by Andrew Taylor: Chemist of Flairform

Using Conductivity to Control Nutrient Concentration

It is important to control the concentration of your nutrients. Burning of roots or foliage can occur if the level is too high. If the concentration is too low then deficiency symptoms will occur. The concentration of nutrients and additives is usually set by the manufacturer, which is stated as the volumetric dose rate, for example, four to five teaspoons per gallon *(figure one)*. However, for the main inorganic nutrient, conductivity (EC) meter* is a helpful dosing aid.

*Also includes CF and TDS meters

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Add nutrient to reservoir at the following rates:
Hydroponics e.g. NFT, Rockwool, clay, perlite
4 - 5 tsp/gal. Target EC 1.6-2.3mS.

Figure one:
Nutrient labels often list dosage rates in terms of both volume and EC.

Table one 'a' General target conductivity (EC) values for different stages of plant growth.
(Conductivity Meter calibrated using 2.76 mS/cm standard)

	Cuttings/ seedlings	Vegetative phase (Grow)	Flowering/ fruiting phase (Bloom)
Hydroponics (e.g. NFT, Rockwool, clay, perlite)	0.6* to 1.0mS	1.6* to 2.3mS	1.6* to 2.3mS
Coco fibre / Soil	0.6* to 1.0mS	1.3* to 1.6mS	1.3* to 2.0mS

* Note, use the lowest EC when air temperatures are above 86ºF or the EC of make-up water exceeds 0.5mS.
Note that these target EC values are 'net' values i.e. in excess of the make-up water's EC. For example, if the make-up water has a conductivity value of 0.2mS, the target EC for cuttings and seedlings would be 0.8 to 1.2mS (i.e. EC of make-up water + recommended EC).

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Figure two: Stir nutrient tank well before sampling. Then leave the electrode in the sample for a few minutes before switching the meter on and taking the measurement.

Uses of EC meters

1. EC meters gauge the total concentration of salts in the nutrient solution. Hence they are useful for setting the target EC *(table one)* when a nutrient batch is first made (*see step four below*).

Note: *EC meters will not detect organics such as vitamins, hormones, etc.*

2. EC meters are also useful for maintaining the target EC as nutrient and water is consumed in re-circulating systems. However, because both good and bad salts are included in the reading, re-circulating nutrients must be frequently dumped because of the likelihood of toxic levels of bad salts like chloride present, and an imbalance of good salts.

Units

EC measurements are typically stated as mS (CF and ppm are common, but unequal alternatives). For example, distilled water and organics have an EC of zero mS. Mature flowering plants, however, typically require a nutrient solution EC of around two mS.

Obtaining conductivity readings

Step 1. Make sure the meter is calibrated.

Step 2. Remove a 'representative' sample from the nutrient reservoir:

+ For re-circulating systems ensure the reservoir is always filled to the same volume. If the reservoir is only half full, the conductivity reading will be twice as high as what it would be when full.

+ Stir the nutrient thoroughly prior to sampling.

+ Ensure the sampling container is clean.

Step 3. Rinse electrode in distilled water before immersing in the sample. Wait a few minutes* before switching the meter on and recording the EC *(figure two)*.

**Wait longer if the sample's temperature is significantly different from 77°F.*

Step 4. + If the EC is below target, add nutrient to the water until correct (to calculate this refer to table two). When making a new batch of nutrient, use the label's volumetric dose rate as a guide.

