NELSON® TURF

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by Acclima

Digital TDT™ Soil Moisture Sensor Regulated Automatic Irrigation Controller Model 8710 EZ PRO MAX

Design Guide

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Nelson Turf EZ PRO MAX System Design

2-Wire Interconnect Specifications

2-Wire Device Overview:

Nelson by Acclima irrigation control systems use moisture sensors to measure the absolute water content of the soil and use this measurement to apply the optimum amount of water at the proper time. This process requires the sensors to communicate with and receive electrical power from the controller. Nelson by Acclima has developed a proprietary system that allows multiple sensors (and other devices) to receive power and maintain communications over just two wires.

For new systems, a single wire pair (or multiple wire pairs) can be used to circumscribe the property and interconnect all sensors, valves, flow meters, etc. attached to that 2-wire network. The 2-wire bus serves dual purposes: First, it conveys 24 volts ac to provide power for the valves and for other devices on the system. Second, it conveys a special combination of frequency domain and time domain multiplexed signals to maintain robust, error-free communications with the sensors, valve adapters, flow meters, etc.

For existing (retrofit) timer-based irrigation systems, underground wiring is already in place to activate solenoid valves. It makes sense to use these existing wires to provide both power and communications with sensors to avoid the installation of new wiring for the sensors and other devices. In such cases, an existing wire pair to a valve can be used to attach sensors and other devices to the system. The existing valves and the newly added sensors then share the wire-pair and all are in communication with the controller over that pair.

Valves cannot be directly connected to new or to the existing 2-wire network because the 24 volts ac present on the network would activate them continuously. Valve Adapter devices (sometimes called decoders) are needed to interface the valves to the 2-wire bus. These adapters contain electronic switches that apply power to the solenoid valves under command from the controller. Nelson by Acclima sensors also contain a single electronic switch so that there is no need to install a valve adapter device when a sensor is installed using existing zone wiring to a single valve.

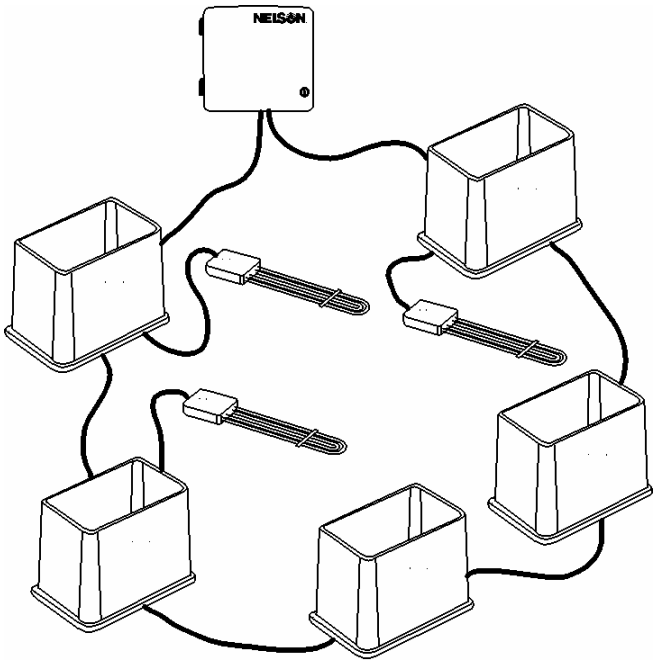
The Nelson by Acclima flow meter interface is also an adapter that interfaces a Data Industrial flow meter to the Nelson by Acclima 2-wire system. The interface module also contains an electronic switch that can be used to control the master valve that is usually installed near the flow meter. It also houses a pressure transducer that is intended to be installed downstream from the flow meter for the purpose of monitoring manifold water pressure.

Layout Patterns

The basic layout patterns for the Nelson by Acclima 2-wire system are: (1) a loop design (2) a star design or (3) a combination loop-star design.

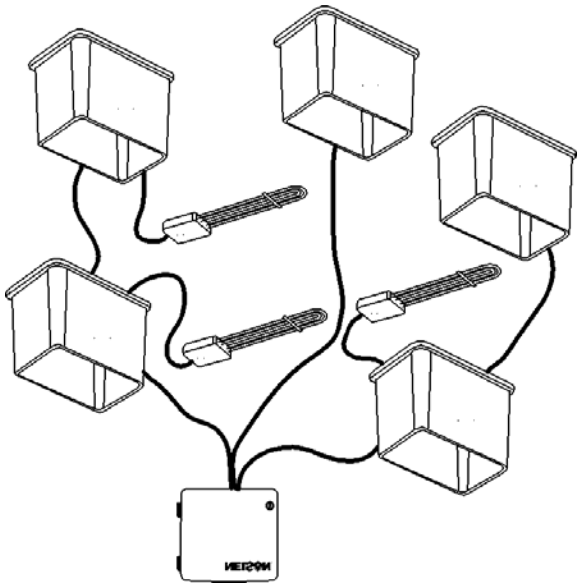
1. Loop Design:

