Signature CONTROL SYSTEMS, INC.

FIELD CONTROL SYSTEMS

CONSTELLATION

OPERATION MANUAL

Network Sensors

ACNS Series

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Network Sensors – ACNS Series

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Introduction and Design Considerations

Introduction

Signature's Network Sensors (Sensors) can broadcast up to four soil measurements (moisture, conductivity, temperature, and wetted front) across the patented Peer-to-Peer communications network. Any program running on any controller in the network can be configured to either start or stop based on adjustable measurement thresholds for any of the four sensor inputs.

Firmware Options

Network sensors are designed to work with Signature's Constellation Series controller(s) running firmware versions 6.00.00+ and higher.

Network sensors provide four soil measurements: soil moisture, soil bulk conductivity, soil temperature, and wetted front. Readings can be acquired individually or in the following combinations:

ACNS1 – Soil Moisture
ACNS2 – Soil Bulk Conductivity (EC)
ACNS3 – Soil Temperature
ACNS4 – Wetted Front
ACNS5 – Soil Moisture and Soil EC
ACNS6 – Soil Moisture, Soil EC, Soil Temperature
ACNS7 – Soil Moisture, Soil EC, Soil Temperature, Wetted Front

The type of sensor is factory set at the time of purchase.

Firmware upgrades or changes to the Network Sensor are handled by the controller over the network connection, so there is no need to disturb the sensor once it is installed.

Design Considerations

Each field controller supports a maximum of two 1000 ft [300 m] cable runs with up to 15 sensors each. Network cables are minimum AWG18, dual twisted-pair. Each Network supports a maximum of 999 controllers and/or sensors.

It is important to remember that even though you can put 15 sensors on a single run of wire off of a field controller, each controller can only assign 4 remote sensors to control programs (and the digital sensors are all considered remote sensors). For example, if you have a field controller with one ACNS7 sensor, you could fill all four of your available remote sensor slots. Additional sensors can be added to the sensor line, but they would be strictly for data collection and not program functions, unless they are called by another controller. However, you could have multiple sensors installed around the property and depending on the time of year, you may want a program to track sensor 501 in the spring and sensor 502 in the summer, for example.

Field Installation, Controller Connections and Programming

The installation and use of Network Sensors requires three steps: (1) Installation of the Sensor in the field, (2) Connection to a field controller, and (3) Programming of the Sensor. These steps are covered in order in the next sections.

Section 2 | Field Installation

Installing a Network Sensor

Sensor Measurements

The sensor reports the average of soil moisture and bulk soil electrical conductivity along its active length of about 6 inches (15 cm), which is 1¼ inch (3 cm) from the top and 1 inch (2.5 cm) from the bottom of the sensor, no matter if the sensor is installed vertically or horizontally. Under most conditions, the sensor's field of influence radiates about 4 inches (10 cm) out from the flat side of the sensor, and about 1 inch (2.5 cm) from the tip.

Sensor Orientation

The sensors can be installed vertically or horizontally. Horizontal installation is preferred in cases where soil properties at a particular depth are desired, such as turf grass. Vertical installation is preferred in cases where soil property measurements through the depth of a root zone are desired, and to locate the wetting front measurement near the lower end of the sensor and root zone, such as in deep rooted shrubs or trees.

With horizontal orientation, soil can be more easily packed around the sensor while providing a more precise measurement of soil moisture at a specific depth. When installing the sensor horizontally, the sensor orientation should be such that the vertical surface area is minimized so as to provide the least obstruction to the propagation of water through the soil. No portion of the sensor should be less than six inches below finished grade of the soil in a horizontal installation.

Vertical installation is preferred for covering the majority of the root zone depth with a single sensor. Soil compaction around the sensor is often more difficult in a vertical installation, however. The best way to minimize soil disruption in a vertical installation is to use an auger and insertion method, to be described shortly.

