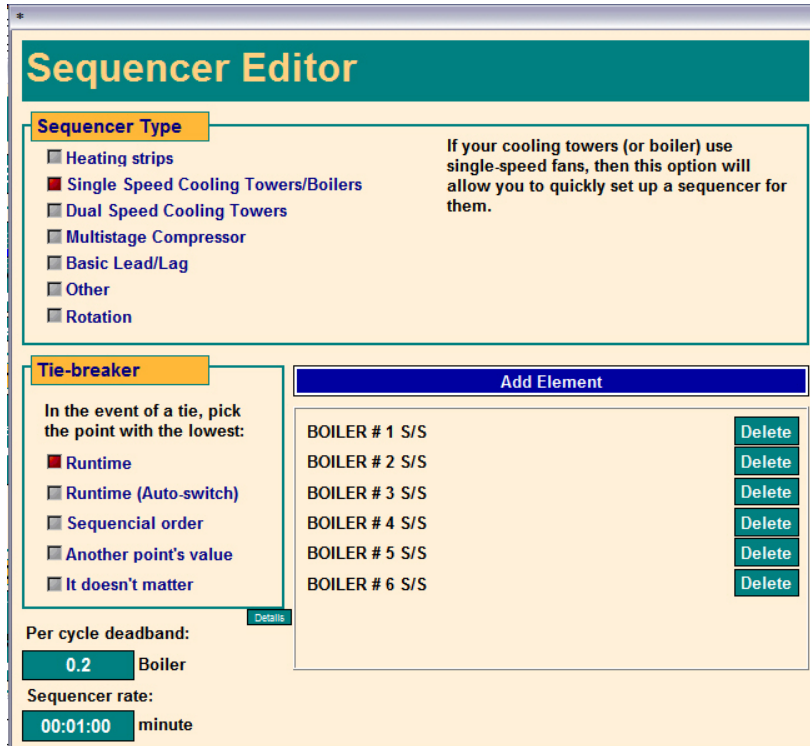


CBAS In-Depth: The Sequencer

The easy way to start and stop equipment based on run time.

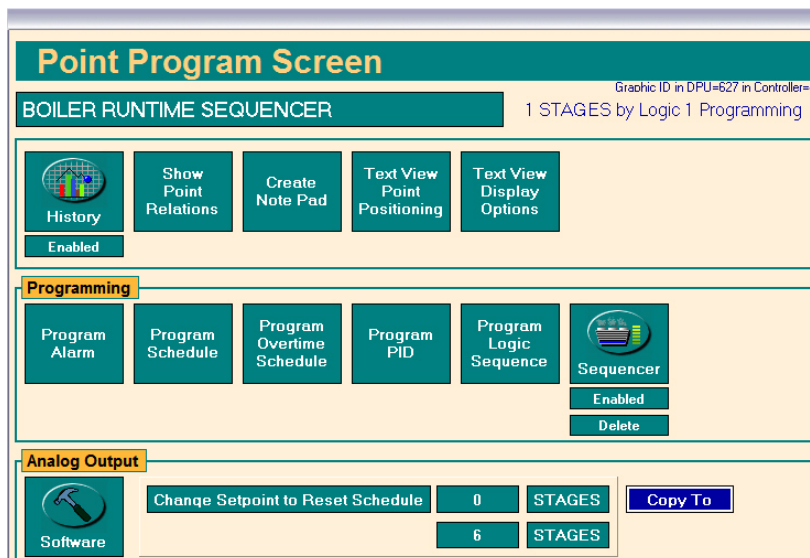


A good way to tell if you need a sequencer is to ask yourself this question: “Do I have multiple pieces of equipment that combine to control a single entity—such as supply temp?”

If the answer is *yes*, then the sequencer is for you—even if you don’t want to use fancy runtime rules. The simple analog quantity is both simpler and works far better.

A sequencer takes several binary points and combines them into a single continuous analog output. This feature can be found on the Point Program Screen of a Software Analog Output Setpoint.

Recently, Rudy Singh, of C&S Building Services in New York, used the Sequencer to automate the use of six Boilers in one of the buildings at the Statue of Liberty National Monument. He wanted to sequence the boilers based on need and lowest run-time. First he added runtime



points to the start/stop points for the boilers. He then went to the sequencer and added the six boiler start/stop points as well as choosing the type of equipment to sequence (*see screenshot, top left*).

The next step is to make the range of the units on the point containing the Sequencer “0-6” (*see screenshot, bottom-left*).



Next, Rudy created a logic sequence that commands the Sequencer point to the right number of Stages based on need. In this case, he used a logic sequence.

Because “Runtime” is selected in the Tiebreaker section of the Sequencer Editor, the Boiler with the least amount of runtime will be the first to come on when a boiler is needed. The Boiler with the most amount of runtime will be the first to go off when one is no longer needed. If “Runtime (Auto-switch)” had been selected, then a boiler would be shut down and another automatically started when runtime dictates. When adding elements to the Sequencer using Auto-Switch, you will be prompted for the “Auto-Switch Difference”, which is the number of minutes that the highest runtime must be over the next highest runtime before it is shut down and another element started. Without Auto-switch, the starting order of the Elements only changes when one with a higher runtime is shut down, thus moving the others up in the order.

