

Automated Dosing

in Guardian™ Grow Manager Version 4.2.12



ÆssenseGrows



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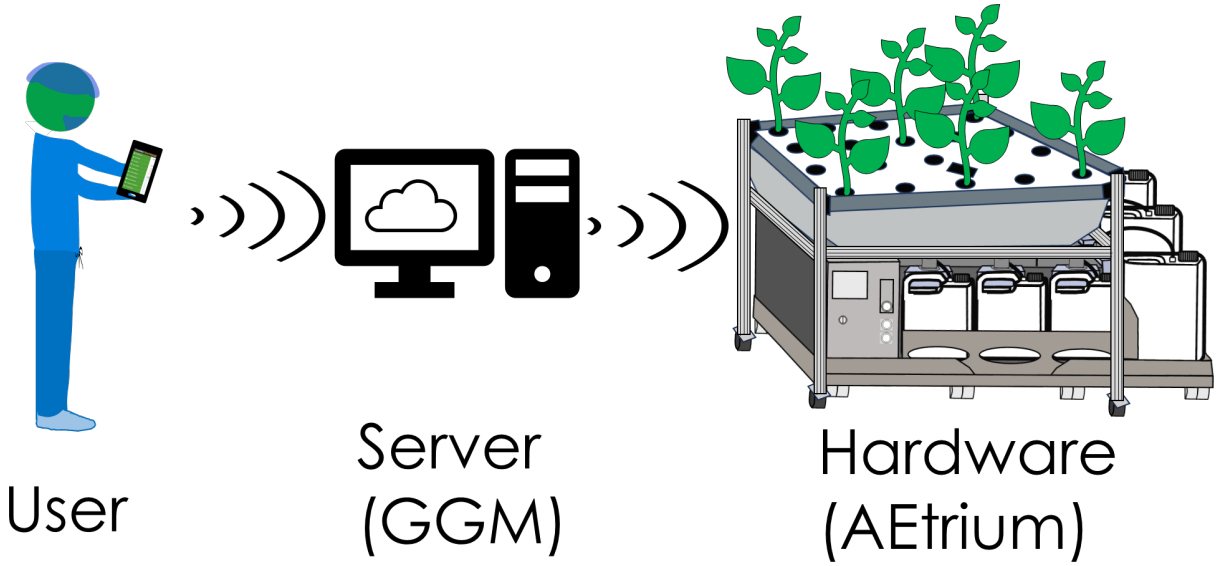
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Introduction

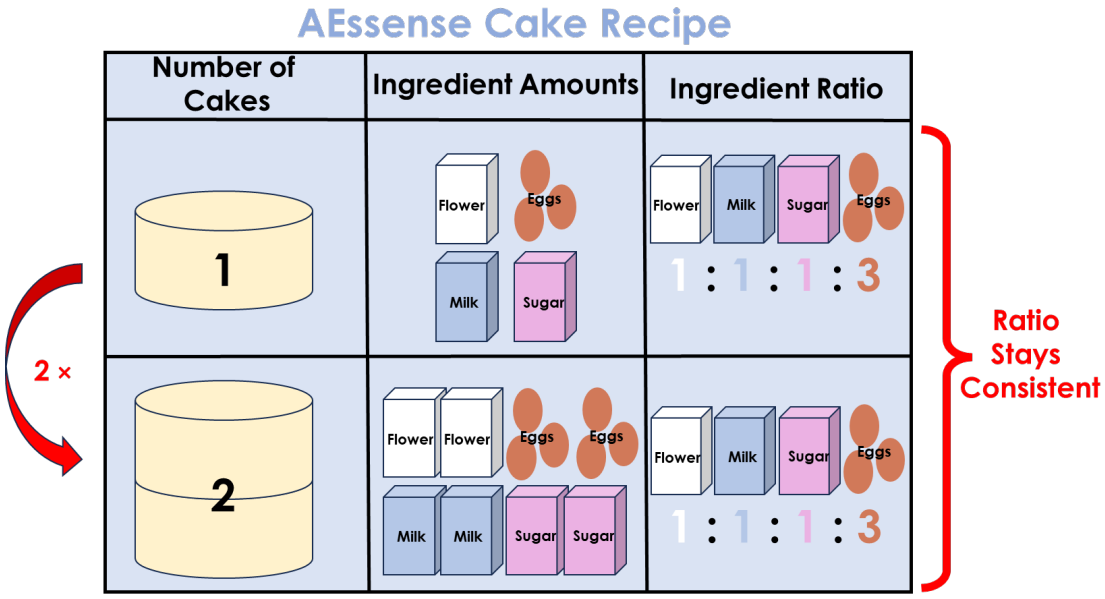
The AEtrium system allows growers to precisely and repeatedly regulate environments for aeroponic plant cultivation. The AEtrium system combines hardware (physical components) and software (programs) to regulate the environment automatically. The Guardian Grow Manager™ (GGM) is the software program responsible for commanding the hardware (AEtrium-2.1, AEtrium-4, etc.). Within the GGM program, users can configure how the AEtrium system behaves, processes data, performs calculations, and commands the hardware to control the environment.



