



SMARTCOACH FREQUENTLY ASKED QUESTIONS (FAQ)

1. INTRODUCTION

This document summarizes the most commonly asked questions about SmartCoach products, software and technology.

2. FREQUENTLY ASKED QUESTIONS (FAQ)

Below are reported the most frequently asked questions and their answers, divided by category.

3.1. GENERAL QUESTIONS

- Q:** What is the difference among “Power Encoder”, “Weight Encoder” and “SmartCoach Lite”?

A: They are three different types of encoders/recording devices. The *Power Encoder* is a linear wire encoder usable with weights and weight stack machines, but also has an additional input for use with flywheel devices (see dedicated FAQ). The *Weight Encoder* is like the Power Encoder but without additional input, hence it can only be used for weights. Finally, *SmartCoach Lite* is an acquisition device which can only be used with flywheel devices.

There are these three different options so that the customer can choose the one which exactly fits his needs without having to pay for features he won't need.
- Q:** What is a “pack”?

A: A pack is a bundle containing a SmartCoach acquisition device and the software with exactly the required modules. For the most popular packs, two versions exist: a basic one where the software only has the most important modules, and a “plus” version with additional, more advanced modules. The most popular packs are:

 - *Performance* and *Performance+*: they both come with a SmartCoach Power Encoder as recording hardware (useable with both weights and flywheel devices), plus software with basic or extended set of software modules, respectively
 - *Inertia* and *Inertia+*: same as above, with SmartCoach Lite as recording hardware (useable with flywheel devices only)
 - *Fitness* and *Fitness+*: same as above, with SmartCoach Weight Encoder as recording hardware (useable with weights only)
 - *Platinum*: SmartCoach Power Encoder + software with all modules + additional services

- *Planner*: software only, with the necessary modules to use it as a powerful training schedule editor

3. **Q:** **What does “modular software” means?**

A: The software has several functions grouped in functional modules. Some are meant for more basic functions, some for advanced features (such as the module to analyze raw data). In an effort to provide exactly what the customer needs, each module can be purchased separately to adjust the software precisely to your needs and budget

4. **Q:** **Can I use SmartCoach on a Mac?**

A: Sure. You will need to have a Windows virtual machine emulator or, better, a separate partition with Windows installed (suggested: Windows 7 or above).

The reason why the software is not Mac native, is that on a Mac it is possible to install Windows-based software (as explained before), but not vice versa. In addition, in a SmartCoach Pro system where several SmartCoach Pads are installed in the sports club own network, this is always a Windows-based network because it offers advanced safety options (such as mounting the server as a virtual machine).

3.2. TECHNOLOGY AND SCIENCE

1. **Q:** Are there any validation studies on SmartCoach?

A: A validation is required whenever a new technology is developed, to ensure that technology is able to measure reliably the variable it aims to (in case of the Power and Weight Encoder, the lifting speed). If a device uses a reliable, previously validated technology, validation is not necessary but, rather, a calibration certificate to ensure that the device measures correctly.

For example, if a company invents a thermometer which measures temperature using an innovative method (e.g. by measuring the room pressure), this has to be validated. But if that company produces a quicksilver thermometer, whose technology is known to be reliable to measure temperature, it has no need to validate that methodology again, but rather to prove that its measurements are accurate.

This is the case of SmartCoach devices: they use the proven, validated methodology of linear wire encoder (see e.g. Bosco C. *et al.*, 1995) used in hundreds of previous studies. This technology relies on measuring the lifting speed; then, given the known load, the Newton's Law is used to compute force and power.

Of course we can provide upon request a calibration certificate, issued by an independent certification authority, which states the reliability of measurement of our devices within specifications.

SmartCoach has been used so far in tens of different, independent scientific studies, both with weight and flywheel training studies, published on peer-reviewed journals. A copy of those papers is available upon request to their respective authors.

2. **Q:** What is the sampling frequency of SmartCoach, and is it sufficient?

A: SmartCoach devices use a sampling frequency of 100 samples/s (100Hz), which has been chosen based on sound scientific bases, namely on the Nyquist-Shannon sampling theorem. This fundamental theorem of the Information Theory states that the minimum sampling frequency (f_s) required for lossless data acquisition shall be at least twice the maximum bandwidth (B) of the signal to be acquired; the faster a signal varies in time, the larger is its bandwidth.

Therefore, any sampling frequency satisfying the requirement $f_s > 2B$ guarantees lossless acquisition. Using a much higher sampling frequency does not further improve the acquisition quality, but rather degrades the signal/noise ratio by picking up a larger portion of the wideband noise in the background. In other terms, the sampling frequency must be adequately high given how fast the acquired signal changes over time, but not excessively such as to degrade the signal/noise ratio. Of course a sampling frequency of 100Hz is insufficient for other types of signals, such as in raw EMG recordings.

