The Kaffelogic Roaster's Companion

A guide to customising the roast

with the Kaffelogic Nano 7 Benchtop Coffee Roaster

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Contents

Introduction

Roasting coffee is not just a matter of heating the beans until they are hot enough. It requires controlling the rate of heating to maintain a specific temperature gradient within each individual coffee bean throughout the entire process.

The complete set of instructions that control the rate of heating is a *roast profile* or *profile* for short. The curve that is obtained by plotting time vs. temperature throughout the roast is known as a *roast profile curve*. The curve is just one part of a complete profile – there are other settings, as well as the *fan speed curve*.

Define the profile and you determine which flavours appear in the roasted coffee and how they are balanced. You determine the roast style.

The Kaffelogic roast system is profile driven. This is what gives it the ability to accurately reproduce a roast with consistent results every time. Fortunately you do not need to know much about these profiles to get fantastic results from your Kaffelogic—it is designed to make everyday use very simple.

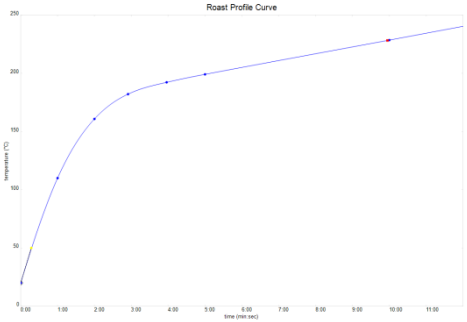
The Kaffelogic Roaster's Companion is not intended to teach you roasting. It is intended to get you started using the Kaffelogic at the level of roasting knowledge that you already have. When you want to extend your knowledge you are best to consult a book such as Scott Rao's *The Coffee Roaster's Companion.*

Bracketing

The beginner will find the built-in profile delivers excellent results without the need for any adjustments. For a first roast, just add green coffee beans and press 'Start'. However most people will want their coffee either darker or lighter and this is achieved by adjusting the level up or down before roasting.

Bracketing is a systematic way of finding the level you like. Bracketing means creating a series of roasts at different levels, centred on the recommended level for the profile. The recommended level for the built-in profile is 3.3, so a good series would be 2.9, 3.1, 3.3, 3.5, and 3.7. Roast a batch at each of these different levels and pick the one you like the most. Then try one stop either side, for example, if you liked 3.1 try 3.0 and 3.2.

Bracketing is best used to find the optimal point using the roast style the profile is intended for. For example, the built-in roast profile was designed for a *medium espresso* roast style. When roasting Colombia Popayan Supremo beans for a medium espresso roast, using the default profile, the best level is 3.6 If you are after a significantly different roast style then it's time to try a different profile.



a typical roast profile curve

The limitations of bracketing

If you are trying for a considerably lighter or darker roast style you will find that as you turn the level down from the recommended level at some point the flavour will start to be undeveloped and lacking sweetness, and as you turn it up above the recommended level at some point the flavour will be dominated by burnt tones. To achieve a completely different roast style you are best to choose a different profile.

It is also possible for a profile curve to have a second sweet spot. For example, the default profile also gives excellent results around the level 1.5 if you rest the beans for 3 days. Fortunately with a Nano roaster radical experiments are affordable so you can discover this sort of thing without risking much coffee.

Roast phases

Drying

During the first phase of the roast the temperature gradient in each bean is established. The beans are at their highest moisture content and therefore their highest heat conductivity. Establishing a good temperature gradient is a matter of applying a suitable amount of energy. It is this temperature gradient that gives the roast its momentum to carry it successfully through the next stages. This stage is usually known as 'drying', but that's not a very romantic term when it's all about building momentum.

Maillard

The second phase is where chemical changes triggered by heat commence. The Maillard reaction is one of the most important of these. It is during this phase that long chain sugar formation starts, giving caramel and roasted food flavours to the coffee. Slowing down or reversal of the rate of rise is thought to interfere with some of the long chain sugars and damage the flavours of the coffee so it is particularly important that the rate of rise does not change sharply. A steadily falling rate of rise is considered optimal. The Maillard phase starts with colour change—where the green beans start to look yellow—at about 160°C, and later generates noticeable additional heat from about 180°C.