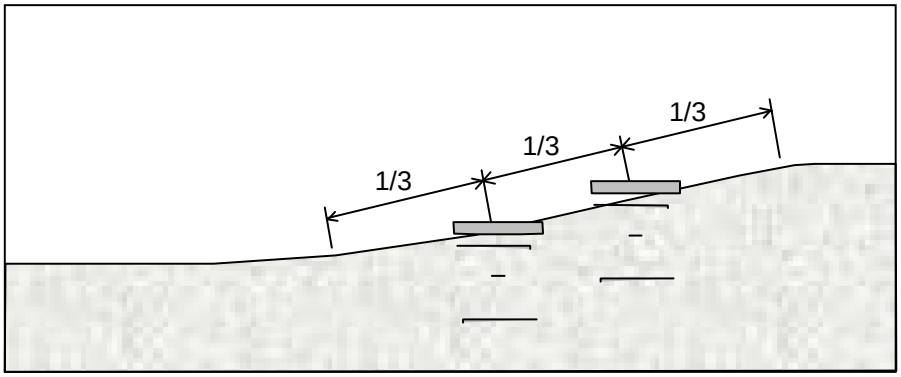
Site Selection

It is generally recommended that sensors be located in when you have changes in soil type, plant material, micro climates and topography.

On hilly ground, locate the sensors at about two thirds of the vertical rise between the low and high points of a given zone. The hilltop normally presents the driest conditions in the field and should only be used when trying to control growth in this area. Locating sensors in wet or low areas is not recommended.

On sloping surfaces, locate sensor sites at one third and at two thirds of the vertical rise between the bottom and top of the sloped area.

Sensor Placement in Sloped Areas



A soil sampling probe is very useful in locating suitable sites to position soil moisture sensors. By probing the soil in several locations around prospective sites, a representative site typical of the field can be determined. When probing, check for soil type, moisture, and compaction.

Turf Grass Installation Site Assessment

Turf grass usually requires more frequent irrigation than most other plant types in a landscape due to the shallow root zones and effects of ET (evapotranspiration). Accordingly, soil moisture sensors should be placed at the driest location relative to the average of the perspective zones. The driest locations are usually:

- Areas with significant and uninterrupted exposure to wind or sunlight
- Areas at higher elevation

Soil moisture sensors should be placed within the root zone of the grass, in contact with relatively undisturbed soil. The potential root depths for some turf grass (according to recommendations published by Cooperative Extension University of California) are provided below:

- **Shallow** (1-8 inches): Poa annua, Creeping bent grass, Colonial bent grass
- **Medium** (8-18 inches): Kentucky bluegrass, Red fescue, Ryegrass, St. Augustine
- **Deep** (18-60 inches): Zoysia grass, Bemuda grass, Tall fescue

Installation Tools

A tile/drain/ditching spade, which has a long thin blade, is often the best field installation tool for horizontal installations. The spade typically has a blade of 3 to 5 ½ inches (8 -14 cm) wide and 10 to 14 inches (25 - 36 cm) long. This blade is the width of or slightly wider than the network sensor.

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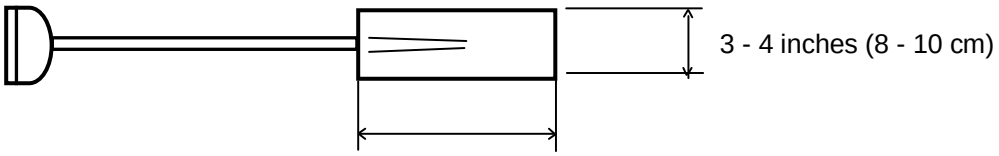
Probe Installation Spade



If excavation with a shovel is necessary, it is recommended that all of the removed soil be placed into a container or bucket in the same layers that it was taken out of the soil. This will ensure that all of the soil taken out is eventually replaced and close to its original composition.

The sensor cable should extend on-axis away from the sensor for at least 2 inches (5 cm) to reduce the potential for electromagnetic interference between the cable and sensor, and to reduce the likelihood of water following the cable towards the active area of soil moisture measurement.

