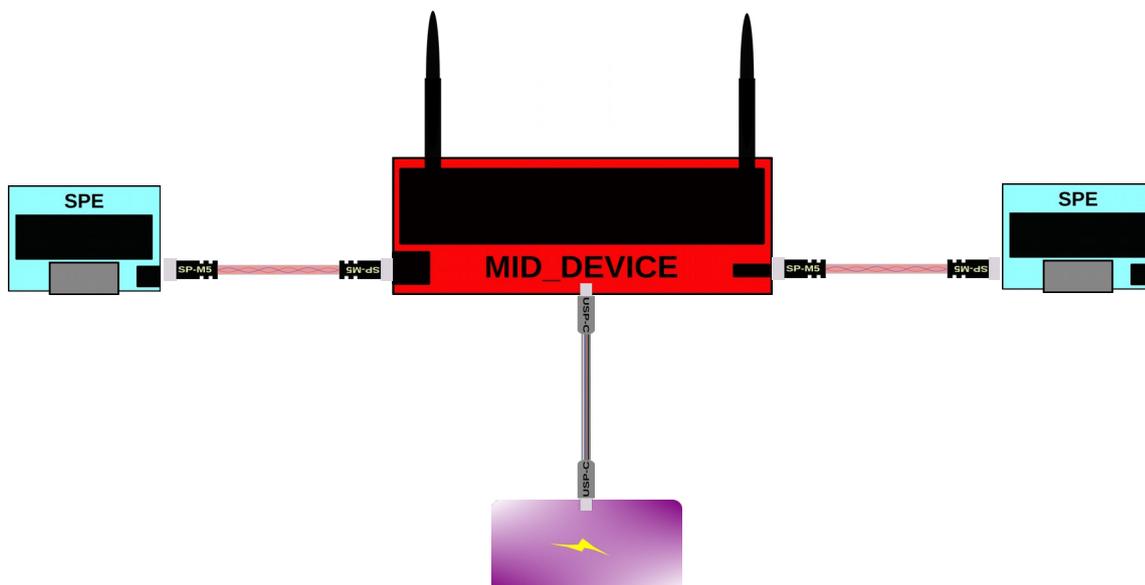
The power bank is connected to the Mid Device via a USB-C PD charging cable. Four sensors can be charged simultaneously via Single Pair Ethernet cable.

1.3 Set up the browser

The software that runs on the desktop, notebook, tablet or smartphone is a so-called web application. Such applications use HTML5 with the APIs defined there and can in principle be opened in any browser. Since device version 3.2, we have been pursuing the strategy of using the latest API standards, even if jet not all browser manufacturers have implemented the new features. This enables us to develop more efficient programs. However, not all browser types can use initially for a short time. With version 3, it only took five months for all common modern browsers to master the new functionalities.

As of February 2022, the new features we are using in AE version 4 are proficient on Android M, Chrome OS, Mac and Windows 10 operating systems. A current version of the Chrome, Edge, Opera, Chrome Android, Opera Mobile or Samsung Internet browser may need to be installed.

On Linux, the Chrome browser works if Kernel 3.19+ and BlueZ 5.41+ are installed and flag `#enable-experimental-web-platform-features` is set.

1.4 Scan all devices
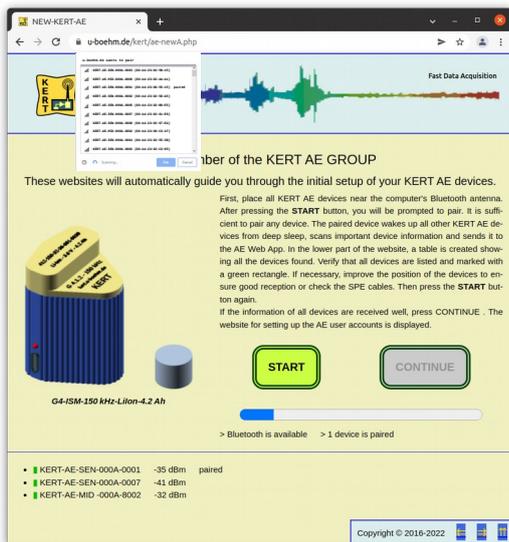
Now place all KERT AE® devices near you and open the website www.kert.u-bohm.de/ae-new.php in the browser. This website will automatically guide you through the initial setup. You will get to know some important perspectives of the KERT AE® Launcher (see 2.). After pressing the START button, you will be prompted to pair. It is sufficient to pair only any device. The paired device wakes up all other KERT AE devices from deep sleep, scans important device information and sends it to the AE Web App. In the lower part of the website, a table is created showing all the devices found. Verify that all devices are listed and marked with a green rectangle. If necessary, improve the position of the devices to ensure good reception or check the SPE cables. Then press the START button again.