Development

The third phase is called 'development' because it is here that the final transformation of grassy flavours into developed roast flavours takes place. Development starts at *first crack*—when the beans begin to snap a little like popcorn, but less dramatically. First crack lasts for a minute or so and typically starts at around 205°C. Later in the development phase there is a recurrence of snapping known as second crack. Second crack is quieter than first crack and can be hard to hear. It marks the emergence of darker roast flavours such as smoky and burnt toast notes. The roast is usually ended after first crack and before, or just into second crack, between 220 and 230°C.

Profile selection

Ideally the supplier of your green beans will also supply profiles for those beans. However, you will find a choice of profiles on the Kaffelogic website and community forum.

1. Find the appropriate profile on the Internet.
2. Download and save that file. If you have *Kaffelogic Studio* installed you can tell your browser to open the profile in *Studio* with a single click.
3. Copy the file to a USB memory stick into a folder called /kaffelogic/roast-profiles. If you have *Kaffelogic Studio* installed you can do this with a single click.
4. Plug the USB memory stick into your Kaffelogic Nano 7.
5. Press 'Profile' repeatedly until you see the profile you want.
6. Press ▸ to load that profile.
7. You are now ready to begin roasting with the new profile.

When you load a new profile the level is automatically set to the recommended level of that profile. If the profile has been matched to the beans you are good to go. If you are mixing things up a bit you might want to try bracketing or development time analysis after loading the new profile.

Development time analysis

The length of the development phase (the time after first crack has started) is one of the important determinants of roast quality. Scott Rao recommends that the development phase should constitute 20–25% of the total roast duration.

Using the same profile, different beans will start first crack at different times. This means that if you are adapting a profile to work with a new lot of beans, you can benefit from development time analysis.

To use development time analysis**,** start the roast at a level higher than you intend to roast to, for example 4.0. During the roast, listen for first crack. When you decide that first crack is under way, press ☰ then ▸ to record the start of first crack. The display now changes to show the time since first crack started (development time), the percent of the total roast time made up by the development time (development time ratio), and the change in temperature since first crack started.

For example, if a roast takes 10 mins, and first crack starts at 7:30, development time is 2½ mins, and the development time ratio is 2.5/10 or 25%.

Wait until your desired development time percentage is showing on the display. Press ▸ then **-** to end the roast.

The level will be automatically set to the point where you stopped the roast. You can use that level as the basis for bracketing to fine tune the results.

Profile creation

A roast profile curve tells the roaster the exact temperature required at each time during the roast. The shape of a roast profile curve is critical for determining the development of flavour during roasting.

The temperature probe is highly sensitive and is in contact with the beans during the roast. It is a good, although not perfect, indicator of bean surface temperature. (It is also influenced by air temperature, so true bean surface temperature is 5 to 10 °C below probe temperature.)

Kaffelogic roast profile curves are open ended. This means they specify the temperature over time, but they do not specify when to end the roast. The end of the roast is controlled by the roast level: a number from 0.1 to 5.9 that is set by the user. A single profile curve can be used to obtain a range of roast darkness simply by varying the level.

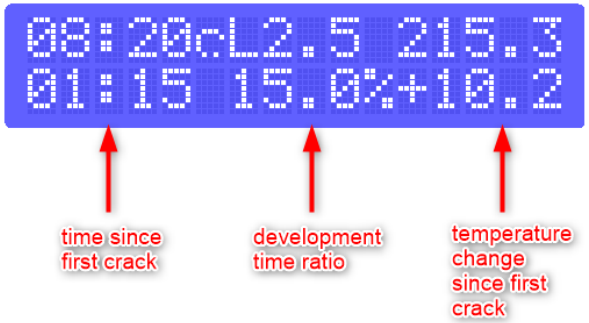
A profile is usually designed to produce a certain kind of roast from a certain kind of coffee bean. It is optimised to one particular roast style and bean origin.

Creating a new profile from scratch is a major endeavour, however you might want to begin by making small changes to existing profiles.

To begin editing profiles, download *Kaffelogic Studio* from the support page at kaffelogic.com. Familiarise yourself with the software before continuing.