Table one 'b' Recommended nutrient strength for specific plant species**

Vegetables	Garlic 1.5-2.0mS	Tomato 2.0-3.0mS	**Herbs**	**Flowers crops**
Artichoke 1.0-2.0mS	Leek 1.5-2.0mS	Turnip 2.0-2.5mS	Basil 1.0-2.0mS	African Violet 1.0-1.5mS
Asparagus 1.5-2.0mS	Lettuce 1.0-1.5mS	Zucchini 2.0-2.5mS	Chicory 2.0-2.5mS	Aster 1.5-2.5mS
Barley 1.5-2.5mS	Okra 2.0-2.5mS		Chives 1.5-2.5mS	Begonia 1.5-2.0mS
Bean 2.0-3.0mS	Onion 1.5-2.0mS	**Fruit**	Fennel 1.0-1.5mS	Canna 1.5-2.5mS
Beetroot 2.0-3.0mS	Pak-Choi 1.5-2.0mS	Banana 2.0-2.5mS	Hops 1.5-2.5mS	Carnation 2.0-3.0mS
Broccoli 2.5-3.0mS	Parsnip 1.5-2.0mS	Black Currant 1.5-2.0mS	Lavender 1.0-1.5mS	Chrysanthemum 1.5-2.5mS
Brussels Sprout 2.5-3.0mS	Pea 1.0-2.0mS	Blueberry 1.5-2.0mS	Lemon Balm 1.0-1.5mS	Dahlia 1.5-2.0mS
Cabbage 2.5-3.0mS	Pepino 2.0-3.0mS	Melon 2.0-2.5mS	Marjoram 1.5-2.0mS	Ferns 1.5-2.0mS
Capsicum 2.0-2.5mS	Potato 2.0-3.0mS	Passionfruit 1.5-2.5mS	Mint 2.0-2.5mS	Fichus 1.5-2.5mS
Carrot 1.5-2.0mS	Pumpkin 2.0-2.5mS	Paw Paw 2.0-2.5mS	Mustard Cress 1.0-2.5mS	Freesia 1.0-2.0mS
Cauliflower 1.5-2.0mS	Radish 1.5-2.0mS	Pineapple 2.0-2.5mS	Parsley 1.0-2.0mS	Impatiens 1.5-2.0mS
Celery 2.0-2.5mS	Spinach 1.5-2.5mS	Red Currant 1.5-2.0mS	Rosemary 1.0-1.5mS	Gladiolus 2.0-2.5mS
Cucumber 2.0-2.5mS	Silver Beet 1.5-2.5mS	Rhubarb 1.5-2.0mS	Sage 1.0-1.5mS	Palms 1.5-2.0mS
Eggplant 2.5-3.0mS	Sweet Corn 1.5-2.5mS	Strawberries 2.0-2.5mS	Thyme 1.0-1.5mS	Roses 1.5-2.5mS
Endive 2.0-2.5mS	Sweet Potato 2.0-2.5mS	Watermelon 2.0-2.5mS	Watercress 0.5-1.5mS	
Fodder 1.5-2.0mS	Taro 1.5-3.0mS			

** This is a guide only. Values are represented as EC (mS/cm² abbreviated to 'mS'). Generally use the lower value for run-to-waste systems (e.g. coco fibre, rockwool, soil) or where day air temperatures are above 86°F. Use the higher values when growing in re-circulating systems (e.g. NFT, Flood & Drain) where day air temperatures are below 86°F.

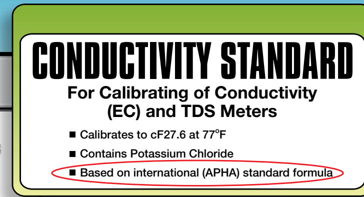

Figure three:
When calibrating meters ensure to use a conductivity standard that is based on international standards.

+ If the EC target is exceeded then add more water ("top-up" water). To calculate this, refer to table three.

Refer to table one 'a' for commonly recommended EC levels for the main stages of growth. These levels are suitable for the majority of plant types (for specific plants see table one 'b'). Within certain limits, there is no need to be precise with EC levels because plants will generally only consume what they need. Most species will tolerate being above or below the recommended value by at least 10 to 20 per cent.

5 **Step 5.** When complete, rinse electrode with distilled water. Store the electrode in distilled water when not in use.

Calibrating EC meters

Unless an EC meter is calibrated, you cannot confidently use EC recommendations like those supplied on many nutrient products. Calibrating cross-checks the meter's accuracy against a solution of known conductivity called a "conductivity standard" *(figure three)*.