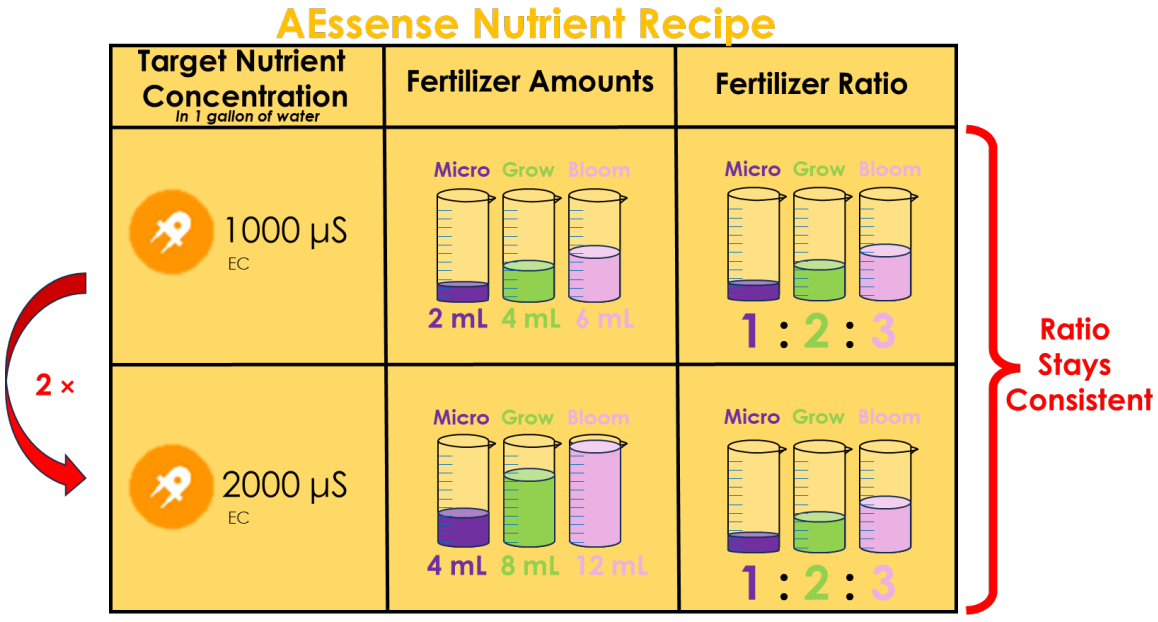
One important feature of the AEtrium system is its ability to automate fertilizer dosing. This automation helps ensure that plants receive the right amount of nutrients they need for healthy growth without the need for constant manual adjustments.

Essential Tenants of Nutrient Dosing

Proper nutrient dosing is analogous to baking a cake. If you want to make a single delicious cake, the correct amount and ratio of ingredients must be mixed into the batter. If you wanted to make a double recipe, the amount of ingredients would double, but the ratio of ingredients would stay the same.



In the context of a hydroponic nutrient reservoir, it's essential to mix both the correct amount and ratio of fertilizers in the reservoir to ensure the plants have adequate access to the nutrients they need for healthy growth at each stage of production.



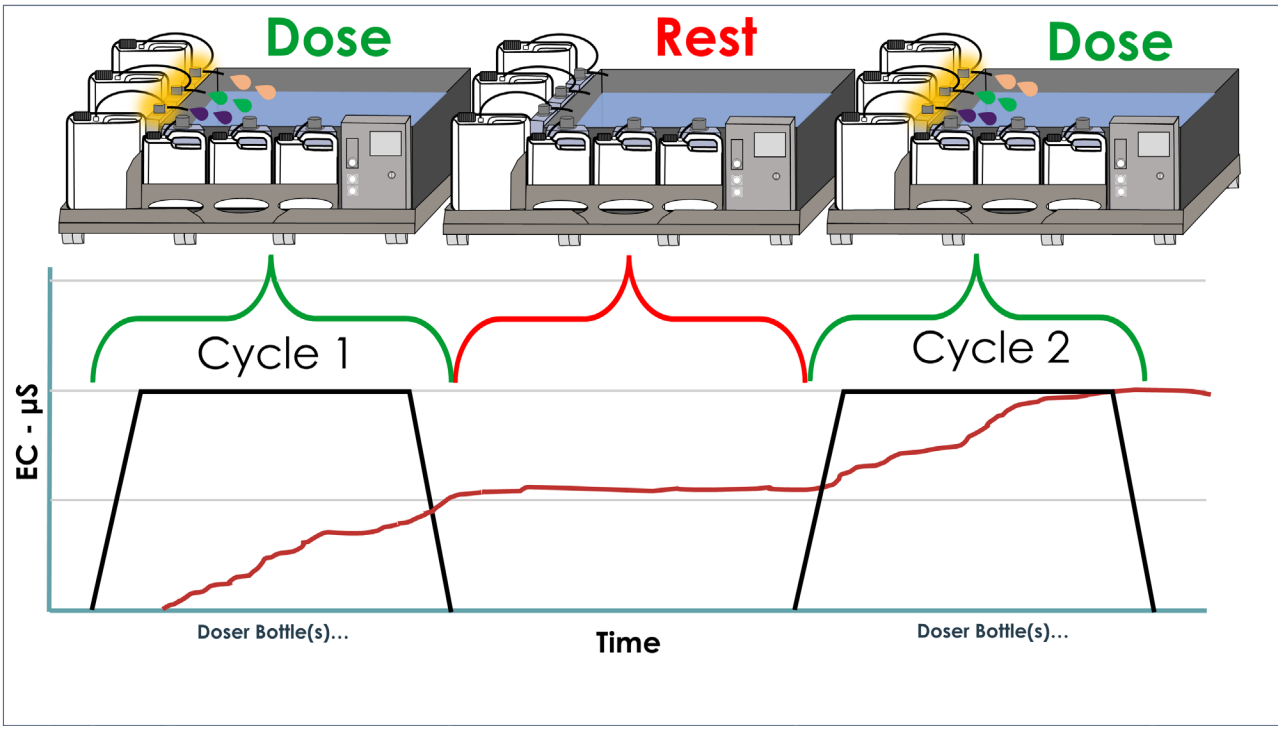
Guardian Grow Manager Automated Dosing

The GGM is capable of automatically managing the delivery of fertilizer(s) into the nutrient reservoir. Users set specific fertilizer dosing configurations in their GGM server and the AEtrium system manages the rest. When the dosing commences, the system's dosing pumps and sensors coordinate to automatically ensure the reservoir accurately reaches both:

1. **The Target Nutrient Concentration** *(Target EC)*
2. **The Target Fertilizer Proportions** *(Fertilizer Ratios)*

Automated Dosing Basics – Dosing Cycles

The basic structure of all automated dosing performed by the AEtrium system is the same. Dosing of the reservoir occurs in cycles. The peristatic dosing pumps connected to each of the fertilizer bottles dose fertilizer(s) for a specified period, take a break, and then start dosing again. The breaks allow the system to intermittently provide a buffer for adequate mixing, check for errors, and determine whether the target nutrient concentration (EC) has been reached (at which point the dosing stops).