Hearing first crack

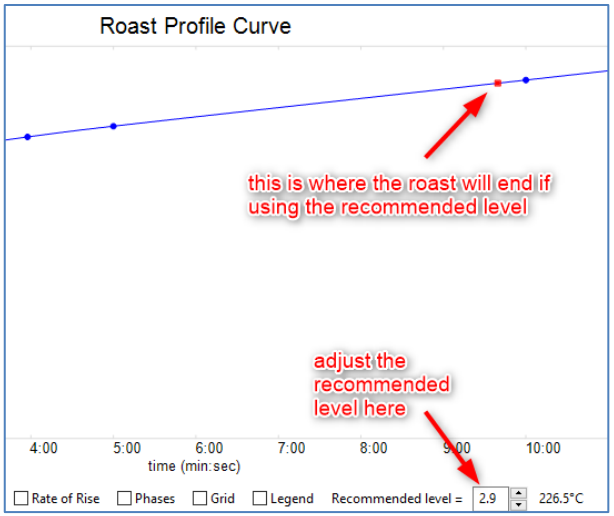
Most beans will have a distinctive first crack, although some will be harder to hear. Some people count the start of first crack as being when the third isolated snap is heard; my preference is to wait until you first hear three snaps in one second.

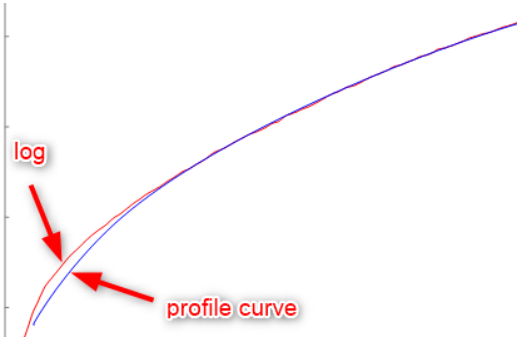


the display after recording the start of first crack

The development of flavour

The degree to which flavour develops is influenced by both development time and momentum. If a roast tastes over- or under-developed it may be an issue of momentum. It could be the drying and Maillard phases that need your attention.





this roast is starting above the profile curve

Recommended level

A profile will have an optimal end point. That point is defined by the *recommended level*.

You will probably want to finalize the recommended level towards the end of the design process by performing several test roasts. The user will always be able to alter the level, but the recommended level should be one that is a generic best for the profile.

Preheat power

The roast chamber has a low thermal mass which allows it to come into temperature equilibrium with the beans quickly at the start of the roast. This initial part of the roast—while equilibrium is being established—is called *preheat* and lasts less than 60 seconds. It is not a true preheat like in a drum roaster where the chamber is preheated without beans; preheat in a Kaffelogic is the time before the roast control algorithm fully takes control.

Preheat power affects the initial power used for preheat and defines the rate of rise for the first minute. The default setting is 1050 Watts to achieve 110°C at 60 secs. If you need a slower or faster start to the roast, adjust accordingly. *Studio* will give you recommendations that help you set this value when you save the profile. Then collect and examine roast logs.

It is generally better to start with enough power to put the roast above the profile curve. It will lock onto the profile curve within the first two minutes, well before colour change.

Starting the roast in this way may seem counterintuitive to those accustomed to a drum roaster, but the drum roaster is preheated *before* the beans are added. When the beans enter a drum roaster they experience a steep rise in temperature that is not shown by the bean temperature probe. In a roaster like the Nano 7 the temperature probe tracks the initial steep temperature rise, so the profile curve must also track that steep start.

The maximum value for preheat power is 1400, but it is probably wise not to exceed 1300 to allow for variations in room temperature and mains voltage.

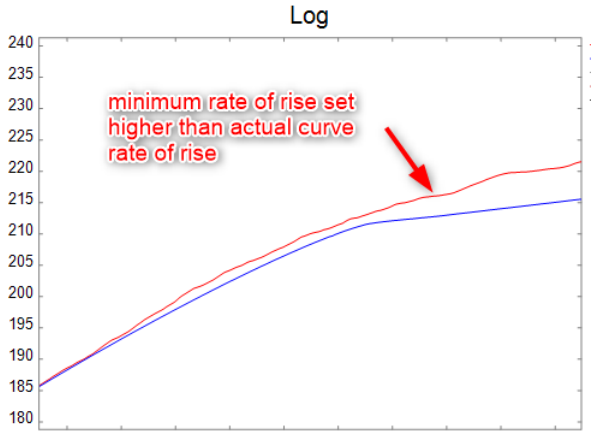
(*Roast required power* is a different thing. It is used to check that there is sufficient voltage available from your mains supply. Usually you can leave it at the default value. If you use more than 1200 watts of preheat power you might need to increase roast required power to match. Roast required power is an advanced setting.)