The loop architecture is useful in rectangular properties where the water manifold is installed around the perimeter of the property. The 2-wire bus is laid in the same trench with the water manifold. At each valve box a large service loop is created. The 2-wire bus circles the entire property and returns to the controller where it is terminated at the 2-wire output terminals on the controller. With this arrangement each point on the system has two paths to the controller. If the 2-wire bus gets cut at any single point the system will continue to operate.



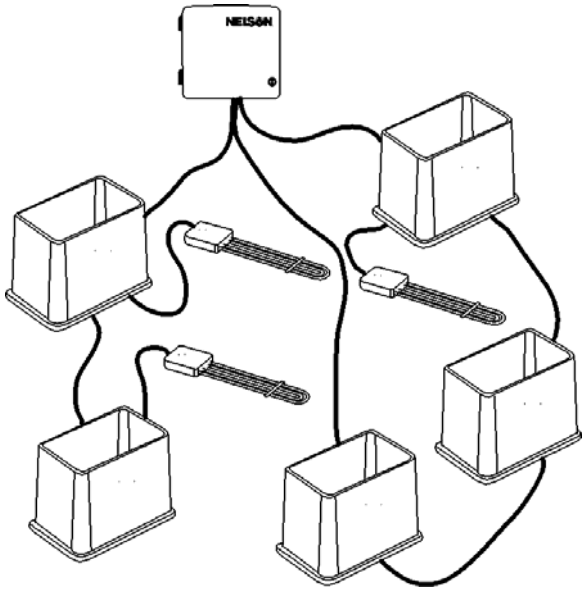
2. Star Design:

The star architecture is useful for complex-shaped properties with narrow peninsular turf plantings and for properties with multiple isolated water sources. A separate branch of the 2-wire network can be installed into each turf segment or water supply area. The star approach does not allow redundancy to the devices on the system as does the loop architecture. If a 2-wire bus conductor gets cut, the downstream devices will fail to operate. The star segments do not need to return to connect at the controller. A branch can be created from an existing leg at any point along that leg. Any number of branches can be installed provided the total paired wire length of the 2-wire bus does not exceed 10,000 feet.



3. Combination Loop-Star Design:

A loop design can be created with stubs protruding from a main loop to pick up peninsular areas or isolated water supply areas.



Maximum Distances & Loading

The maximum distance from the controller to the most remote valve, sensor or flow meter on the network is 4,000 feet. The maximum amount of paired wire that can be installed in the loops and branches on one system is 10,000 feet.

Wire Sizes and Specifications

A 2-wire system must convey the power for all devices attached to the system, and allow them to be activated independent from all others. If multiple valves are to operate simultaneously, the current for all the operating valves must flow through the 2-wire system. The 8710 EZ PRO MAX system supports simultaneous valve operation of four valves plus a master valve or pump relay (or fifth valve). The maximum length for a 2-wire leg is shown in the table below. First select the number of valves that are to operate simultaneously (include the master valve as the fifth valve). Then from the table determine the wire size that is needed for a given distance from the controller. For a loop design, double the distance.

Maximum Distance from Controller in feet:

Wire Size	**1 Valve Activated**	**2 Valves Activated**	**3 Valves Activated**	**4 Valves Activated**	*5 Valves Activated*
14 Ga.	3,300	1,650	1,100	800	650
12 Ga.	4,000	2,600	1,750	1,300	1,050
10 Ga.	4,000	4,000	2,750	2,050	1,650

Absolute Soil Moisture Sensing

Determining the Number of Sensors Needed

Moisture sensors control irrigation by zone. It is therefore important that irrigation zones are designed to provide consistency of the following characteristics:

- Soil Type (sand, loam/silt, clay)
- Microclimate (full shade, partial shade, full sun, full sun with south or west facing hillside, reflection from buildings, wind exposure)
- Sprinkler Precipitation Rate (pop-up sprayers, rotors, impact)
- Plant Type (Fescue, Bermuda, Flowers, Shrubs, Trees)

Design your zones such that the entire zone area is homogeneous with respect to these characteristics. Then group like zones with respect to the above characteristics. Zone groups need not be related geographically.