Available Automated Dosing Process Options

Three separate automated dosing processes exist in the GGM for users to choose from. These include:

1. **Hybrid Dosing**

2. **EC Feedback Dosing**

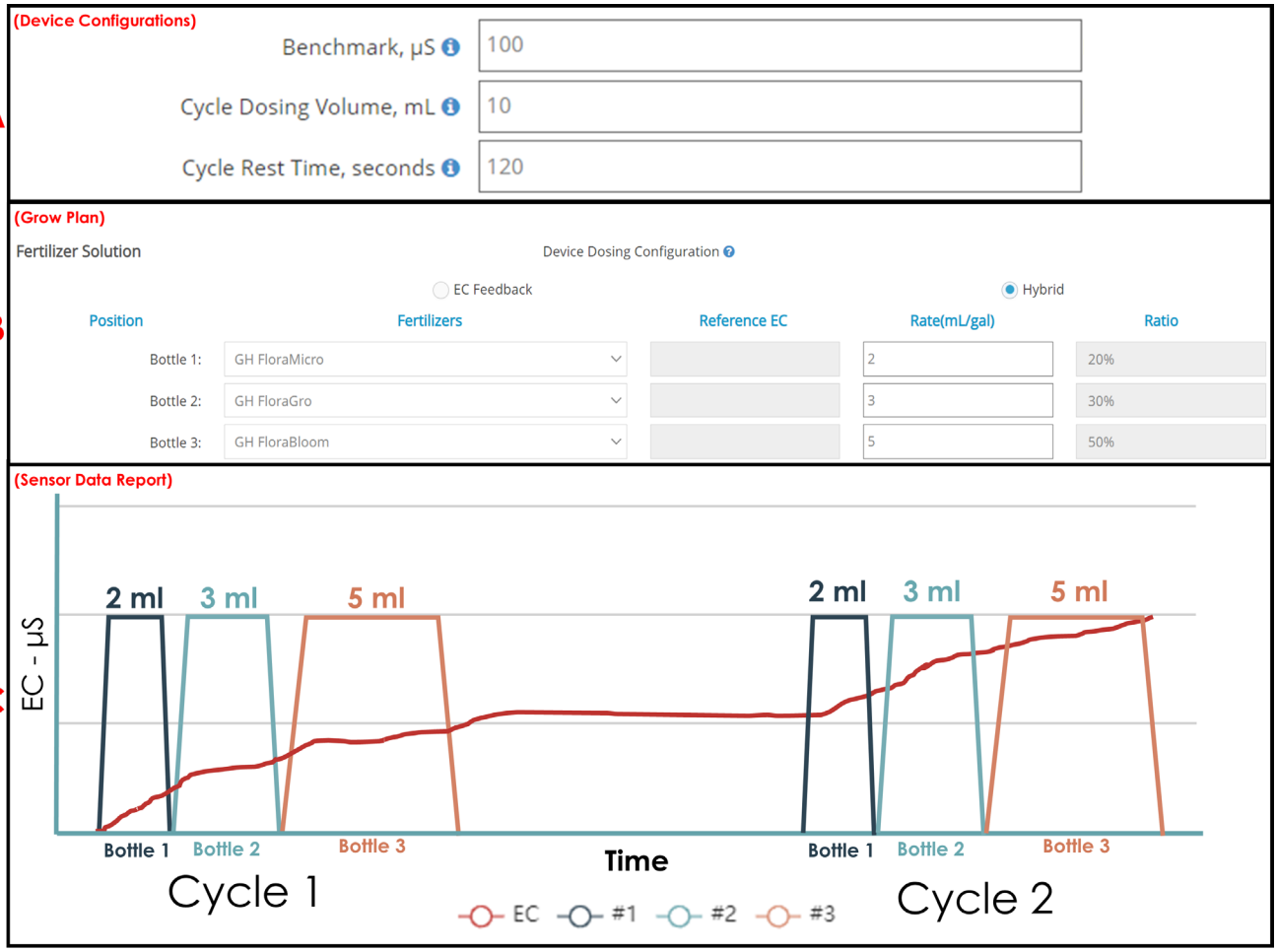
3. **Fast Dosing**

The approaches used by each doing option to manage the peristaltic dosing pumps within and between cycles differ considerably. Additionally, the calibration and setup required to use each process is different. The following pages cover descriptions, essential calibrations, and setup instructions for each of the automated dosing processes available for use with AEssense equipment.

1. Hybrid Dosing

When **Hybrid** *dosing is selected, the AEtrium system will attempt to add a specific volume of fertilizer to the reservoir during each dosing cycle. The* **Cycle Dosing Volume (mL)** *setpoint (located in the device EC Dosing Configurations menu) is used by the system to determine the total amount of fertilizer, in milliliters (mL), the system will attempt to add to the reservoir during each dosing cycle. The system maintains the target fertilizer proportions during each dosing cycle by referencing the current fertilizer's* **Rates (mL/Gal)** *(set in the active grow plan), by dividing the* **Cycle Volume** *amongst the fertilizers accordingly.*

Hybrid Dosing – Example



In the above example, the **Cycle Dosing Volume** *is set to 10 mL, and the fertilizer* **Rates (mL/Gal)** *are set to 2, 3, and 5 mL for bottles 1, 2, and 3, respectively. As a result, the system adds 2 mL from bottle 1, 3 mL from bottle 2, and 5 ml from bottle 3 – for a total of 10 mL added to the reservoir during the first* **Dosing Cycle**. *Once all bottles have dosed, the system rests and determines which action to take next. If the EC sensor determines the target nutrient concentration (Target EC) has not been reached, an additional cycle commences after the rest period concludes.*

1a. Hybrid Dosing - Additional Configurations

- **The Cycle Rest Time, seconds**, *setpoint (located in the device EC Dosing Configurations menu) determines how long the system will rest between* **Dosing Cycles.**
- *Hybrid Dosing can be configured to automatically switch to an alternate set of* **Cycle Dosing Volume** *and* **Cycle Rest Time** *setpoints when the reservoir EC approaches the target EC.*
    - *The* **Benchmark, (µS or PPM)**, *setpoint (located in the device EC Dosing Configurations menu) is the number of remaining EC units (µS or PPM) from the* **Target EC** *at which the system will switch to the alternate set of* **Cycle Dosing Volume** *and* **Cycle Rest Time** *setpoints.*