Another perspective

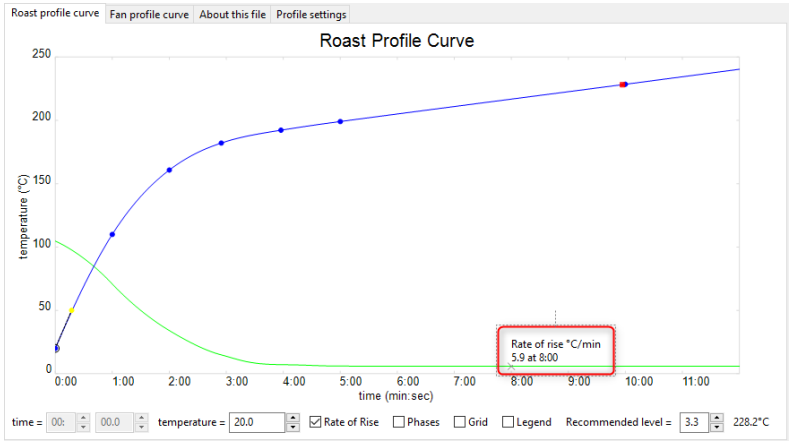
There is a useful forum post that explains preheat power and zone boosts at https://kaffelogic.com/community/viewtopic.php?f=6&t=36&p=163.

Roast min desired rate of rise

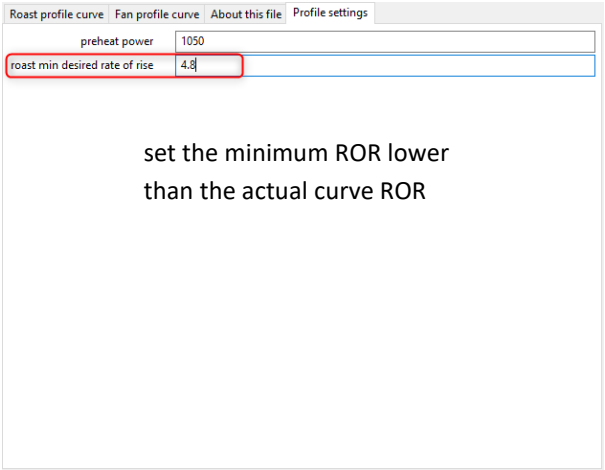
This is the anti-stall setting. If your roast creeps above the profile curve for any reason, you do not want the controller to try to cool it down just to meet the curve. That could stall the roast. By imposing a minimum rate of rise you can avoid this. The roast will re-join the curve, but without ever going below the minimum rate of rise. The minimum rate of rise must be lower than the lowest rate of rise on your profile curve; otherwise the controller cannot follow your profile curve. When you are using the profile designer, click on the green rate of rise line and you can see the exact rate of rise of your profile curve at every point. Use this as a guide to decide on a minimum desired rate.