Other choices in the Tie Breaker section include:

- **Sequential Order** starts and stops Elements in the order they are added in the Elements section.
- **Another Point’s Value** allows you to throw in a wild card based the activity of other equipment, like cooling towers. You will be prompted for the other point each time you add an Element.
- If you choose *It doesn’t matter*, the Sequencer will arbitrarily choose the next Element for you.

Per Cycle Deadband is used to prevent short-cycling equipment, just like any other deadband. Normally, if the point is calling for 1.5 Boilers, the 0.5 will round up and the next element will come on. If you set the Deadband at 0.2, the next element will come on at 1.7 ($1.5 + 0.2 = 1.7$), and when a unit must go off, it happens at 0.3.

The **Sequencer Rate** determines how often the sequencer evaluates the conditions. It could also be looked at as the amount of time to wait between commanding pieces of equipment on or off. However, if two or more elements are needed, they will be started at the same time after the Sequencer Rate time has elapsed. In the example above, the Sequencer Rate is unnecessary because the logic will only allow the number of boilers needed to change by one every ten minutes. A Rate of one second would be fine in this case.

If two or more elements need to be started at once, by default they will be started at the same time, after the Sequencer Rate time has elapsed. There is a way to limit how many pieces can start at one time. There is a small “Details” button just below the Tie Breaker section of the Sequencer Editor.

If you change the “*Maximum cycle changes per evaluation*” to one, only one element will come one. After the Sequencer Rate time has elapsed, the Sequencer will evaluate again and another element will come on if needed. By default, this parameter is set to eight, which will allow all elements to come on at once. In the case of chillers, this can cause an electrical surge and possibly an additional charge from the power provider.



SEQUENCER EDITOR

Running Parameters

Maximum cycle changes per evaluation: 1

Maximum number of cycles simultaneously on: 4

Maximum number of cycles simultaneously off: 255

Number of retries before error condition: 0

Sequencer dead-band: 0.3 Units

Autoswitch Difference (Off): 0 Minutes

Rate: 00:01:00 minute

Sequencer Type: 9 Advanced Edited Sequencer

Let's say you have eight boilers and you don't want to use more than six at any time. Change "Maximum number of cycles simultaneously on" to six. The same can be achieved by setting the high range of the analog point to six.

Let's say you want to make sure that there is always one boiler on. Change "Maximum number of cycles simultaneously off" to seven. With a total of eight elements, that will leave one on. The same can be achieved by setting the low range of the analog point to one instead of zero.

There is a limit of eight "Elements" in the sequencer. Rudy had a situation in another building where he needed to sequence ten boilers. To get past the eight-element limitation, he programmed two sequencers with five elements in each. Then he added logic that makes one sequencer the *Lead* and the other the *Lag*. His logic toggles the Lead and Lag once a week. He could also use a third Sequencer set on **Basic Lead/Lag** to do the same.

If an element is part of a **Binary In/Out combination**, or **Linked Binary**, this is automatically recognized. In this case, if an element fails to start, it will be locked out of the sequence and another element is started. The Priority of starting or stopping an element is Logic Level 1. A failed unit is locked out with Priority Logic Level 2. Having "Linked Binary" points gives you the full functionality of the Sequencer, by enabling the "Lockout" functionality. You can link Binaries by clicking the **Link to Binary** button on the Point Program Screen of the outputs.

You may need to **Scale Database** when adding Elements to the Sequencer. If so, you will get an error message when closing the Sequencer Editor: "Cannot save this resource in side panel XXXX because there is no space available. Sequencer Element Table is full." To scale the database, go to Utility Mode and Scale Database on the System Menu. If you are using more than 1 Sequencer, raise the number of Sequencers. Then, raise the number of Sequencer Cycles to meet the total number of elements.

Basic steps to setting up a Sequencer:

1. Add your start/stop (Binary Output) points for the elements of the Sequencer.
2. Add status (Binary Input) points for those elements (optional).
3. Link the outputs to their corresponding input points (optional).
4. Add runtime points to either the input or output (this must be done *before* adding Elements to the Sequencer).
5. Add a software analog output setpoint to contain your Sequencer



6. From the Point Program Screen of the AO point, click the “Program Sequencer” button.
7. Choose a sequencer type.
8. Choose a tie breaker.
9. Add elements.
10. Make any necessary changes under the Details button.
11. Save your settings by exiting the Sequencer Editor
12. Change the range and units on the Point Program Screen to match the equipment you are controlling. (*Example: 0-6 Stages*)
13. Write logic or PID on that point to change the number of stages/elements based on need.
14. Test your Sequencer.

If the settings in the Sequencer Editor need to be changed, you must delete the Elements, make changes, and re-add them.

Your Feedback is Welcome

The Sequencer is a very useful feature that can make the central plant sequence of operations much easier to program and optimize. The creative programmer can surely find many other ways to use it. We would be happy to learn of any innovative new uses. Please let Computrols know what you come up with.