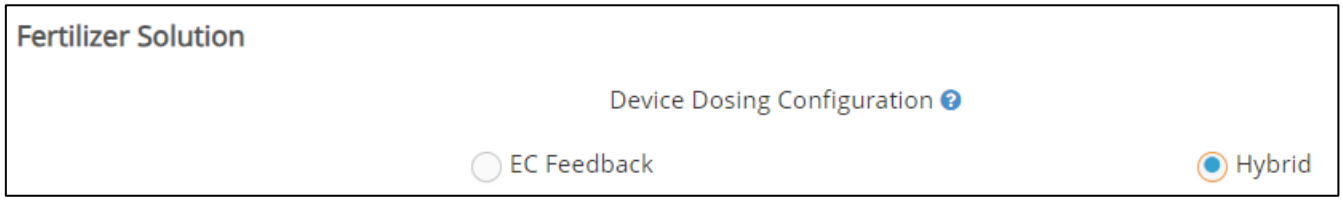
    - *Doing so can prevent the system from overshooting the target nutrient concentration (***Target EC***) by reducing the amount of fertilizer added during each* **Dosing Cycle** *as the reservoir approaches the target EC.*

1b. Hybrid Dosing - Essential Calibrations

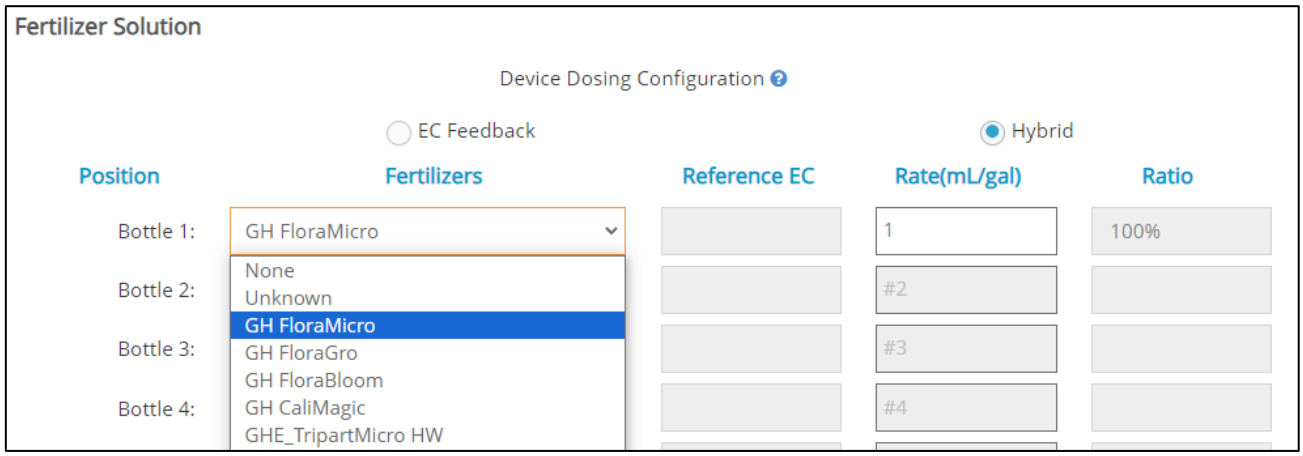
For **Hybrid Dosing** *to function accurately - each active peristaltic dosing pump must be calibrated. The dosing pump calibrations allows the system to make slight adjustments and correct for differences in flow rates between the separate peristaltic pumps. For details on how to perform this calibration, see the included Tech Note for GGM Version 4.2.12.*

1c. Hybrid Dosing - How to Setup

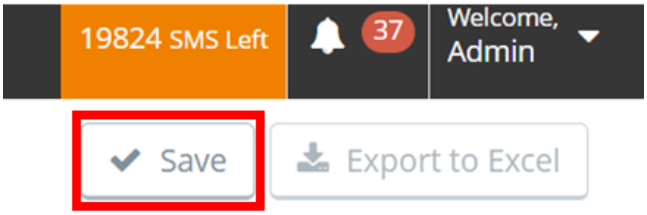
After the aforementioned configurations and essential calibrations have been set, running Hybrid Dosing is a straightforward process. Within the **Fertilizers** *section of a new* **Grow Plan**, *select "***Hybrid***" from the two device dosing configurations.*



Once **Hybrid** *is selected, choose the fertilizers currently in use from the* **Fertilizers** *dropdown menu and input the desired fertilizer* **Rates (mL/Gal)** *for each.*



Finally, configure any remaining sections of the **Grow Plan** *(Target EC, pH, Water Pressure/Pump, Etc.) and save the* **Grow Plan**.



Devices loaded with this **Grow Plan** *will now dose using the* **Hybrid** *automated dosing process. Any device-specific* **Hybrid** *dosing calibrations and configurations stored in the device-specific EC dosing configurations menu will be automatically referenced and affect the* **Hybrid** *dosing processes for that device individually.*

2. EC Feedback Dosing

When **EC Feedback** *dosing is selected, the AEtrium system will dose the configured fertilizers one at a time, until a specific increase in the reservoir nutrient concentration (EC) is detected by the EC sensor. Within the EC Feedback automated dosing process, each* **Dosing Cycle** *is unique. Instead of dosing a specific volume from each bottle, the system doses each bottle continually until a specific increase in the reservoir nutrient concentration (EC) is measured from each bottle. In other words, when the dosing begins, the first fertilizer bottle will run until a specific increase in the nutrient concentration has been measured for that bottle before the next bottle will begin.*

The **Step Value** *setpoint (located in the device EC Dosing Configurations menu) is used by the system to determine how many collective EC units (µS or PPM) the system will attempt to dose from all of the configured fertilizers. The system determines what proportion of the* **Step Value** *must come from each fertilizer bottle based on the configured fertilizer* **Rates(mL/Gal)** *and* **Reference EC Values** *stored in the grow plan.*