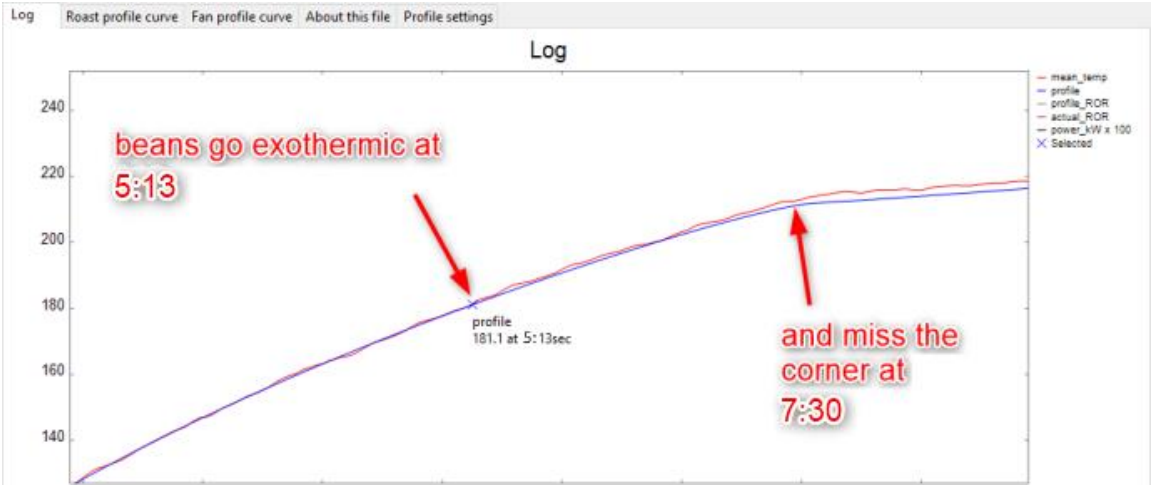
example of what happens if minimum ROR set too high



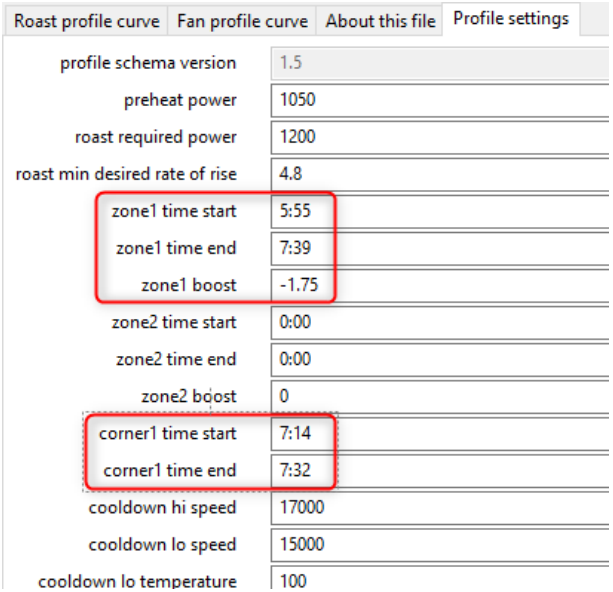
measure the actual curve ROR by clicking on the green line



set the minimum ROR lower than the actual curve ROR



The above faults are rectified with a zone boost and a corner. The values are arrived at after several trial roasts with different values.



Advanced settings

Zones and corners are advanced settings. Use the *Kaffelogic Studio* menu to select Options > Difficulty > Advanced.

Zones and corners

The Nano 7 won't always follow your profile curve perfectly and you may need to tweak the profile to improve the fit. The two main causes of departure are bean thermodynamics and profile corners.

Bean thermodynamics

During certain times of the roast the beans will be generating or absorbing heat faster than the control software can cope. A typical time for nett heat generation (exothermy) is between about 180°C and 205°C. During this time you may see the log curve drifting above the profile curve. During first crack energy is absorbed (endothermy) by water turning to steam and this can cause the log curve to dip below the profile curve. This is especially noticeable as a sudden dip in the actual ROR log curve.

When you are working with one profile curve and one type of bean you will find the zones of exothermy and endothermy are consistent from roast to roast. This means you can accurately anticipate where they will happen, and apply pre-emptive corrections using time-based zone settings.

The simplest zone setting to apply is a 'boost'. A boost is a number of degrees per minute to add to the control algorithm during that zone. If the log curve is drifting above the profile curve apply a negative boost, and if it drifts below the curve apply a positive boost. Estimate the degrees per minute that it is drifting, and

that gives you an idea of how much boost to apply. As a rule of thumb apply a maximum of +/- 5.

It may take considerable trial and error to get the best settings for zone boost; allow half a dozen trial roasts to get things finely tuned.