Assign a sensor to each group. A uniform, flat site with full sun exposure, turf planting only and identical sprinklers will have zones with identical characteristics and will need only one sensor. It is recommended, however, to avoid referencing more than 8 zones to one sensor to assure adequate time to irrigate as needed.

For example, if a single sensor controls 14 zones, when water is demanded all 14 zones should irrigate during the next watering window. There may not be enough time to handle 14 zones in one watering period. At the end of the period, the dry zones will be "stacked" and have to wait until the next watering window. By breaking the group in two, however, only 7 zones will water to complete the cycle demanded by the first sensor. Over a short time period the 7 zones controlled by the second sensor will automatically assimilate to a different daily schedule, thus providing a more uniform daily watering load.

A typical ratio of sensors to zones is 1 sensor for every 4 to 8 zones.

Determining Placement of Sensors

Sensors should be installed in a zone representing the zone group to be controlled by that sensor as follows:

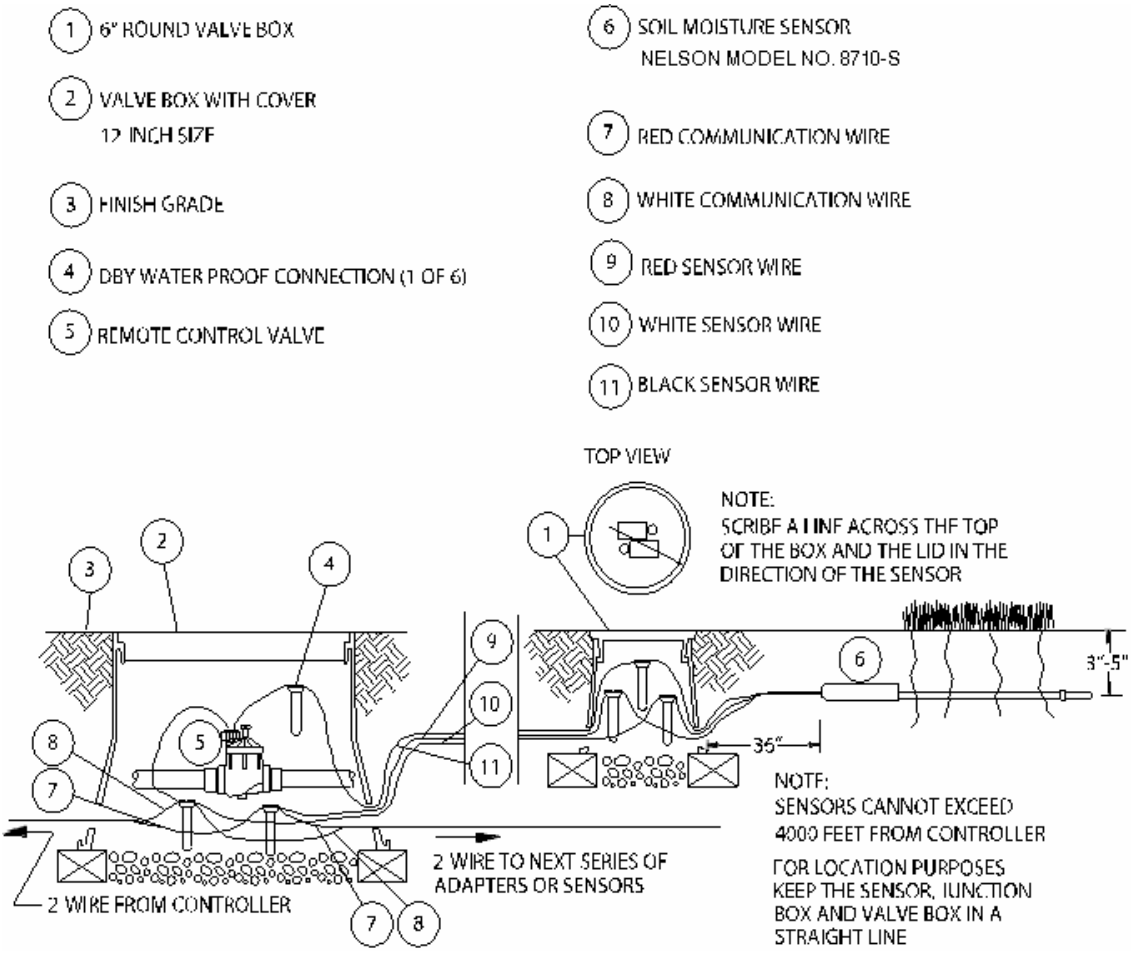
- Avoid low spots and areas where excessive water accumulates such as near sidewalks or at the base of slopes.
- Avoid perimeter locations where sprinkler spray patterns are not representative of the entire zone.
- Avoid shallow soil areas or areas underlain with impermeable subsoil. There must be drainage underneath the sensor.
- Choose an area of healthy turf with deep, well-drained soil.
- If irrigation distribution uniformity problems exist, install the sensor in an area of the zone that receives average or a little less than average distribution for the zone. *Be sure to get around to fixing your distribution problems.*
- If the zone is partially shaded, choose a sunny portion of the zone
- If the zone is on a hillside, install the sensor 1/3 down from the top -- never at the bottom.
- Avoid areas of high foot traffic or poor turf quality. The sensor must measure the transpiration caused by the turf.
- Keep sensors at least 4 feet away from sprinkler heads or other sources of ground flooding.
- Avoid installing sensors where overspray from another zone will affect it, unless strip zones are installed with deliberate, uniform, overlapping water patterns.

