

How to Build a Basic Glass Firing Schedule: FULL FUSE

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Understanding a firing schedule:

Most glass firing schedules in terms of stages, also called segments or ramps. The first few segments program the heating rate and target fusing temperature. How you set these will depend on:

- the size of your piece or pieces
- the size and thickness of your kiln shelf
- whether your glass is dark or light
- what level of fusing you desire

The last few segments are dedicated to gradually cooling the glass and holding the kiln temperature steady at certain points to allow the glass to adjust and regain its interior organization and strength. This controlled cooling process is called *annealing*.

I always write up my firing schedule on a sheet of paper ahead of time, so that it's easy to enter it into the programmable controls of the kiln. (I date it, too, and describe what I'm trying to accomplish in that fuse, so I have an instant record.)

In every firing schedule, I have four columns with the following labels across the top:

Segment (From 1 to whatever number of ramps you'll need for that firing).

Rate (This is how fast you want the kiln to heat, measured in degrees per hour. Generally speaking, the bigger or thicker the piece of glass, the slower you heat it.)

To Temp (This is your target temperature for that segment. If you've taken a basic fusing class, you'll know that glass has to be heated carefully so it won't crack.)

Hold (Soak) (Depending on where you are at in the process, it might be beneficial to hold the target temperature at that same point for a prolonged period of time).

First, I'm going to explain a simple firing schedule, based on that developed by the research team at Bullseye Glass. This schedule is best for small pieces. Larger pieces will require more steps to avoid air bubbles getting trapped under the glass. If you're fusing pieces larger than 6 or 7 inches, you're going to want to use a different schedule that contains more steps, going slower and soaking more often. In that case, I suggest you download my "Firing Schedule for Large Pieces."

Basic Bullseye Firing Schedule

Here's the **first segment**:

<u>Segment</u>	<u>Rate (degrees/hr)</u>	<u>To Target Temp.</u>	<u>Hold (Soak)</u>
1)	250-400°/hr	1225°	0 to 20 minutes

This is your **initial heating rate**. Rule of thumb: The bigger or thicker the piece, the slower you go:

Bigger pieces: 250°/hr.

Medium pieces: 300°/hr.

Small or thin pieces: 400°/hr (max).

In this segment, the most vulnerable temp range is 600-1000 degrees, where the glass is still brittle and can crack if exposed to any temperature shock, like opening the kiln door. So don't open the door or lid during this period, even to peek!

Once you get to 1225°, your glass is beginning to soften, and if you're slumping the piece, this is where the glass is starting to bend and respond to gravity. I'll talk more about slumping in more detail later.

If you're continuing on to a full fuse, Bullseye recommends that you hold (soak) at 1225° for at least 5 and up to 30 minutes.

Here's a quick but important note: Glass does not like spending lots of time at temperatures above 1350°. Held up there too long (usually more than an hour or two), some glasses develop an unsightly "skin" of whitest gunk that's called *devitrification*.

However, 1225° is too low for devitrification to occur, so holding the glass at this temp. for a while is not a problem. Why soak now? I think it's because you want to get your kiln temps. stabilized throughout the interior, including through your glass as well as your kiln shelf. Smaller pieces of glass can be safely soaked for 10 minutes. But if you have a large kiln with a thick, large-area shelf, you're going to want to give that shelf time to heat through fully.

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Basic Bullseye Firing Schedule, continued

OK, here's the **second segment** in your basic full-fuse schedule.

It's called the **Rapid Heat** phase:

<u>Segment</u>	<u>Rate (degrees/hr)</u>	<u>To Target Temp.</u>	<u>Hold (Soak)</u>
2)	500-600°/hr	1450-1490°	0 to 15 minutes

What you want to do here is speed up the firing rate to minimize the time that the glass sits at temps above 1350°. Again, the longer glass sits at very hot temps, the more chance it has of devitrifying. However, I personally think that you retain more control of the process if you fire at 500° or 550°/hr, instead of the flat-out 600°. But it's up to you. You know your kiln, you know your work, so the final decision is up to you.