2. EC Feedback Dosing

EC Feedback Dosing – Example



In the above example, the **Step Value** *is set to 1000 µS and the fertilizer* **Rates (mL/Gal)** *are set to 2, 3, and 5 mL for bottles 1, 2, and 3, respectively. As a result, the system doses from bottle 1 until the reservoir nutrient concentration (EC) increases by 200 µS. Then, the system doses from bottle 2 until the reservoir nutrient concentration (EC) increased by 300 µS. Lastly, the system doses from bottle 3 until the reservoir nutrient concentration (EC) increases by a final 500 µS. Therefore, the system has now increased the reservoir nutrient concentration (EC) by a total of 1000 µS (the configured* **Step Value***). Accordingly, the* **Step Value** *was achieved in the example through a combination of all three configured fertilizer bottles with the fertilizer-specific dosing amounts (in EC) being proportional to their configured* **Rates (mL/Gal)** *and* **Reference EC Values.**[1]

[1] *In practice, individual bottle EC contributions will not be as evenly split, as the fertilizer Reference EC values will not be identical as they were in the example.*

2. EC Feedback Dosing

EC Feedback Dosing – Example



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[1] *In practice, individual bottle EC contributions will not be as evenly split, as the fertilizer Reference EC values will not be identical as they were in the example.*

2. EC Feedback Dosing

Note that in the above example, the first two fertilizer bottles dosed in the first **Dosing Cycle***, then a rest commenced, followed by the third fertilizer dosing in the second* **Dosing Cycle** *until the entire dosing* **Step Value** *was achieved. As previously mentioned, in* **EC Feedback** *Dosing, each* **Dosing Cycle** *can be unique. This is because, the* **Dosing Cycles** *will run according to the configured* **Run Time** *setpoint, in seconds (located in the device EC Dosing Configurations menu) before the* **Rest Time** *(also located in the device EC Dosing Configurations menu) commences, regardless of the current progress made towards the active* **Step Value***.*

Once the reservoir nutrient concentration (EC) has increased by the entire **Step Value***, the current* **Dosing Cycle** *ends immediately, and an additional rest period commences. At this point, the system determines which action to take next. If the EC sensor determines the target nutrient concentration (Target EC) has not been reached, additional* **dosing cycles** *will commence attempting to meet the following* **Step Value** *after the rest period concludes. If the number of EC units remaining between the target EC and the current EC is less than the configured* **Step Value***, the system will automatically assume a smaller* **Step Value** *that precisely bridge the remaining number of EC units to be dosed.*

2a. EC Feedback Dosing - Additional Configurations

The **EC feedback target percent %***, setpoint (located in the device EC Dosing Configurations menu) can be used to set a wider range of acceptable fertilizer-specific target EC values the system to recognize as a stopping point (before continuing on to the next fertilizer in the sequence). This feature allows the* **EC Feedback** *dosing process to be more dynamic in its approach and helps to prevent over or underdosing caused by delayed EC sensor readings.*

- *Example:*
  - **Fertilizer 1 target EC dosing contribution***: 200 µS*
  - **EC feedback target percent %:** *90*
    - *Corresponding fertilizer 1 target EC dosing contribution range: 180 µS – 220 µS*
      - *The system will recognize any EC value increase between 180 µS and 220 µS from fertilizer 1 as an acceptable fertilizer 1 dosing contribution stopping point*

2b. EC Feedback Dosing – Essential Calibrations

For **EC Feedback** *dosing to function accurately, a fertilizer calibration procedure must be performed for each of the fertilizers being used. Specifically, users must measure the relative strength of the fertilizer* **(Reference EC)** *and enter this value into the* **Fertilizer** *tab of the system* **Configurations** *menu.*

The procedure for measuring the **Reference EC** *value of a fertilizer is as follows:*

1. *Fill a container with either 1 gallon or 1 liter of fresh water (depending on preferred units of measurement).*
2. *Measure the starting EC value (µS or PPM) of the fresh water using a recently calibrated EC sensor probe and record this value as* EC_1.

Fertilizer Name:	GH FloraMicro		
Sample #	EC_1	EC_2	EC_Δ
1	50		

3. *Using an accurate graduated cylinder or pipettor, measure and add 10 mL of the fertilizer being measured into the fresh water container and mix thoroughly for 30 seconds. Measure the resulting EC value (µS or PPM) of the mixed solution using the same EC sensor probe and record this value as* EC_2.