A recent publication (Bardella P. *et al.*, *Optimal sampling frequency in recording of resistance training exercises*, Sports Biomech. 2016) using SmartCoach proved that a sampling frequency of 100Hz is by far more than sufficient in any practical case and even under the most explosive exercises.

A much higher sampling frequency than required by the Nyquist-Shannon theorem has no scientific evidence and is barely used as a (conceptually wrong and deceiving) selling argument.

3. **Q:** How do I calibrate my SmartCoach encoder?

A: SmartCoach linear encoders use a digital, calibration-free technology to measure speed, based on a wire wound on a spring-loaded drum. As the wire is pulled, the drum is spun. The drum has a number of equally spaced holes detected by a digital photocell, which creates a train of electric pulses. Speed is computed from the interval between subsequent pulses, knowing the diameter of the drum and the number of its holes (which are constant over time). For this reason, since none of those parameters or physical variables change over time, a periodic calibration is not necessary. The same is true for use with flywheel devices, where a similar sensor is mounted on the shaft to measure rotational speed.

Other types of commercial encoders use a different technology, such as an analog tachometric generators which produce a voltage proportional to speed that require periodical calibration. This is the reason why SmartCoach devices require no calibration while other encoders do.

3.3. SOFTWARE AND LICENSE POLICY

1. **Q:** **Is the software free?**

A: The software is free to download for evaluation purposes. However, as for any professional product or service, the software is not for free because of the continuous investments in time and money to improve it by adding new features. Selling the software (at a reasonable price) allows us to keep up with the highest quality standards required by our professional customers. The software can be purchased alone (if you already have a SmartCoach encoder or recording device) or in a *pack* together with the hardware.

2. **Q:** **How do I purchase and obtain the software?**

A: Whenever you buy the software (alone or in a pack together with any SmartCoach device), you are provided with an activation code sent by e-mail. You can download and install the software yourself from www.smartcoach.eu/downloads. Once installed, you will have to dial in the activation code to unlock it.

3. **Q:** **How many copies of the software can I install?**

A: The purchase of the software (alone or in a pack) comes with an activation code sent to you by e-mail. It can be used to activate, by default, one copy of the software on a given computer. Of course you can purchase a license with two or more activations if you need to have several copies of the software installed.

4. **Q:** **What does the expiry date on my license mean?**

A: The license and activation code received by e-mail upon purchase of the software have an expiry date, by default 12 months from purchase. You have to activate all the copies of your software, through the provided activation code, within that date. After that date, the activation code can no longer be used to activate the software.

In addition, if software upgrades are released before that date, you will be entitled to obtain them for free.

5. **Q:** **Do I have to renew my license each year to keep using my software?**

A: Absolutely not! Once the software has been activated, it will remain fully functional for a lifetime, even after the license has expired. Simply, after expiry, you will not be able to get new upgrades for free, but you can keep your current software version perfectly functional.

6. **Q:** **How can I upgrade the software by adding more modules?**

A: Contact your Distributor and ask for the desired modules. They will update your license and, as soon as you restart the software, it will automatically retrieve the activation for the new modules and activate them. Note that, if you want to purchase new modules and your license has expired, you will also have to purchase a license extension (the least possible being one month).

7. **Q:** **My computer broke down. How can I move the software to a different one?**

A: The software is personal, not transferrable and linked to the machine where it has been installed. If you need to move the software to a different computer for whatever reason (damage, theft, etc) you will have to pay a small fee for a license substitution, in which we will disable the previous license (therefore disabling the previous copies) and create a new one for the new computer.

If you previously purchased the *LicenseSafe* insurance (included in the *Platinum* pack), substitution is for free.

3.4. SOFTWARE INSTALLATION AND UPGRADE

1. **Q:** What are the minimum requirements to install the software?

A: The software installs on any Windows-based PC from Windows XP or above (minimum suggested: Windows 7) with at least 1GB of RAM, one free USB port (two if you intend to also mount the wristband reader), screen resolution 800x600 or above.

For Mac users, any Windows virtual machine emulator is required or, better, a separate partition with Windows 7 or above installed.

2. **Q:** How do I find the installation files, and what should I install?

A: Go to www.smartcoach.eu/downloads. There are two components to install: a) the database engine, based on a Microsoft component (SQL Express for SmartCoach) and b) the software itself. Both have to be installed, in this order.