General Installation Notes

- Install sensors at depths suitable to avoid damage from aeration equipment or other machines or tools likely to be used. A 6” minimum depth below grade for horizontal installations is recommended.
- Do not install sensors near metallic equipment such as valves or sprinkler heads. Provide a 24” guard band if possible.
- Route the cable away from the sensor body to avoid the potential of electromagnetic interference with the measurement.

New Landscape Installations

Sensors are preferably installed before turf grass sod is laid. The sensor should be buried in the soil at the midpoint of the maximum turf root density and the turf grass sod laid on top.

For horizontal installations, position the sensor with the sensor “blade” oriented vertically. This will ensure the sensor element is at a constant depth and that the sensor housing presents minimal obstruction to the natural seepage of water through the soil.

For vertical installations, use a small auger to remove a few inches of topsoil to expose the area where the top of the sensor is to be located. Use a 1”-wide chisel or similarly shaped device to prime an opening in the soil into which the sensor can be inserted. Press or gently tap the sensor into place once the chisel has been removed, taking care to disturb the surrounding soil as little as possible.

Existing Turf Installations

If turf grass is already installed, it is important to disrupt the soil and root zones as little as possible.

Horizontal Method (A):
Horizontal installation should be done by digging back behind where the sensor will be installed exposing a vertical wall, use your 1" chisel for a starter hole, insert the sensor and tap it into the vertical wall, repack the soil behind the sensor to its original compaction. This way the sensor is installed with the least amount of soil disruption around it giving you more accurate readings right away.

Horizontal Method (B):
For horizontal installations near the surface, turf should be cut and rolled away to preserve aesthetic appearance as much as possible. Using a square point shovel or turf edger, cut a 4"x8" rectangular piece of turf grass sod to a depth near the midpoint of the maximum root density, and minimum depth of 6 inches. Remove the cut square of turf grass by rolling it back to expose the soil below. Place the sensors on the top of the soil, with the sensor "blade" oriented vertically, and press the sensor into the soil. Surround the visible portion of the sensor with some loose soil from the underside of the cut turf, and compact the soil around the sensor to displace air and foreign materials.

Cut a trench for the sensor cable and make the appropriate electrical connections, ensuring the connections are strain-relieved and fully sealed.

Replace the turf grass sod to completely cover the sensor, and gently compact the turf grass sod making sure that there are no channels that will allow water to seep in and pool around the sensor. Additional soil can be added on the top of the sensor location so that it may wash into any remaining gaps by irrigation and rain.

For deeper root zones, the sensor can be installed vertically or horizontally. Horizontal installations will likely require excavation of the area using a shovel. Less soil disruption will occur for vertical sensor installations, where a small auger can be used to provide access to undisturbed soil at the desired depth. Once a hole is augured, a 1" chisel or similar device can be used to prepare a channel in the soil into which the sensor can be inserted. Press or gently tap the sensor into place once the chisel has been removed, taking care to disturb the surrounding soil as little as possible. Cut a trench for the sensor cable and make the appropriate electrical connections, ensuring the connections are strain-relieved and fully sealed. Fill the augured hole with soil and cover the hole and cable trench to meet aesthetic requirements.

Notes Concerning Installation Near Solid Set and Micro Sprinklers

Locate the Sensors one-third to one half the distances from the sprinkler head to the edge of the wetted area. Keep in mind that some sprinklers have a flat or even wetting pattern, some have a doughnut-wetting pattern near the sprinkler, and others have triangular distribution that is designed for 50% sprinkler overlap. Locate the sensors in an area with uniform water application.

NOTE: It is important in locating the top sensor so that a minimum of 4 inches (10 cm) of soil is covering the sensor. With less than a four-inch covering the sensor will not give accurate readings and is subject to damage from mechanical equipment. In horizontal installations, the depth should not be less than 6 inches.