Fertilizer Name:	GH FloraMicro		
Sample #	EC_1	EC_2	EC_Δ
1	50	1000	

4. *Subtract* EC_2 *from* EC_1 *and record the value (*EC_Δ*).*

Fertilizer Name:	GH FloraMicro		
Sample #	EC_1	EC_2	EC_Δ
1	50	1000	950

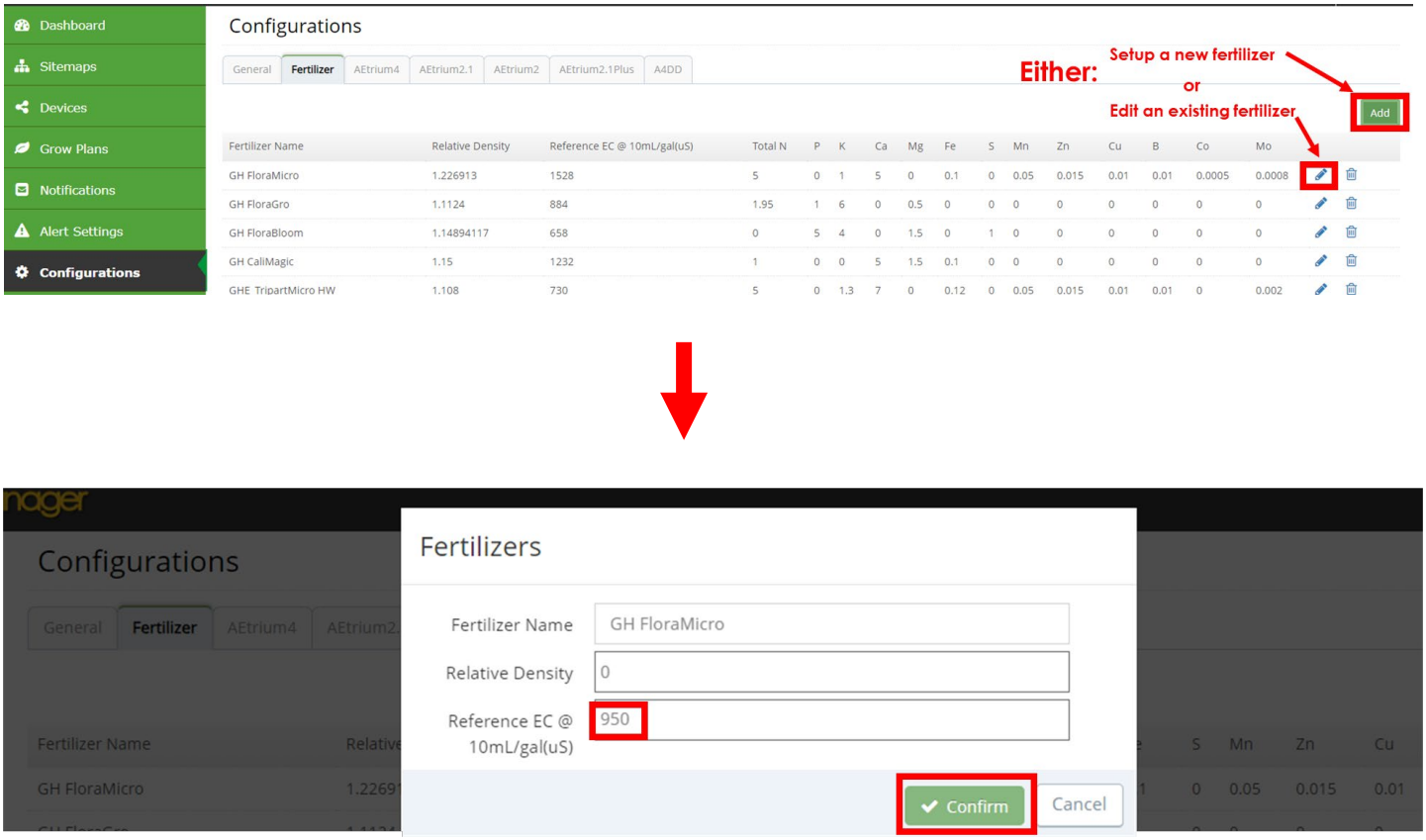
$$EC_2 - EC_1 = EC_\Delta$$

5. *Repeat steps 1-4 two more times (for a total of three). Then average the three* EC_Δ *values to find the* **Reference EC** *value.*

Fertilizer Name:	GH FloraMicro		
Sample #	EC_1	EC_2	EC_Δ
1	50	1000	950
2	40	1100	1060
3	60	900	840
Reference EC:	950 µS/cm		10mL/1 gal

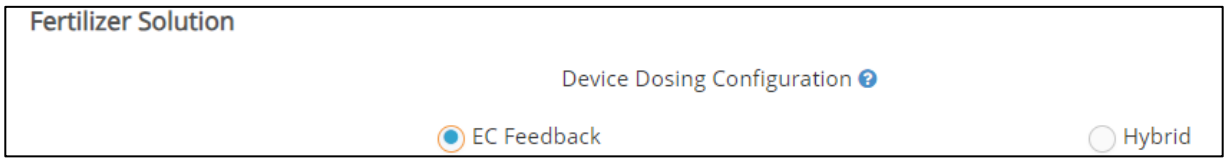
2b. EC Feedback Dosing – Essential Calibrations

6. *Enter the determined* **Reference EC** *value into the* **Fertilizer** *tab of the system* **Configurations** *menu.*

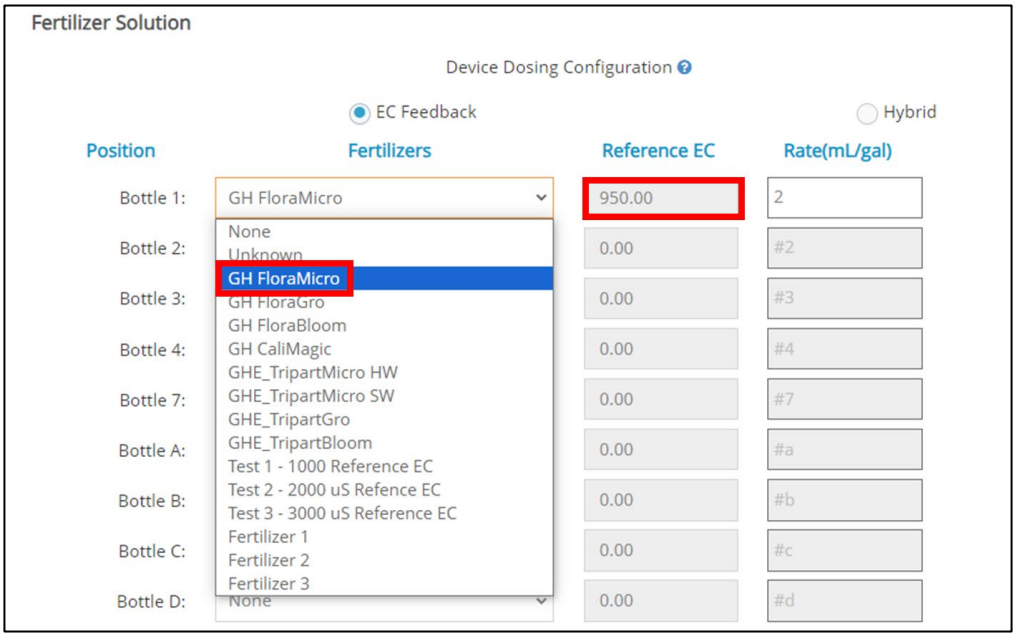


2c. EC Feedback Dosing – How to Setup

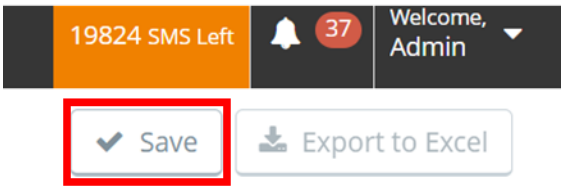
Once the **Reference EC** *values for each of the fertilizers that will be used have been saved,* **EC Feedback** *dosing can be used with any grow plan. Within the* **Fertilizers** *section of a new* **Grow Plan**, *select "***EC Feedback***" from the two device dosing configurations.*



Once **EC Feedback** *is selected, select the fertilizers currently in use from the* **Fertilizers** *dropdown menu and input the desired fertilizer* **Rates (mL/Gal)** *for each. The saved* **Reference EC** *value for each fertilizer will automatically populate when a fertilizer is selected.*



Finally, configure any remaining sections of the **Grow Plan** *(Target EC, pH, Water Pressure/Pump, Etc.) and save the* **Grow Plan**.