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To calibrate, either refer to your meter's instructions, or do the following:

1 **Step 1.** Rinse electrode in distilled water then gently wipe with a tissue to remove excess water. Immerse electrode in 2.76 mS/cm (CF 27.6) Conductivity standard* for five minutes, then calibrate the meter so that it reads the following:

+ For conductivity meters – calibrate to 2.76 mS/cm or CF 27.6.
+ For TDS meters – calibrate to 1800 ppm (or as directed).

***Note:** *To prevent contamination of the stock solution, decant a portion into a smaller container and discard once used.*

2 **Step 2.** Remove electrode from conductivity standard and rinse with distilled water. The meter is now ready to be used.

Maintaining EC electrodes

Cleaning conductivity electrodes: Conductivity meter electrodes normally become coated with impurities. The degree to which this occurs will depend upon the nature of the samples being tested, and whether or not the electrode is rinsed with distilled water and properly stored after each use *(figure four and five)*.


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Figure four:
To help ensure ongoing accuracy clean the electrode with distilled water after use.

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Figure five:
Storing the electrode in distilled water will help prevent salt build up.

Table two How much nutrient is needed to achieve the target EC?
(Conductivity Meter calibrated using 2.76 mS/cm standard)

Volume of nutrient (tsp) required per gallon = (Target EC* *minus* Current EC) / 100 fold EC^ x 7.6

* Obtain from **Table one 'a'**
^ Calculate the nutrient's EC when diluted 100 fold with distilled water.

Example: Plants are in flowering phase in a hydroponic system. From **Table one 'a'** the maximum 'target EC' is 2.3mS. The 'current EC' in the nutrient reservoir is 1.9mS. My nutrient's 100 fold EC is 3.3mS. I therefore need 0.9 teaspoons of nutrient per gallon to achieve an EC target of 2.3mS i.e. (2.3 - 1.9) ÷ 3.3 x 7.6.

Table three How much top-up water is needed to lower the EC?
(Conductivity Meter calibrated using 2.76 mS/cm standard)

Target volume** = Current EC / Target EC* x current volume

*Obtain from **Table one 'a'** **Assumes top-up water has nil EC.

Example: The 'current EC' in the nutrient reservoir is 2.8mS. From Table 2.3, the 'target EC' is 2.3mS. The reservoir currently contains ~35 gallon of nutrient solution. The target volume is therefore ~42 gallons (i.e. 2.8 ÷ 2.3 x 35). Hence 7 gallons of top-up water is needed to achieve 2.3mS.

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"Regular cleaning will maximize electrode performance and ensure a longer working life."

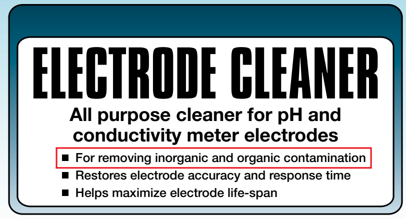

Figure six:
Ensure to use an electrode cleaner that can remove both inorganic and 'organic' contamination. Most cleaners will only remove 'inorganics'.

Electrode contamination causes a loss in sensitivity and, therefore, accuracy. Regular cleaning will maximize electrode performance and ensure a longer working life.

Note that when testing nutrient solutions, both organic and inorganic contaminations tend to co-occur. It is therefore important to use an all-purpose cleaner *(figure six)*. Be aware that most cleaners usually only remove inorganic contaminants, like salts.

Storing conductivity electrodes: Store the electrode in distilled water when not in use *(figure five)*. This will help prevent salt build-up which tends to encrust the electrode if left to dry out.

Purchasing a conductivity meter

The following specifications are important considerations:

+ Ability to produce readings in Siemens (e.g. "mS") or CF. Avoid meters that will only yield TDS (ppm).
+ Calibration facility: Helps ensure accuracy even when electrodes are not performing to original specifications due to electrode contamination, physical damage, etc.
+ Housing that is both waterproof and floats – helps protect against accidents/mishandling.
+ Temperature compensation: A built-in temperature sensor allows the meter to adjust readings to display what it would be if the temperature was at 77°F.
+ Long battery life – with auto-off feature to prolong battery life. MY

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Figure seven:
Popular styles of conductivity meters: Availability ranges from the more expensive laboratory grade (left), to the inexpensive pocket sized (right).

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