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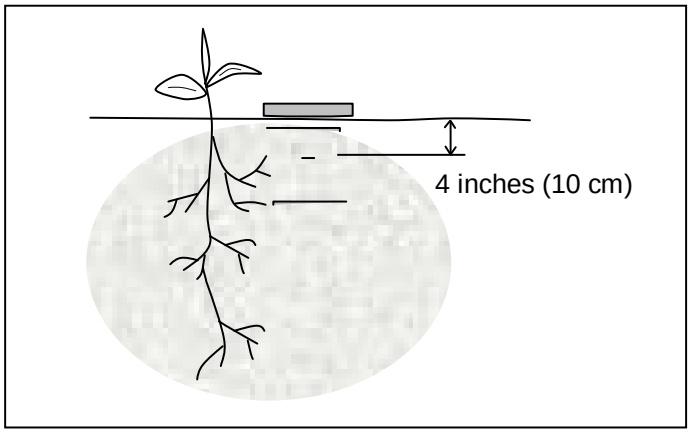
Minimum Recommended Sensor Depth



Cable Guidelines

The sensor is furnished with a high quality cable suitable for direct burial or exposure to direct sunlight. It is resistant to damage from insects, abrasion and normal environmental exposure.

Mechanical contact with the cable by hoes, cultivators, or animals such as coyotes, gophers, and rats can easily damage the cable. Cable damage is responsible for almost all problems obtaining sensor readings.

To prevent mechanical damage, it is strongly recommended that the cable be installed in 3/4-inch electrical conduit. This size conduit is required to accommodate the passage of the plug connector.

To install the cable in conduit, place the cable through a 90 degree elbow at the sensor in the ground, then a three foot (1 meter) length of straight conduit up above the soil surface. At the end use two 90-degree elbows to keep rain water from entering the conduit. Make sure that all the conduits and elbows sit correctly. Glue the conduit joints. Pack the soil well around the conduit, as water may follow the conduit down, and give false readings.

Extended Cable Lengths

If necessary, the sensor cable can be extended up to 1,000 ft [300 m]. This may be useful in reading the unit at the edge of a field or for direct wiring to a data logger. Little to no loss in sensitivity should be experienced from cable lengths up to 1,000 ft. [300 m].

Cable may be spliced by the customer. All connections should be made inside a waterproof box using silicone filled, waterproof, and wire nut connectors. These waterproof connectors are available at local electrical/hardware suppliers, such as Home Depot.

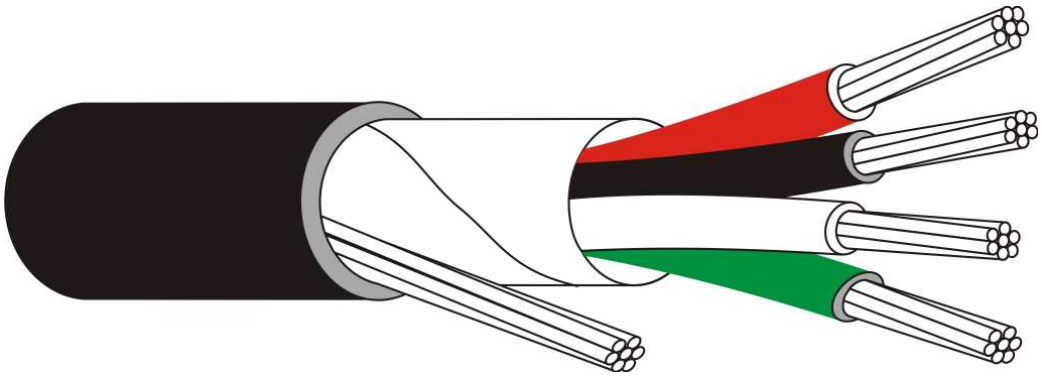
Communication Cable

The sensor cable should never be spliced into the communication cable, but should have a dedicated 4-core cable terminating in the controller.