Devices loaded with this **Grow Plan** *will now dose using the* **EC Feedback** *automated dosing process. Any device-specific* **EC Feedback** *dosing calibrations and configurations stored in the device-specific EC dosing configurations menu will be automatically referenced and affect the* **EC Feedback** *dosing processes for that device individually.*

3. Fast Dosing

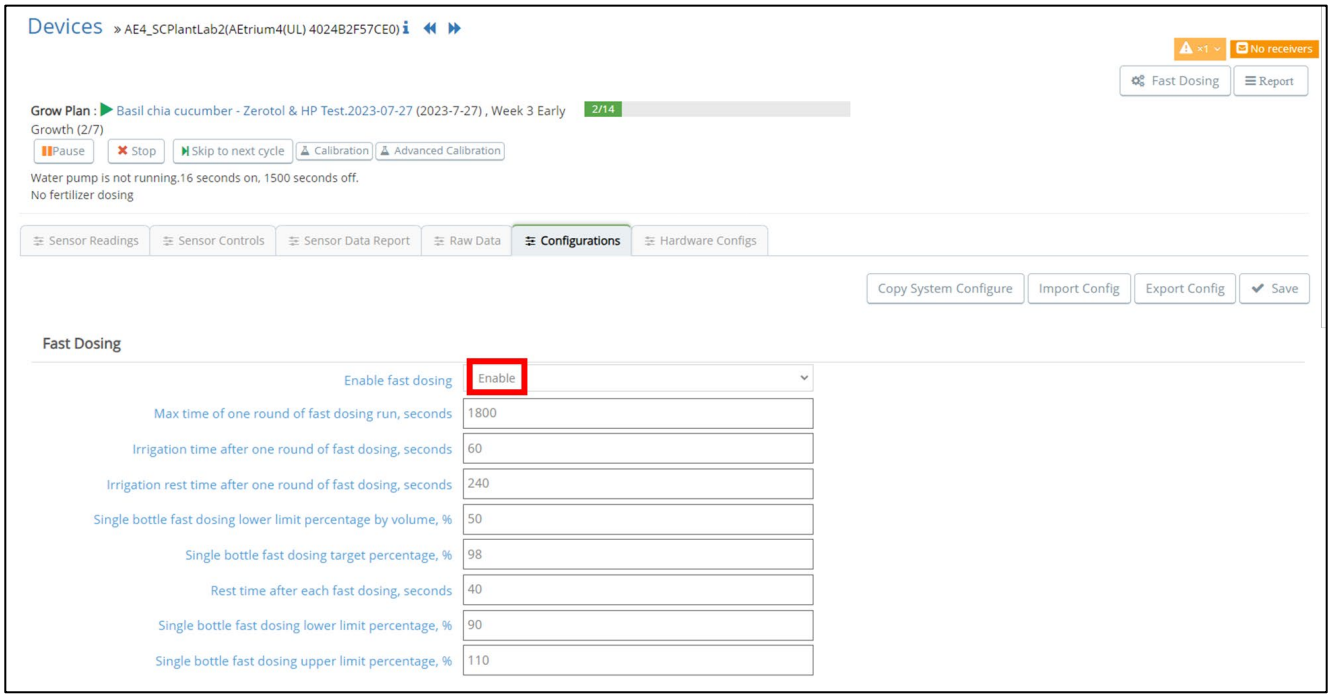
Fast Dosing *is a unique dosing option that allows the system to automatically dose the reservoir up to 4 times faster than either the* **Hybrid** *or* **EC Feedback** *dosing processes.* **Fast Dosing** *was designed to redose a newly flushed reservoir to working order as fast as possible.* **Fast Dosing** *uses a combination of the automated dosing processes previously discussed in both the* **Hybrid** *and* **EC Feedback** *dosing processes. Specifically,* **Fast dosing** *uses a modified* **Hybrid** *dosing process to quickly bring the reservoir EC close to the target value by adding large volumes of fertilizer from each bottle at a much greater speed during an extended* **Dosing Cycle.** *Once the reservoir nutrient concentration (EC) gets close to the target value, the system uses* **EC Feedback** *dosing to arrive at the target EC value through several small, additional dosing steps.*

3a. Fast Dosing – Essential Calibrations

Because the **Fast Dosing** *process builds upon the framework of the* **Hybrid** *and* **EC Feedback** *dosing options, the essential calibration procedures for both must be maintained for the* **Fast Dosing** *process to run accurately. Additionally, a separate fast dosing speed calibration must be performed for each active peristaltic dosing pump. For details on how to perform the fast dosing speed calibration, see the included Tech Note for GGM Version 4.2.12.*

3b. Fast Dosing – How to Setup

Unlike the **Hybrid** *or* **EC Feedback** *dosing options,* **Fast Dosing** *cannot be configured in a grow plan. Instead, fast dosing must be enabled in the* **Fast Dosing** *section of the device configurations tab.*



Note: The **Fast Dosing** *section is only visible by users with a* **Super Admin (SA)** *account role. However, once enabled, the* **Fast Dosing** *logic can be manually activated by any account role other than* **Viewer**.