Correct Sensor Installation

Before installing sensors in existing turf, thoroughly water the turf. This will make installation much easier, expedite grass recovery and facilitate determination of moisture control thresholds.

Sensors are installed horizontally, within the root mass, which is usually about 4 inches beneath the turf. Cut a U-shaped slit in the sod 2 feet square and 6 inches deep. Roll back the sod toward the uncut side. Smooth out the soil in the bottom of the hole and place the sensor at 4 inches depth. Pack soil around the rods so that the compaction there is similar to the compaction of the undisturbed soil. Also try and keep rocks and grass clippings away from the rods. Replace the sod and tamp it down with the back of your shovel. Seal around the edges with your fists.

The three wires protruding from the end of the installed sensor are likely insufficient to reach the nearest valve box where a connection to the 2-wire system can be made. Three wires of sufficient length to reach the valve box must be spliced to the sensor wires. Use a 6 inch wiring box placed about 12" from the head of the sensor to make the wiring connections. Use DBY connectors inside the box.



At the valve box end of the sensor wires, attach the wires from the sensor to the 2-wire system as shown in drawing 2. The black wire from the sensor can be used to control a solenoid valve if needed. To use it attach it to one of the wires on the solenoid valve. Attach the other solenoid wire to the common (white) wire of the 2-wire bus. If the sensor will not be connected directly to a valve, cap the end of the black wire with a wire nut and DBY connector.

If you are installing an 8710 EZ PRO MAX controller write down the sensor serial number before you cover it. The serial number is the "address" of the sensor that the controller will need to identify and communicate with that sensor. It will be needed to configure the system.

Water Turn-on Threshold

After installation and configuration, the watering threshold must be set for the sensor. The proper setting is 75% of field capacity. That corresponds to a 50% depletion of plant-available water. Field capacity is the amount of water the soil can hold without percolation due to gravity. You should avoid allowing the soil to dry below the 50% depletion limit because the turf will suffer stress below that point. You can easily determine field capacity by flooding the sensor area with 10 gallons of water then waiting for the water to percolate to the subsoil and recording the sensor reading. For sandy soils, that will take only minutes. For loamy/silty soils it may take hours. For clay it will take overnight. If you are in doubt do the flooding in the evening then come back in the morning and take a sensor reading. Early in the morning the soil will be at field capacity. Multiply this number by 0.75 and use that for the water turn-on threshold for the zone.

Controlling the Amount of Water Applied

There are two methods of setting the amount of water to be applied to a sensor-controlled zone. Both of these methods bring the soil moisture content up to field capacity to a depth of 10 inches. The 8710 EZ PRO MAX controller allows the use of either method. You need to know the effective precipitation rate of your sprinklers for each method. Both methods take advantage of a few points of soil hydrology that first needs consideration:

Note that 0.1 inches of water applied to 10 inches depth of soil will increase the average absolute moisture content of the full 10 inch depth by 1%. That fact is independent of soil type. To raise the moisture content of 10 inches of soil by 5% takes 0.5 inches of water.

When soil moisture exceeds field capacity the excess water is pulled down by gravity until it is absorbed down to field capacity by the lower soil layers. Thus a wetting front percolates downward until the wetness of that front and the reservoir above it is dissipated down to field capacity. At that point the downward percolation stops.

Thus, if the soil is at the depletion limit (75% of field capacity) and we wish the top 10 inches to be brought back up to field capacity, then we must apply the difference in percentage points as tenths of inches of water. For example if the field capacity is 28% then the depletion limit is 21% and 0.7 inches of water is needed to bring the top 10 inches from 21% back to 28% moisture content. Assuming the effective precipitation rate for the sprinklers is 1 inch per hour, it would take 42 minutes to apply this amount of water.

