AE445

UF UNIVERSITY of FLORIDA
IFAS Extension

# Smart Irrigation Controllers: Programming Guidelines for Evapotranspiration-Based Irrigation Controllers[1]

Michael D. Dukes, Mary L. Shedd, and Stacia L. Davis[2]

*This article is part of a series on smart irrigation controllers. The rest of the series can be found at http://edis.ifas.ufl.edu/TOPIC_SERIES_Smart_Irrigation_Controllers.*

## Introduction

Irrigation systems are installed to provide water as a supplement to rainfall for maintaining plant health and aesthetics. Typically in Florida, irrigation is applied with an automated, in-ground system utilizing an irrigation timer programmed with user-defined irrigation schedules. However, homeowners who use these systems may apply more water for landscape irrigation than homeowners without automatic irrigation systems due to a "set it and forget it" mentality regardless of seasonal fluctuations in plant water needs.

"Smart" technologies for irrigation have been developed to apply irrigation to the landscape based on plant water needs while conserving our increasingly limited water resources. An overview of Smart Irrigation Controllers can be found in *What Makes an Irrigation Controller Smart* http://edis.ifas.ufl.edu/AE442. Ideally, these technologies will conserve water while helping to maintain landscapes of acceptable quality to consumers. *Operation of Evapotranspiration-Based Irrigation Controllers* http://edis.ifas.ufl.edu/AE446 presents general operating principles associated with ET controllers.

This publication will present programming guidelines for several examples of ET controllers available in Florida.

## Controller Inputs

ET controllers vary according to the way they receive data, as described in *Operation of Evapotranspiration-Based Irrigation Controllers* http://edis.ifas.ufl.edu/AE446, but can also vary based on the types of programmed inputs used for irrigation scheduling. Depending on the manufacturer, each controller can typically be programmed with various conditions specific to the irrigation system and landscape.

1. This document is AE445, one of a series of the Agricultural and Biological Engineering Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date February 2009. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
2. Michael D. Dukes, associate professor; Mary L. Shedd, graduate student; Stacia L. Davis, graduate student; Department of Agricultural and Biological Engineering; Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611.

### Irrigation System Inputs

Irrigation systems have parameters specific to their design and installation. Some common parameters include application rate and efficiency. Both application rate and efficiency factors are determined by the type of irrigation emitters such as sprinklers, spray heads, and drip irrigation.

Irrigation Type – The type of sprinkler used for the irrigation system affects the rate that water is applied to the irrigated area and the efficiency of water application. This input can generally be selected from a set of choices available in the ET controller (Table 1).

Application Rate – Rates of water application vary depending on the brand, type and installation details of sprinklers. Typically, the application rates of rotors are lower than spray nozzles. This rate has units of depth per time (such as inches/hour) and can be used to calculate the irrigation runtime from the depth found using the soil water balance (*Operation of Evapotranspiration-Based Irrigation Controllers* http://edis.ifas.ufl.edu/AE446). The rate of application can be located in the manufacturer's specifications or determined by performing a distribution uniformity test. See LH026, "How To Calibrate Your Sprinkler System", for information on how to determine the application rate of your system.

Efficiency – Irrigation efficiency is discussed in Efficiencies of Florida Agricultural Irrigation Systems http://edis.ifas.ufl.edu/AE110. Generally, landscape sprinkler systems are considered to be inefficient. For scheduling purposes in the ET controller instead of using low quarter distribution uniformity (DUlq), it is recommended that the low half distribution uniformity (DUlh) be used. In absence of uniformity testing information the following efficiencies may used as an estimate: rotary or impact sprinklers, 70-80%; spray heads, 60-80%; drip or other microirrigation emitters, 80-90%. The concept of irrigation efficiency and uniformity can be found in Understanding the Concepts of Uniformity and Efficiency in Irrigation http://edis.ifas.ufl.edu/AE364. The lower the efficiency number input to the controller, the more water that will be applied because the controller will compensate for lower efficiency (i.e. more losses) by applying more water. It is best to use as high an efficiency value as possible to limit over-watering.

### Landscape Inputs

Landscape conditions typically included as inputs to the controllers are soil type, plant type, slope, sun, and shade. The controllers generally have options available for each condition. Examples of inputs to an ET controller and inputs typically applicable to Florida are listed in Table 1.