3. **Q:** I want to upgrade an existing copy of the software. How shall I do?

A: Go to www.smartcoach.eu/downloads. You don't have to download or install the database engine again. Also, you don't need to uninstall anything; just download and install the software only (setup_smartcoach_nnn where nnn = version).

4. **Q:** How do I know when a software update is available?

A: The simplest way is to leave enabled the option for automatic update check. You can find it in Tools>Options>Network, Update. Each time the software is started, it automatically checks for updates. If any, it shows a message with the list of improvements of the new software and let you download it automatically (if the free update period has not expired yet). Of course you can also check manually on www.smartcoach.eu/downloads.

5. **Q:** After installation I am asked if I want to import a demo database. What is that?

A: After a fresh installation you have no data (no athletes/patients, no training schedules etc). Clicking "Yes" creates a demo user (athlete/patient) with examples of training schedules and pre-recorded exercise and test data, which you can use to evaluate the software or take inspiration from. You can always delete that demo user afterwards.

6. **Q:** I installed the software but it tells me that, since I do not have a license, the software will start in "demo mode". What does it mean?

A: When you install the software for the first time, it has not been activated yet and has no license. Therefore it starts with several functions disabled which still allow evaluating its functionalities before purchase. If you purchase the software (alone or together with any other SmartCoach product) you will get an activation code which allows unlocking it, giving access to all of its functions.

7. **Q:** How do I check for software upgrades, and how can I obtain them?

A: Each time the software is started, it automatically checks for updates. If there is a new version available, you will be notified with a message with a list of improvements in the new version. If your license hasn't expired, you will have the option to download and install the upgrade. If your license has expired but you want to upgrade to the new version, you will have to purchase a license extension. You can change the settings for automatic update check in Tools>Options>Network, Updates.

8. **Q:** How often are upgrades released?

- A:** Upgrades are not released on a regular basis. They depend largely on product development, on how many suggestions we receive for improvements, etc. We believe it's much more professional to release less upgrades with substantial improvements, than several upgrades with small, non-significant changes. Therefore, we do not commit in releasing a minimum number of upgrades per year.

3.5. USE WITH WEIGHTS

1. **Q:** Can the load be expressed in lbs instead of kg?

A: Of course! The SmartCoach software is available in four different languages (English, French, Spanish, Italian) and with both metric (kg, m/s) or imperial units (lbs, ft/s).

You can change the language and units from the **Tools>Language and units** menu.

In a SmartCoach Pro environment, you can even set each element (Pads, server clients) with different languages and/or units, and conversions are done automatically.

2. **Q:** Can I measure non-linear weight exercises?

A: In a non-linear weight exercise the weight is not following a purely vertical path, such as in a biceps curl.

In this type of exercise, the load (M) is subjected to a combination of:

□ vertical movement, where the force is given by: $F_v = M(g+a)$

□ horizontal movement, where the force is given by: $F_h = Ma$

where $a = dv/dt$ = acceleration measured, g = gravity acceleration and with the relative contribution of the two components changing constantly over the range of motion. With the arm horizontal and forearm fully extended, the movement is initially almost purely vertical, while with the forearm at 90deg it's almost purely horizontal.

Of course, the linear encoder with its wire connected to the barbell is not able to measure these two components separately, as it assumes a vertical movement. Therefore, the power estimated will be different from the actual mechanical power developed. It would be anyway extremely complex to exactly measure the movement and compute the two components.

However, if the encoder position is normalized and kept identical in different series (or sessions), and if the range of motion is comparable across different series, the discrepancy becomes a systematic error. So, while the exact actual power is measured with a systematic error, the relative change between sets (e.g. the % improvement over time, which is the most important variable), is perfectly correct.

3. **Q:** Why is power different among encoders of different manufacturers?

A: Any well designed and calibrated encoder, of course, should measure raw speed correctly with minimum, negligible discrepancy among each other.

However, when it comes to the calculation of average power, there is regrettably no univocal definition on how it should be calculated, and each manufacturer uses its own "recipe". Some discard a short interval at the beginning and end of the concentric (CON) and eccentric (ECC) phase. Some others consider the CON and ECC phase as the fraction where the speed is at least a given percentage of the top speed reached in each repetition, etc. However doing so, a part of the actual CON or ECC phase is arbitrarily discarded. What is even worse from a scientific point of view, is that these criteria are seldom released by the manufacturers.

The SmartCoach approach is more straightforward and, especially, completely transparent. The software detects as CON and ECC phases the most possible portion of the actual CON and ECC phases (by definition, where $v>0$ or $v<0$); namely, the epochs where speed is above $\pm 0.05m/s$, with duration of 150ms or above, and a displacement of at least 50, 100 or 150mm (depending on the exercise type). These values ensure a robust rejection to artifacts, while retaining as much as possible of the actual CON or ECC phase.