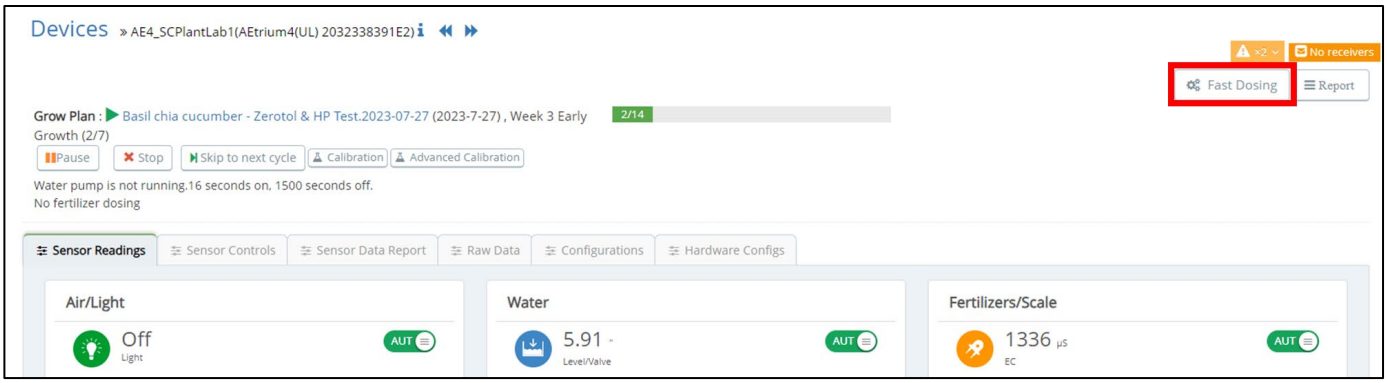


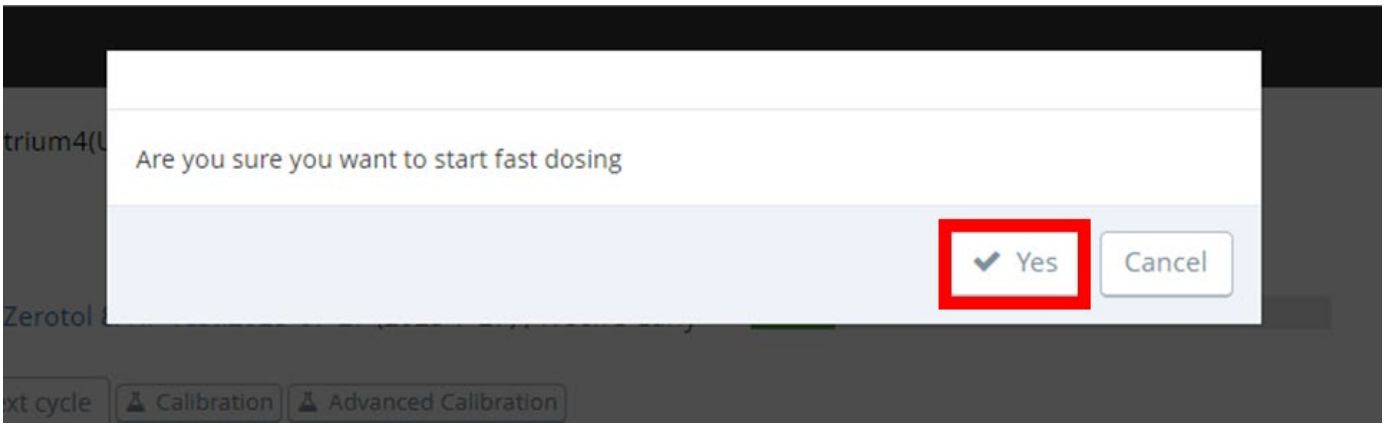
To enable **Fast Dosing** *for your devices*, *or gain* **Super Admin (SA)** *account status, reach out to an AEssense support member for help.*

3b. Fast Dosing – How to Setup

Once **Fast Dosing** *is enabled on a specific device, there are two ways for an AEtrium system to run it:*

1. *Automatically*
    a. *When* **Fast Dosing** *is enabled on a device running any* **Grow Plan**, *the device will activate* **Fast Dosing** *after a scheduled flush at the beginning of a new grow cycle. This process allows the system to quickly replace the flushed fertilizers using the configured fertilizer* **Rates (mL/Gal)** *and Target EC setpoints in the new grow cycle.*
2. *Manually*
    a. *Fast dosing can be manually started by clicking the "Fast Dosing" button located at the top of the device page on any device with* **Fast Dosing** *enabled.*





When Fast Dosing is manually started, the current grow plan will pause. Dosing will proceed until the Target EC is reached or for up to 30 minutes, at which point the system will irrigate, and then complete the dosing.

AEssense Recommendations & Considerations

All three automated dosing options possess the potential to achieve both accuracy and precision when they are appropriately configured and calibrated. Each method has its advantages and can be effective in various scenarios. However, based on extensive in-house testing and analysis conducted by the AEssense team, we recommend users to opt for the **Hybrid** *dosing option. The* **Hybrid** *dosing option has consistently demonstrated superior accuracy in attaining desired nutrient target ratios. The* **Hybrid** *dosing option stands out as the clear choice not only due to its superior accuracy but also because of its simplicity of setup. This user-friendly aspect makes it highly accessible and appealing to both new and experienced users alike. The reduced maintenance requirements relative to the other dosing options ensures the dosing system consistently maintains the correct nutrient ratios over time with less effort, enabling a more streamlined workflow, and empowering growers to focus more on optimizing the other aspects of their cultivation and achieving the best possible yields.*

For experienced users who prefer a more hands-on approach and would like to utilize the **Fast Dosing** *option, it is important to note that Fast Dosing does require regular calibration of both* **Reference EC** *values and* **Doser Pump speed** *values on a monthly basis. This means that users who opt for the* **Fast Dosing** *option will inevitably find themselves updating the required dosing calibrations more frequently. While this level of involvement might be appealing to some experienced growers who enjoy fine-tuning their systems, it also means investing more time and effort into the maintenance and monitoring of the dosing setup. Ultimately, the choice between dosing options will depend on the user's preferences, experience level, and desired level of involvement in the dosing process.*

For additional help with dosing option considerations, reach out to a member of the AEssense team. The AEssense team remains committed to assisting its grow partners in achieving the greatest yields and peace of mind while operating AEssense equipment. Our expertise and support are readily available to ensure our grow partners make the most informed decisions and optimize their cultivation processes to the fullest.

Contact

A *3036 Scott Blvd, Santa Clara, CA 95054*

O *1.650.564.3058*

E *info@aessensegrows.com*