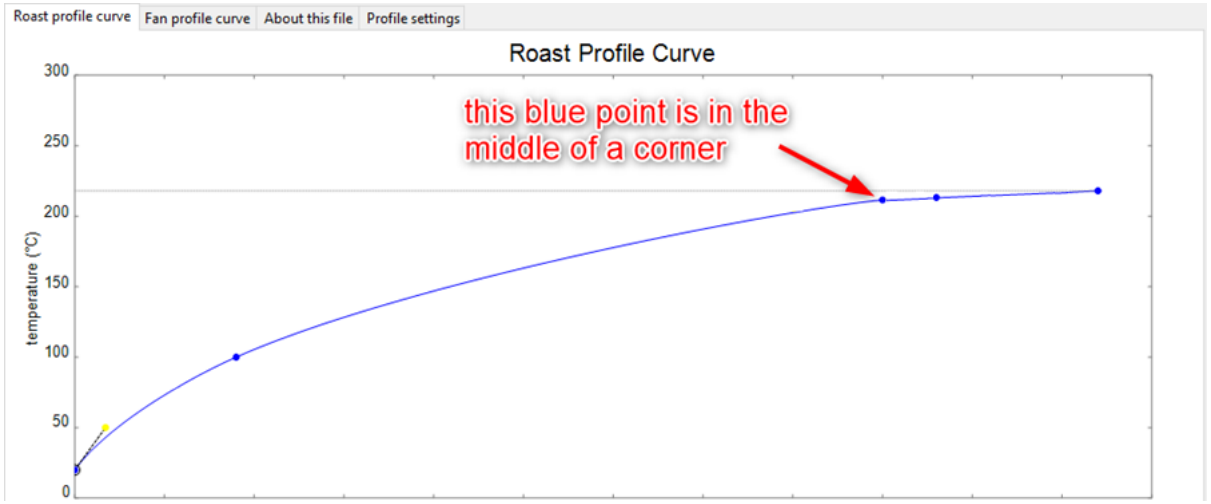
You will want to finish any negative boost prior to the onset of first crack. You might find a setting that acts as a good general setting for the beans you tend to roast – this will save you from the need to individualise the zones for every bean origin.

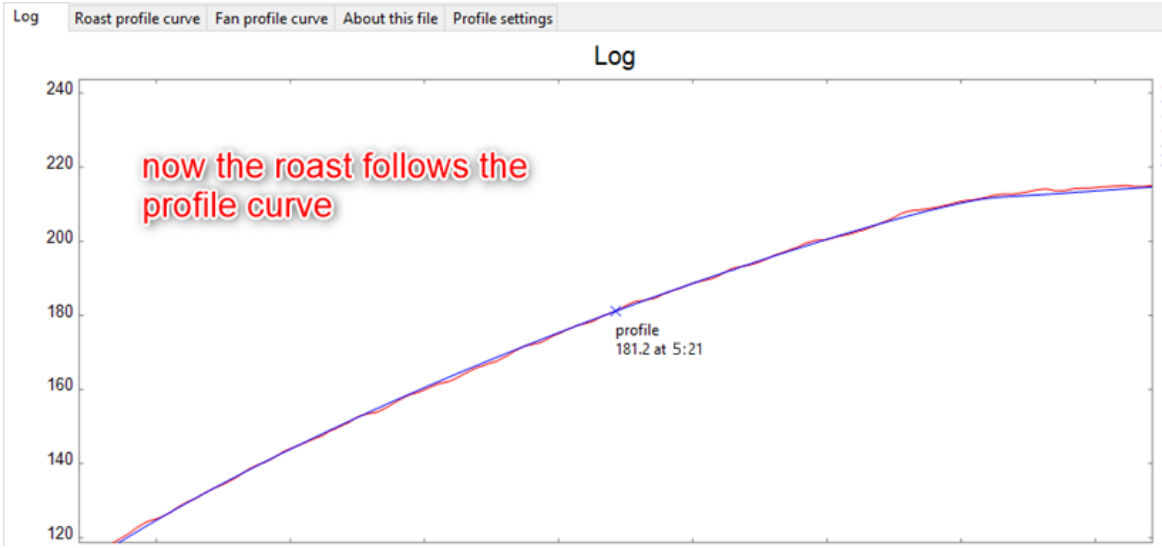
Profile corners

The control software can follow gentle curves, but sometimes you will want a more sudden change; a corner or tight bend in the roast profile curve. If you see a corner being overshot, you can tell the controller to anticipate the corner. A corner is usually associated with a blue point in the editing view of the roast profile curve.