Controller Cable Lengths

If using hard wire communication cable between controllers, the maximum length between controllers is 4,000 ft [1200 m]. The cable lengths of the network sensor should be subtracted from that length with the total length of communication cable and sensor cable adding up to 4,000 ft [1200 m]. For example, if the sensor cable length is 1,000 ft [300 m], the maximum communication cable length between controllers would be limited to 3,000 ft [900 m] for that set of controllers.

Obviously, if using radio communications for communication, the only limit is the 1,000 ft for the sensor cable.



Typical Sensor Cable

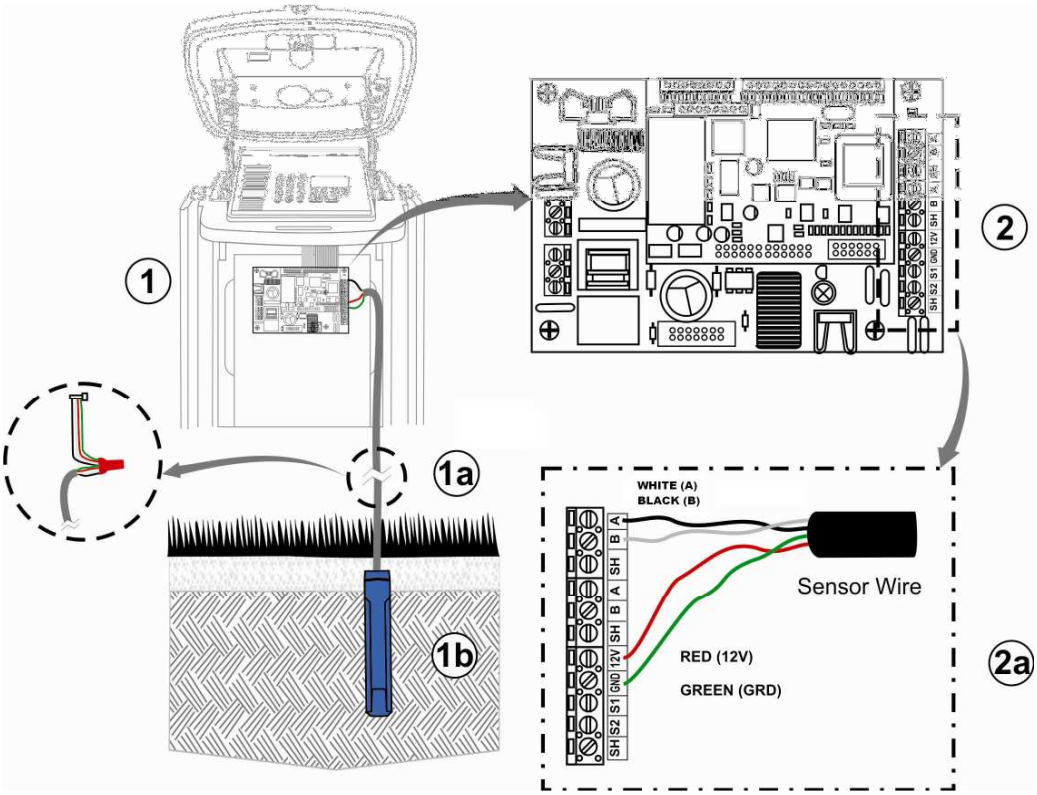
Section 3 Field Controller Connection

Connecting a Network Sensor to a Field Controller

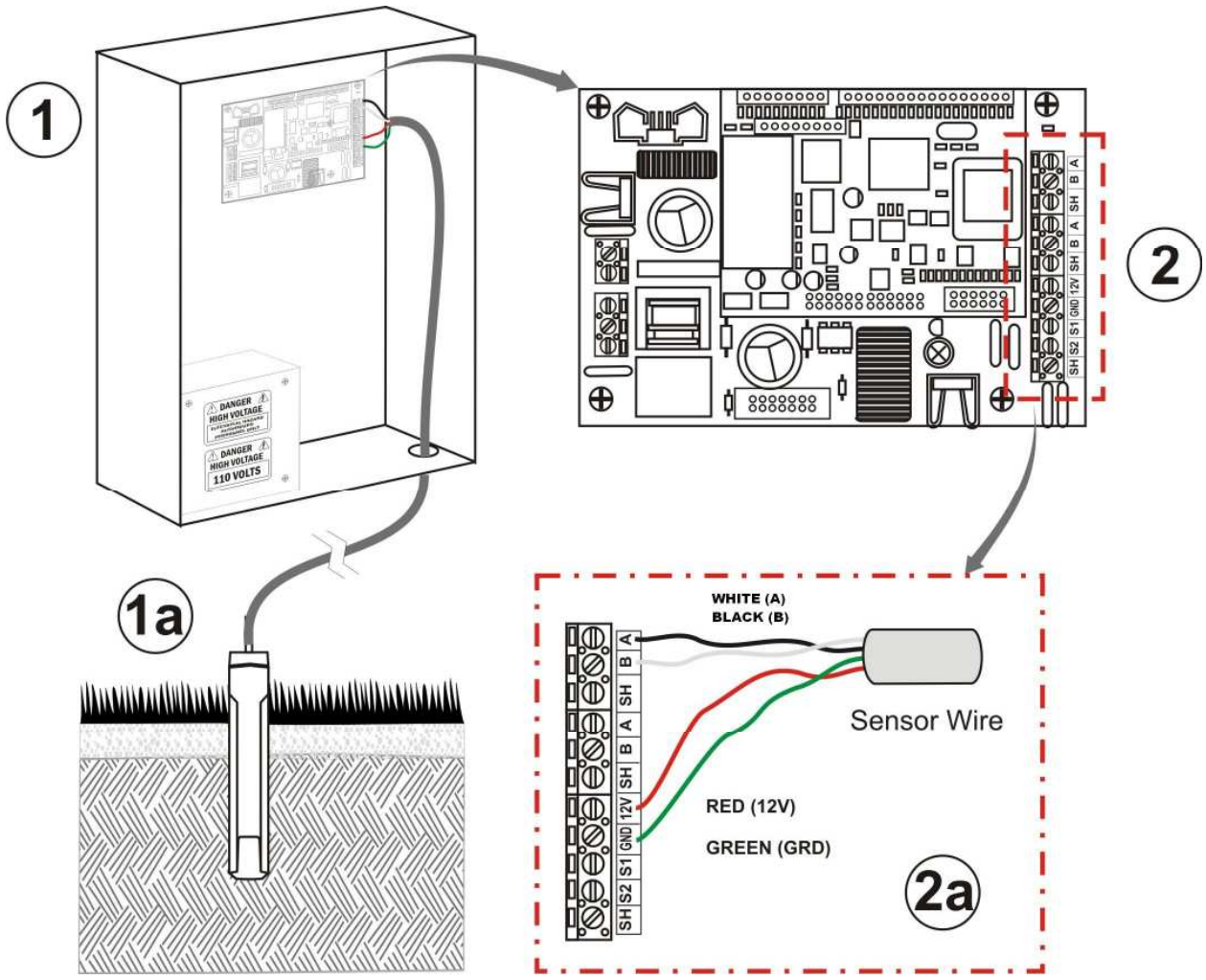
Controller and Sensor Connections

ACPAC Card connections detail:

- White - “A”
- Black – “B”
- Red – “12V”
- Green – “GND”



Typical Pedestal Installation and Hardwire Connections



Typical Wall Mount Enclosure Installation and Hardwire Connections

Section 4 Programming a Network Sensor

Programming a Network Sensor to be used in Programs

NETWORK SENSOR PROGRAMMING

Remote Link Interface

Because the Sensors do not have their own User Interface, the Controllers must take on that responsibility via a 'Remote Link'. Because the sensors are 'peers' in the network, they have an address and can be interrogated and configured via the communication bus from a Controller.

Using the 'Remote Link' option from the Main Menu, the address of the Sensor is entered. (NOTE: Galaxy firmware types do not have this capability).