What should your target temperature be for a full fuse? Again, it depends on your kiln and what kind and size of glass you have in it. Small, single-layer pieces will probably be fine at 1450°, but larger pieces might require going all the way to 1490°. Darker glass (especially black opal) will full-fuse around 1475-1480° with no soaking required, while lighter-color glass demands 1490° and a 5 to 10-minute soak. These temps can vary, depending on your kiln. Note that the higher you go and the longer you soak, the more you risk losing the definition of edges and accessory glass. Too low, though, and your two sheets won't fully melt into one. And if you're fusing enamels or powders, you'll have to aim for the target temps that are best for them. But the basic rule of thumb is: longer soak for larger pieces.

Keep in mind that when we get to this point, we're talking about very small time periods here—often 10 to 15 minutes. So it's best to stay nearby and visually check your glass every ten minutes as it nears the target temp. Check by peeking quickly into the kiln while wearing protective glasses. I highly recommend testing and keeping records until you find a target and soak time that works best for your kiln and the glass you work with most often.

Once the glass looks the way you want it to, don't let it cook any more or you risk losing that look. So STOP heating! Once you do, the kiln will start cooling naturally. If you are lucky enough to have a Rampmaster III programmable control panel, you can push the "skip to the next step" button to go directly to the cool down and annealing phases. Or, if the opposite effect occurs and you need more heating, use the "add time" button on your Rampmaster III to extend the heating time until your piece is perfect.

Basic Bullseye Firing Schedule, continued

Now that your piece is fused, the story isn't over. Your kiln has to go through a very gradual cool down with stops and holds along the way that will permit the glass to adjust and anneal as it re-enters a solid state.

Firing Schedule for Fused Glass That's Cooling, i.e., Ramps Coming Down:

<u>Segment</u>	<u>Rate (degrees/hr)</u>	<u>To Target Temp.</u>	<u>Hold (Soak)</u>
[going	4000°/hr (AFAP)	900°	1.00 (1 hour)
down	100°/hr	700°	01 (1 minute)
after	4000°/hr (AFAP)	200°	00 (no hold)
fuse]	ALARM prompt	enter: 9999	(turns off alarm)

(Note: 4000° is just a code for the kiln to cool "AFAP"= As Fast As Possible).

Whatever you're fusing, you'll always end with the above segments. If you're working with thicker glass, you would just extend the time for the anneal soak at 900° from 1 hour to 1.5, 2 hours, up to *days* if you have a giant piece.

Why end at 200° instead of room temperature? Because room temps vary, and you just want a temp that turns off your program. Why keep the program working until 75°? At 200°, your kiln can turn off and just cool on its own. However, DON'T take your glass out until the kiln temps have dropped below 100°. Above 100°, glass can still crack from thermal shock if it's put down on a cool surface or rinsed with even lukewarm water. Be patient!

Just remember that you can wreck a piece by going too fast, but you can almost never go *too slow!*

Now that I've explained all the ramps in detail, let's put them all together on the next page:

Basic Bullseye Firing Schedule for a Full Fuse

This is our **basic fusing schedule**, with 5 segments:

<u>Segment</u>	<u>Rate (degrees/hr)</u>	<u>To Target Temp.</u>	<u>Hold (Soak)</u>
1)	250-400°/hr	1225°	0 to 20 minutes
2)	500-600°/hr	1450-1490°	0 to 15 minutes
3)	4000°/hr (AFAP)	900°	1.00 (1 hour)
4)	100°/hr	700°	01 (1 minute)
5)	4000°/hr (AFAP)	200°	00 (no hold)
RMIII Prompt:	ALARM	enter: 9999	(turns off alarm)

Once you've written it down your choices for each segment, you can enter your finished schedule in, step by step, into whatever number program number you want in your kiln's control panel.

However, if you're fusing pieces that are larger than 8", you're going to want to slow this basic schedule down to allow any air that might get trapped under your glass to escape. In that case, I suggest you download my write-up: [Firing Schedule for Large Pieces](#).

Keep your wits about you, keep good records, and keep on having fun!

Judith Kiriazis is the author of this piece, which has been designed as an introductory tool for glass fusers. Individuals using this information are also expected to implement appropriate safety measures and basic common sense. Therefore, both she and Bullseye Glass disclaim any damages from use or misapplication of this information.

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