Soil Type - Choosing the correct soil type can be extremely important to the soil water balance. Soil type affects the amount of water that can be held in the root zone and the infiltration rate of water into the root zone. Sand generally has high infiltration rates with low soil water holding capacity while clay has a very low infiltration rate, but holds water extremely well (Operation of Evapotranspiration-Based Irrigation Controllers http://edis.ifas.ufl.edu/AE446). Also, soil type affects the amount of runoff that can occur and is determined from the infiltration rate. If the infiltration rate is too low, most of the water will be lost to runoff and will not enter the root zone. Most soils in peninsular Florida can be classified as "sand" while those in the panhandle can be classified as "sandy loam". Fill soils may also be classified as "sand". However, site specific conditions need to assessed and appropriate soil type selected. On some construction sites, substantial compaction limits infiltration and root growth. For these sites, the top soil should be tilled to ameliorate compaction.

Plant Type – The type of plant in a landscape affects the irrigation required. Plant types are selected for the purpose of defining the appropriate crop coefficient and possibly defining an appropriate root depth. Crop coefficients and plant water requirements are described in Operation of Evapotranspiration-Based Irrigation Controllers http://edis.ifas.ufl.edu/AE446 and Basic Irrigation Scheduling in Florida http://edis.ifas.ufl.edu/AE111. Deeper root systems allow for longer periods between irrigation events. Some controllers allow you to choose custom crop coefficients and root depths that will override the default values given for the plant type option.

Slope – ET controllers may use the slope of an irrigated area to create multiple irrigation start times with shorter durations for each irrigation event. This will reduce runoff allowing water to infiltrate into the soil after each event.

Microclimate –The percentage of the irrigated area covered with shade may be used by the ET controller to adjust the amount of water applied. Evapotranspiration (ET) in a shaded area will be lower than ET in an area with full sun.

### Weather Conditions

ET controllers may have several options limiting irrigation during windy or rainy conditions. As wind speeds increase, the ability for the irrigation system to apply water efficiently decreases and evaporative loss of water increases. Also, irrigation should be reduced or suspended during periods with adequate rainfall.

Rain Sensors – An ET controller may include a rain sensor in the system such as the Weathermatic Smartline Series (see AE221, Residential Irrigation System Rainfall shutoff Devices http://edis.ifas.ufl.edu/AE221 for details on rain sensors). Rain sensors bypass irrigation events when a specific amount of rainfall has occurred. Some ET controllers will refill the soil water after a rain event is sensed by the rain sensor whereas other controllers will only pause irrigation until the rain sensor is dry. Unless a controller measures rainfall on site, a supplemental rain sensor should be used due to frequent and site specific rainfall experienced in Florida. It is important that the rain sensor be connected to a "sensor" port if available on the ET controller so that irrigation bypass events are accounted for properly in the controller.

Rainfall Service – Some signal-based ET controllers receive an input of rain depth from the weather signal. Irrigation may be paused for a preset number of days as a response to the amount of rainfall measured at the weather station. It is possible for the user to program the response to a rainfall event manually. Instead of pausing irrigation, other controllers account for rainfall measured in the weather network as an input to the plant and soil system and the irrigation schedule may be adjusted accordingly.

## Challenges

ET controllers can be very useful tools for improving irrigation water application because they allow the homeowner to "set it and forget it". Most of these controllers calculate irrigation run times and cycles based on the user inputs and weather conditions (Table 1). However, these controllers cannot fix a poorly designed or poorly maintained irrigation system. Thus, it is important to have the irrigation system inspected regularly and to have necessary maintenance performed in a timely manner.

The various controllers operate differently to reduce irrigation water use depending on whether they are add-on devices that bypass fixed events or complete units that calculate run time of irrigation events themselves. While these controllers can be programmed once and left alone, they need maintenance to ensure that the signal is not lost and they are working properly.

Confusion may arise with these controllers when dealing with the programming aspect. The various commercially available ET controllers have different programming terms, inputs, and procedures; there is no standardized model (Tables 2 and 3). Manufacturers design the controllers to be installed by knowledgeable contractors who understand the various inputs. Programming the controller correctly for each unique landscape is critical to the ability of the controller to reduce water use and maintain good landscape aesthetics.

## References

Mayer, P. W., W. B. DeOreo, E. M. Opitz, J. C. Kiefer, W. Y. Davis, B. Dziegielewski, and J. O. Nelson. 1999. Residential End Uses of Water. AWWA Research Foundation and American Water Works Association. Denver, Colorado.