The start is the time at which the controller should start to anticipate the corner. It will normally be around 15 seconds earlier than the associated blue point to give the controller time to adapt. The end is the time at which normal profile curve following will resume. It will normally be a few seconds after the associated blue point.

It may take considerable trial and error to get the best settings for a corner; allow half a dozen trial roasts to get things finely tuned.





Boosting and boating

Imagine you are steering a boat across a wide river. You steer towards a point upstream from the actual path your craft follows because the current is constantly carrying you downstream. In roasting we call the direction you steer for *desired ROR.* A boost alters your *desired ROR*, effectively pointing you further upstream or downstream. To continue the boating analogy, if you know that the current gets stronger at a certain place, you could point your boat a little further upstream when you get to that place. In roasting, if you know the beans start to make heat of their own at a certain time, you can apply a negative boost at that time. That way the control system doesn't have to wait until the roast goes off the line before it adjusts.

Software hints and tips

1. When you select 'New' from the menu, you are given a fresh copy of the default profile. If you want to really start from scratch, simple delete all of the points except the first one (the first point cannot be deleted). Then insert points one at a time as you design your new profile.
2. Keep "Rate of Rise" off while you are editing, then turn it on for final smoothing.
3. When analysing rate of rise curves, it helps to adjust the options settings (Use the *Kaffelogic Studio* menu to select Options > Edit options). *ROR y-axis multiplier* should be set to 5 so that you can see detail. *ROR smoothing of logs* should be set to 30 secs so that you can see trends more easily.
4. When a profile is published it should be accompanied by a statement of the intended roast style and bean origin.
5. Memory sticks can become flaky so it pays to keep a copy of your profiles in the cloud or on a hard drive.
6. During the roast, press ☰ and you will see the option 'Press ▸ to log first crack'. At this point you can select other roast milestones with the + or – buttons. So to log colour change you would press – and then ▸.

Advanced profile development topics

Fan profile curve

Control of fan speed is very important. If the fan is too slow the beans will not circulate adequately and roasting will be uneven. If the fan is too fast the air will not heat up enough and the roast will follow a line beneath the profile curve. Between those two extremes fan speed will affect the style of roast: faster air will give a fluidised-air roasting style, while slower air will give a result slightly closer to drum roasting. The default fan profile has been designed to use the lowest fan speed practicable for a 120g load. Changing the fan speed can make a significant difference.

Adjusting the fan profile curve

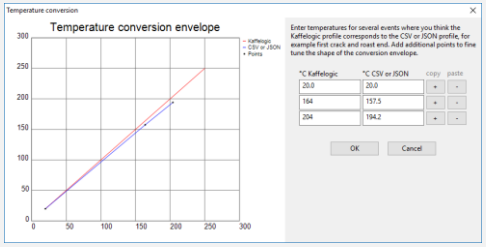
If you decide to make changes to the fan profile curve, testing out fan speeds can be done using timer mode (aka manual mode, press 'profile' and ☰ together) using no heat and adjusting the fan until the desired amount of bean motion is obtained. Load the roaster with green beans to determine the fan speed appropriate for the start of the roast, and with roasted beans to determine the fan speed to use in the later part of the roast. There is no easy way to know if you have used too much fan speed; you will have to try roasting and see how much heating power is used as the roaster follows your profile curve. The maximum power the roaster can deliver is 1400 Watts, but you need to allow some head room here because if the room temperature drops more power will be needed, and if mains voltage drops (yes it does fluctuate!) the maximum power available also drops. So heater power gets over 1300 Watts during a roast you will likely need to use less fan speed at that point.

A subtle point to keep in mind is that the air speed affects the difference between the temperature probe and true bean surface temperature. The faster the air, the bigger the difference. Once you start making changes to air speed, colour change and first crack temperatures will change accordingly.

Roast levels setting

The temperature thresholds for the different levels are defined in the 'roast levels' setting. These are the temperatures at which to stop the roast for each level. For example, the first of these numbers defines the temperature threshold for level 0.0 and the fourth of these numbers defines the threshold for level 3.0. Normally you do not need to change the 'roast levels' setting, but you may choose to do so to bring the behaviour of your profile into line with the expectations of users. The maximum value for any of these numbers is 240°C which is the upper temperature for this roaster.