If the information of all devices are received well, press CONTINUE . The website for setting up the AE user accounts is displayed.

1.5 Define AE user accounts

KERT_AE® knows three user groups AE_KING, AE_USER and AE_GUEST. In the future, only users of the AE_KING group can change basic settings. This includes adding or deleting users, deleting other users' data, and changing AE server settings. AE_GUESTs can only start preset measurement regimes. If a user from a higher or equal group logs in, the new user takes control. The other users who are already logged in only have an observation status.

It is good practice to assign Level 3 reviewers to the AE_KING group, Level 2 reviewers to the AE_USER group, and Level 1 reviewers to the AE_GUEST group. A member of the AE_KING group can change the assignment at any time.

At least AE_KING user must be declared. When the user table is filled, press CONTINUE . The website for registering the KERT_AE devices and users is displayed.

1.6 Register the devices and the AE_KING users

It is strongly recommended to register all devices and key users to automatically receive updates and information to bugs. By default, all found devices and users of the AE_KING group are registered. Users can be added or deleted from the list. All registered users have access to our protected websites. First press SAVE and then CONTINUE when the buttons highlighted green. The website for set update the server is displayed.

1.7 Set up the https server

1.7.1 Overview

The KERT AE web application can be used both with and without a https server. For AE user, both variants differ primarily in where the data storage is located and who has how access to the measurement data. In the simplest variant without a server, the data is an integral part of the browser that generated it. The data is not accessible from the outside of the browser and can only be read by the website that wrote it. This method ensures a high level of security in a simple manner. However, handling the data takes some getting used to, since standard tools such as the file manager cannot be used. The exchange of data with other users and computers is also more difficult and ultimately results in the data having to be uploaded to a server. The figure below shows the setting for the storage setting.

```
Storage Setting

  ☐   Inside the browser with Web IndexDB API.

  ☑   Server URL:  "http://localhost:8080/ae-root/" , "https://my AE server.com"
```

There are three scenarios for storing the measurement data:

I. It is not necessary to store large amounts of raw data, because the final evaluation takes place promptly and only the generated diagrams should be documented. In this case you only have to tick the Web IndexDB API.

II. If you have an internet connection to an https server on which the raw data is to be stored, the files ae-server-*.php must be uploaded to this server and the server domain entered in the form above.

III. You want to store large amounts of raw data even without internet access to the https server. In this case, the server http://localhost:8080 must be installed on the measuring computer. Most browsers accept localhost:8080 as a secure connection. If necessary, this connection must be allowed by the browser settings.

When the buttons are highlighted in green, press `SAVE` and then `CONTINUE`. The firmware update website is displayed.

1.7.2 Setting up a local https server (only for scenario III)

The use of a local https server requires additional installations and careful handling of the files and security guidelines, but increases the flexibility of the measurement system. For desktops and notebooks it is recommended to install Appache2 on the measuring computer from the start. Appache2 is the most commonly used server and there are numerous installation and configuration descriptions on the net for all operating systems. The default setting only allows local access. This is sufficient for the time being and guarantees safe operation. The saved files can usually be found under `C:\Apache24\htdocs\ae-root` on Windows. For Linux, the directory is `/var/www/html/ae-root`. When using Tablets or Smartphones should start with the Web IndexDB API or an external server.

After the default installation, Apache 2 works as an http server. However, the web APIs we use require an https server with SSL certificate. There are two types of certificates: certificates signed by a "Certificate Authority" or CA and "self-signed certificates". A CA is a trusted source for an SSL certificate, and using a certificate from a CA allows the users to trust the website's identity. If you only allow access to the local https server from your own computer, a "self-signed certificate" is completely sufficient. You can create a "self-signed certificate" by using the powershell command pki on windows, openssl is the command on Linux or Mac. Make the necessary settings in `httpd.conf` and `httpd-ssl.conf`. In addition, a PHP interpreter must be installed and the file `ae-server-*.php` must be uploaded and the root folder of the localhost have to entered in the form above.

1.8 Update the firmware

First press UPDATE and then FINISH when the buttons highlighted green. The initial setup is complete and the AE Launcher is displayed.

All settings made in section 1 can be changed using the "**SET BASICS**" perspective.