**Table 1.** Common settings that are programmable in ET controllers to properly schedule irrigation.

| Category | Common Settings | Parameter Effected by Setting | Common Florida Inputs | More Information |
|---|---|---|---|---|
| Irrigation Type | Spray head<br>Rotor<br>Impact<br>Bubblers<br>Drip emitters | Application Rate<br>Uniformity/<br>Efficiency | Spray<br>Rotor | CIR825 |
| Soil Type | Sandy<br>Sandy Loam<br>Loam<br>Clay Loam<br>Clay | Infiltration Rate<br>Water Holding Capacity | Sandy<br>Sandy Loam | SS169 |
| Plant Type | Warm Season Grass<br>Cool Season Grass<br>Combined Grass<br>Flowers<br>Trees<br>Shrubs<br>Mixed<br>Trees<br>Native Grasses | Crop Coefficient (Kc) | Warm Season Grass<br>Mixed<br>Shrubs | ENH860 |
| Microclimate | Sunny all day<br>Sunny most of the day<br>Shady most of the day<br>Shady all day | ET Adjustments | Site Specific | EES43 |
| Slope | 0-5%<br>6-8%<br>9-12%<br>13-20%<br>>20% | Cycle/Soak | Site Specific | |

**Table 2.** Program settings for four commercially available ET controllers irrigating a full sun St. Augustinegrass lawn on a sandy soil and using spray heads.

| Setting | Toro Intelli-sense | Weathermatic Smartline | ET Water Smart Controller 100 | Rain Bird ET Manager |
|---|---|---|---|---|
| Sprinkler Type | Spray Head | Spray | Spray Head | Fixed Spray |
| Application Rate[1] | 1.7 in/hr | 1.0 in/hr | 1.5 in/hr | User-defined[2] |
| Soil Type | Sand | Sand | Sand | Sand |
| Plant Type | Warm Season Turf | Wturf | Lawn - Warm Season | Warm Season Turf |
| Microclimate | Sunny All Day | NA[3] | Sunny All Day | NA |
| Slope | 0% - 5% | 1% - 5% | 0% - 5% | 0% - 3% |
| Efficiency/ Uniformity[4] | 80% | NA | 80% | 80% |
| Zip Code[5] | NA | 32611 | NA | NA |

[1] Application rates are default controller values for the spray head program setting. Site-specific information based on catch can testing should be used if available.
[2] The application rate can be found using on-site catch-can testing or, after choosing the sprinkler type in the scheduling software, the ET Manager lists various sprinkler manufacturers and corresponding models of the sprinkler category to determine the application rate from the technical specifications.
[3] NA refers to settings that do not apply to the controller program settings.
[4] This factor should be based on a catch can uniformity measurement and the calculated low half distribution uniformity value. The values here are merely guidelines in the absence of site-specific information. In addition, these values presume coverage of the irrigated area by 2-3 overlapping heads.
[5] Zip codes should be updated for location of controller.

**Table 3.** Program settings for four commercially available ET controllers irrigating shrubs on a sandy soil and using microsprinkler irrigation.

| Setting | Toro Intelli-sense | Weathermatic Smartline | ET Water Smart Controller 100 | Rain Bird ET Manager |
|---|---|---|---|---|
| Sprinkler Type | Spray Head | Spray | Spray Head | Micro Spray |
| Application Rate[1] | User-defined | User-defined | User-defined | User-defined[2] |
| Soil Type | Sand | Sand | Sandy | Sand |
| Plant Type | Shrubs – Med Water Use | Shrubs | Shrubs | Shrubs |
| Microclimate | Sunny All Day | NA[3] | Sunny All Day | NA |
| Slope | 0% - 5% | 1% - 5% | 0% - 5% | 0% - 3% |
| Efficiency/ Uniformity[4] | 90% | NA | 90% | 90% |
| Zip Code[5] | NA | 32611 | NA | NA |

[1] Application rates should be determined for microsprinkler by measurement since default values do not exist for these controllers. If a value for “drip” irrigation is available in the controller it could be used; however, it may need adjustment over time to provide adequate water to the plant material.
[2] The application rate can be found using on-site catch-can testing or, after choosing the sprinkler type in the scheduling software, the ET Manager lists various sprinkler manufacturers and corresponding models of the sprinkler category to determine the application rate from the technical specifications.
[3] NA refers to settings that do not apply to the controller program settings.
[4] Uniformity of microsprinkler assumes that the sprays are targeted to the root zone of the shrubs.
[5] Zip codes should be updated for location of controller.