Temperature conversion envelopes



Each roaster has a particular temperature probe location and latency. Bean temperature probe readings on one brand of roaster are not meaningful on a different brand without conversion. The relationship is not linear. It is made complex by the fact that heat flows differently at different times during the roast, and probes always have some lag because it takes a certain amount of time to adjust to a temperature change. A temperature envelope captures the complexity of this relationship by capturing a number of key points in the roast, and connecting them together using linear interpolation. The more complex the relationship, the more key points need to be added. As a rule, if you have key points for colour change, first crack, and roast end you can build a good envelope.

Sample roasting with the Kaffelogic

The Kaffelogic Nano 7 is capable of continuous roasting of batches back-to-back. The cool down part of the cycle leaves the roaster ready to carry out the next roast straight away.

If you do experience a build-up of residual heat you will notice that each subsequent roast starts further and further above the profile curve. If this does happen, allow a few minutes cooling time between batches.

When you are carrying out back-to-back roasts leave your roaster plugged in and turned on between roasts. This allows the roaster to retain ambient temperature data correctly, and thereby start each roast with the correct amount of preheat power. Turn the roaster off if you don't intend using it again for two hours or more, otherwise leave it turned on (ignore the "Please turn me off message" – instead press ▸ to cancel the message.)

Developing profiles for a production roaster

The Nano can be used to develop optimal roasting profiles for specific beans, and you can then translate them into Artisan or Cropster profiles for your production roaster.

The recommended process starts with replicating one of your existing production profiles on the Nano. To do this you need to achieve four things:

1. Develop a temperature conversion envelope. This will automatically convert from a production profile curve to a Kaffelogic profile curve.
2. Develop a fan profile curve that allows the Kaffelogic to match the production roast.
3. Develop cool down fan speeds that allow the Kaffelogic to match the production cool down times.
4. Work out what other profile settings you need to change to ensure the Nano 7 is delivering a roast that tastes like the production roast. You might have to change preheat power and minimum ROR. You might get away without changing any of the other settings.

You will want to work on the temperature conversion envelope and fan profile curve iteratively. That is because changes to one will affect the other.

Once you have done a bit of roasting with the Nano you will have a fair idea at what temperature you expect to see colour change, first crack, and drop for the roast styles you are familiar with. Match these with the expected temperatures in your production roaster to produce a first cut at your conversion envelope.

Next, you need to get that production profile ready to transfer. If using Artisan, export it as a JSON file. If using Cropster export it as an Excel file. Then fire up *Kaffelogic Studio* and import it. Import it first as a log, entering the temperature conversion envelope data as part of the import process. Once you are happy that

the import makes sense, import it again, but this time as a profile. At this stage you won't be wanting to merge with fan profile and settings, you will use the defaults. You may want to do some tweaks to the profile curve at this stage, but unfortunately if you do this you may have to manually reverse those changes when transferring your finished profile back to the production system – avoid manually tweaking the curve if you can.

Save that profile and give it a test roast on the Kaffelogic. If the key points are not what you expected, make changes to the temperature conversion envelope and try importing again. Once the key points are lining up, cup with your production roast to establish what further changes are needed.

Now you are ready to make changes to the fan profile curve and profile settings (including cool down fan speed). These changes can be merged in when re-importing the profile as you iterate towards a perfect match to your production roast. Remember, changing the fan profile curve will alter the key points – faster fan means higher temperature on the Kaffelogic.

Once you have achieved a match, you will have a temperature conversion envelope, a fan profile curve, and a collection of profile settings. Of these, all that you will need is the temperature conversion envelope when it comes to transferring your Kaffelogic profile back on to your production roaster. You may also need to do some manual steps such as adding in a turning point. However, the temperature conversion envelope is the key. This allows you to experiment and optimise on the Kaffelogic, and then transfer the results automatically back to your production system.

Once you have done the experimenting and optimising on the Nano it is time to transfer the profile back to the production system. Regardless of whether you are using Artisan or Cropster, make any manual edits such as adding a turning point, then transfer files back by exporting from *Kaffelogic Studio* in the JSON format. Take care to ensure that the same temperature conversion envelope is applied to the export.