IMPORTANT: Setting Sensor ID

The sensor ID# is factory default set to "500" for every sensor. Each sensor must be individually connected to the controller and have the ID# set to a unique ID#. The ID# cannot be another field controller or network sensor.

The ID# must be set before connecting another sensor. For example, after connecting the first sensor, the ID# is set to #501. Then upon connecting the second sensor, remote link to ID# 500 and set the ID# to #502. Upon connecting the third sensor, remote link to ID#500 and set the ID# to #503, or any other unique number.

Sensor Driven Programs

Network Sensors (i.e. Moisture, Temp, EC) are configured with a 'Start' and 'Stop' threshold. When the start threshold is detected, any programs with a Sensor Start configured will start. The program will loop continuously until either a 'Stop' Time is encountered OR the stop threshold is reached. The program will only restart within the same water window if the start criteria are met, otherwise it will run the selected run times and stop.

The Network Sensor will broadcast the current sensor measurement at a programmable interval, thus allowing independent thresholds for each program.

A "Sensor Driven Program" will be defined and distinct from normal programs. A Sensor Driven program is produced when a Program Start Event is selected as a 'Sensor Start'. This selects the sensor number

and the requirement for program start. The requirement consists of a > or < condition with a threshold value.

For example, a Start Sensor requirement may be for a Moisture sensor may be < 20%. When a Sensor Driven program is created, only the following additional Program Start Events are enabled:

- Start Time, which defines the start of the water window
- Stop Time, which defines the end of the water window
- Loop Until Time, which defines the end of the water window
- Start Sensor
- Loop Until Sensor

All other Program Start Events are ignored.

Water Window

The Sensor Requirement is only tested inside the water window. The water window starts with a Start Time and ends with a Stop Time (for an immediate stop of the active cycle) or a Loop Until Time (which will allow the active cycle to complete).

If a Start Time is omitted, the start is assumed to be 12:00:00AM. Similarly, if a stop time is omitted the end is assumed to be 11:59:59PM. Water windows can be reversed; i.e. a Stop or Loop Until time can precede a Stop Time. In this case, the water window will be comprised of 2 windows; the period from 12:00:00AM to the Stop Time, and the period from the Start Time until 11:59:59PM.

Program 'Start Sensor'

The program start sensor option will appear as follows:

0	0	1		:		S	t	a	r	t		0	1		O	f		0	8
→	1	)		T	y	p	e	:		S	t	a	r	T					
	2	)		S	e	n	s	o	r	:		3							
	3	)		R	e	q	:	<		+	0	0	3	5	.	4	0	0	

Program 'Loop Until Sensor'

The Loop Until Requirement allows the program to continue looping until it's requirement is met within the water window. A loop until requires the occurrence of a valid Start Sensor condition before it activates. This can be useful for Moisture Sensing applications in which irrigation will start at maximum soil water depletion (MAD) and continue until field capacity (FC) is reached. Delays between program restarts can be used to accommodate water percolation. This will be achieved by inserting a delay (station = 0) as the last event in the sequential program, or an extended run time in a parallel station.
The program loop until sensor option will appear as follows:

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0	0	1		:		S	t	a	r	t		0	1		O	f		0	8
→	1	)		T	y	p	e	:		L	o	o	p		U	n	t	i	l
	2	)		S	e	n	s	o	r	:		3							
	3	)		R	e	q	:	>		+	0	0	5	1	.	3	0	0	

Outputs

Soil Moisture
Range: 3% to 50%, volumetric moisture content (sandy loam, loam, clay loam)
Accuracy: +/- 1%
Features: Moisture measurement compensated for conductivity and temperature

Soil Bulk Conductivity
Range: 0-12 dS/m
Accuracy: +/- 0.2 dS/m

Soil Temperature
Range: -10 to +70 degC
Accuracy: +/- 1 degC below 70 degC

Wetted Front
Range: 0 to 9
Relative soil moisture differential measurement near nose of sensor

Notes

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