2. Explore the KERT AE Launcher

The software that runs on the Desktop, Notebook, Tablet or Smartphone is a so-called web application. To start your personal KERT AE® Webapplication, enter www.kert.u-bohm.de/ae-web.php in your browser.
When KERT AE® Webapplication opens, the first screen is the login page. After logging in, the **Launcher** will appear without any **Perspective.** The Launcher is the top screen of the application. Perspectives are compilations of views such as setting forms or result plots. The image below shows the "LOAD EXEMPLES" perspective.
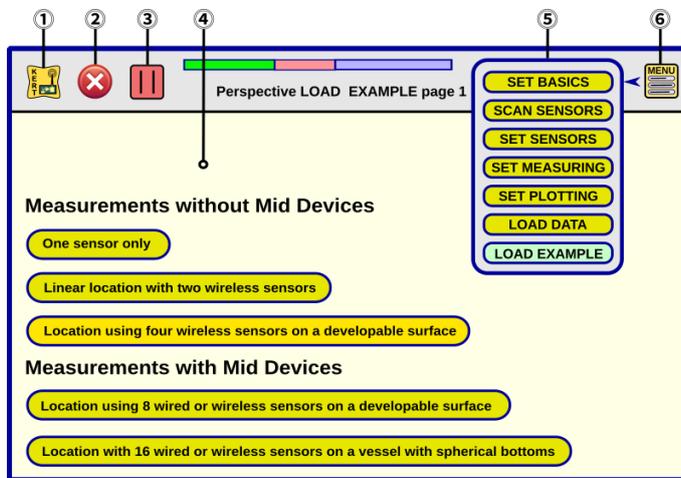
①	The logo button toggles between the selected perspective, the evaluation plots and the status display.
②	This button toggles AE measurement on and off.
③	The record button starts or stops the storage of the measurement data.
④	This is the space for the selected perspective.
⑤	This is the selection list of the perspectives.
⑥	The menu button opens and closes the selection list.

Some perspectives consist of multiple web pages. Click or touch an unused area of the right or left half of the perspective to page forward or backward.

3. Measurement examples

There are five preset measurement regimes that allow you to quickly perform a successful AE measurement.

Measurements without Mid Devices

- ◆ One sensor only
- ◆ Linear location with two wireless sensors
- ◆ Location using four wireless sensors on a developable surface

Measurements with Mid Devices

- ◆ Location using 4 or 8 wired or wireless sensors on a developable surface
- ◆ Location with 8, 12 or 16 wired or wireless sensors on a vessel with spherical bottoms

The examples work with the "AUTOMATIC" setting for many parameters. For instance the threshold is derived from the RMS and peak values of the noise. This procedure always produces reasonable values for the threshold and guarantees successful measurements. However, this is not the best idea for comparative measurements, because different threshold values are set for each measurement. You should first carry out test measurements with the preset parameters. Then carefully change the default setting. In this way, you quickly become familiar with all the setting options.

4. Next steps

- Try the new feature of version 4 for position measurement of the sensors. You only have to enter the geometry of the test object and specify which sensor should be in the coordinate origin.
- Familiarize yourself with the Appache2 server. After installation, a secure configuration is set that only allows local access. This means that the AE data can be used with well-known tools, such as file managers, etc.
- Find out how you can securely access the measurement data from other computers.
- If you use at least one Mid Device, you can also remotely control the measurement over long distances.
- Only the firmware of the sensor and the mid device is proprietary. The browser software is open source. With basic knowledge of Java Script programming, you can create your own evaluation algorithms and presentations of results.

Visit our protected websites for more detailed information. You can log in with the registered email address and your AE password (see 1.6 Register the devices and the AE_KING users).

5. Troubleshooting

If a charging cable is used and there is no connection to the AE Web App, the charging status is indicated by LEDs according to the table below.

Blink Code	Description
red	Charging, connection not possible.
red/green	Charging, connection allowed.
green	Fully charged, connection allowed.
red — — — — —	Temperature error, connection not possible.
green/red — — — — —	Temperature error, connection allowed.
red — — — — —	Timeout error, connection not possible.
red/green — — — — —	Timeout error, connection allowed.

Temperature error means the batteries are too cold or too hot. The permissible range for Li-ion batteries is between 0°C and 45°C. -10°C to 60°C applies for LiFePO4 batteries. Charging will resume when the battery temperature is back within the allowable range. The timeout error occurs when a part of the loading process take much longer than intended. This occurs when either the power of the charging source is too weak or the batteries are defective.

Once a connection has been established to the AE Web App, the LEDs will turn off. Details on the charging status and other errors can then be found in the app. The KERT logo button toggles between the selected perspective, the evaluation plots and the status log.