This also explains why average power is often lower in SmartCoach than in other encoders: by discarding arbitrarily an initial and final portion of each phase (where the speed is closer to zero), the average is biased towards higher values than in SmartCoach, where those portions are not discarded.

With the raw data module it's anyway possible to change these parameters and reprocess an acquisition with different criteria. By increasing the thresholds, the values obtained correlate with those from one or another encoder manufacturer, but at the cost of arbitrarily cutting of a portion of data.

3.6. USE WITH FLYWHEEL DEVICES

1. **Q:** Which flywheel devices are compatible with SmartCoach?

A: SmartCoach is compatible with any flywheel device equipped with a sensor, mounted on its shaft, able to measure the speed. A large and increasing number of flywheel device manufacturers now equip their products with a SmartCoach-compatible.

If any non-SmartCoach compatible flywheel device is equipped with a speed sensor, it's most likely possible to adapt it to SmartCoach with a simple cable adapter. In case of doubt, contact us for support.

We also recently started a new policy - the "*OpenSensor Alliance*", see below - to make technical information freely available to any interested flywheel device manufacturer.

2. **Q:** What is the "OpenSensor Alliance"?

A: It's a new policy to make SmartCoach available for flywheel devices of any brand. We provide technical documentation and support to integrate a SmartCoach-compatible sensor into the flywheel device and to create an exercise library for the SmartCoach software. In this way, flywheel device manufacturers can offer their products with a professional, stable and renowned software tool for recording, feedback and assessment with zero investment, and with the peace of mind that such software undergoes continuous improvement.

Interested manufacturers can contact us at: sales@smartcoach.eu.

3. **Q:** Is it possible to indirectly measure force in flywheel devices?

A: Given the technology used, the sensors mounted on flywheel devices allow measuring accurately the rotational speed. Given that the inertia of the flywheel(s) is known *a priori* and entered in the software, from inertia and speed it is possible to measure the torque T (expressed in Nm) and, by multiplying torque and rotational speed, power can be calculated accurately.

In order to measure force, the lever arm b (i.e. the distance between the point of application of force and the flywheel axis) must be known. Then the force can be computed as $F = T/b$. However, the lever arm changes over the repetition, as more turns of the rope or strap are wound on the shaft. This also depends on the strap thickness, which in turn changes over time (for example if the strap wears out and is no longer perfectly flat), on the length of the range of motion and, for conic shaft devices, also on the axial position along the shaft.

In conclusion, since this parameter cannot be measured or estimated reliably, it is not possible to estimate the force in a sound manner, and this is why this parameter is not measured. To measure the force, a strain gauge or load cell shall be mounted directly on the strap or rope, but this type of montage is not available on the majority of commercial flywheel devices.

4. **Q:** What is a "normalized unit" (n.u.)?

A: While a load in weight lifting is measured in kg, in a flywheel device the resistance parameter is inertia. Inertia is a measurement of a body to remain in its state and oppose to acceleration: the higher the inertia, the higher is the torque (force x distance from axis) required to accelerate or decelerate a spinning flywheel.

The inertia not only depends on the mass, but especially from its distribution: a mass concentrated at a distance from the axis provides more inertia than the same mass along the shaft. Basically, it depends linearly from thickness and density of the material, and quadratically from the distance.

The measurement unit for inertia is kgm^2 . However, since this number is often fractionary and impractical to use, inertia in the software is indicated in normalized units (n.u.) which are integer numbers.

Note that the definition of n.u. is different for different devices, so they are not comparable! However, the conversion to kgm^2 is also reported in the software.

For example, suppose a manufacturer which provides three types of flywheels: A, B and C with multiple ratio between each other ($B = 2x$ inertia of A and $C = 3x$ inertia of A), and the inertia of A being 0.13654 kgm^2 .

Then, the most practical solution is to define $1 \text{ n.u.} = \text{inertia of flywheel A} = 0.13654 \text{ kgm}^2$. In this way, if disk A is mounted, the inertia is 1 n.u. ; if disk B is mounted the inertia will be 2 n.u. ; if A + C are mounted, the inertia will be $1 + 3 = 4 \text{ n.u.}$

In case of conic shaft devices, the software already takes into account the inertia of shaft + cone + plate, and the inertia in n.u. is that of the additional weights mounted in pairs; for example: no weights = 0 n.u. ; 2 weights = 2 n.u. , and so on.



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