1. Sensor Upper Threshold Method:

Set the maximum watering time for the zone to twice the time needed to apply the desired amount of water. This time will not be reached because the sensor will terminate the watering before this 'safety' time is reached. For the example above the maximum watering time would be set to 84 minutes.

Set the turn-off threshold for the sensor to 1.2 times the Field Capacity. In the above example that would be 33.5%. The excess water provides a reservoir that will drive the wetting front well below the sensor. This method is not as accurate as the Watering Time Method in controlling moisture at the deeper soil levels.

2. Watering Time Method:

Set the watering turn-off threshold to 2 times the Field Capacity. This moisture level will not be reached because the watering time will be set to pre-empt it. In the example above the setting would be 56%.

Set the maximum watering time to

$$T = \frac{1.5 * FC}{P}$$

Where T is the watering time in minutes, FC is the Field Capacity expressed in percentage points and P is the effective precipitation rate in inches per hour. In the above example the time would be 42 minutes. Assuming the 4 inch deep sensor reading represents the average moisture content of the 10 inch deep root zone then the entire zone will be brought to field capacity with this amount of water.

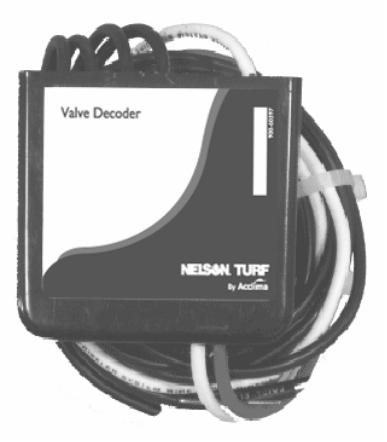
Zone Adapters (Decoders)

Nelson by Acclima Zone Adapters, sometimes called decoders, are transducers designed to receive communications signal input and provide electrical energy output to activate a valve on command. Zone Adapters are only used with the Nelson by Acclima 8710 EZ PRO MAX Central Control System.

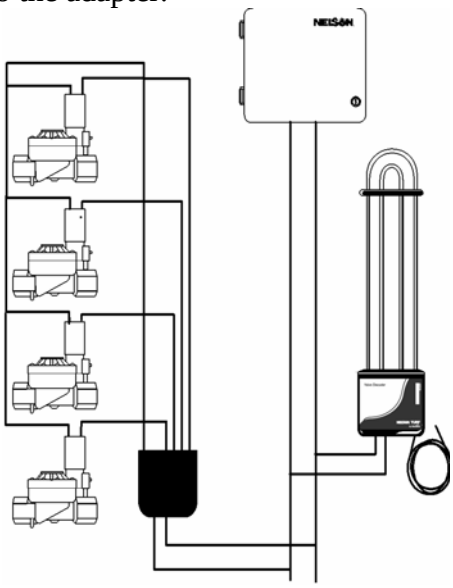
Nelson by Acclima manufactures four different zone adapters. The 2-Zone and 4-Zone Adapters are designed for use in new or existing 2-wire systems. The 16-Zone and 32-Zone Adapters are intended for use in a retrofit upgrade of a traditional end-wire system to avoid installing a new 2-wire communications and control network.

2-Zone and 4-Zone Adapters (New Installations)

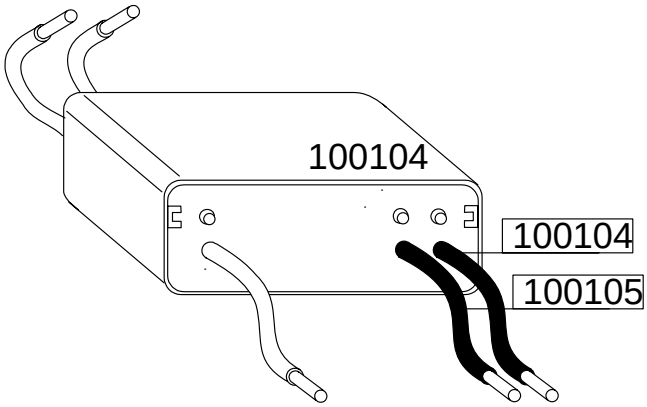
The 2-Zone and 4-Zone Adapters consist of potted electronics suitable ambient exposure in a valve box. On the “input” side of the adapter are one red and one white wire that connect anywhere on the 2-wire bus to their corresponding red and white wires.

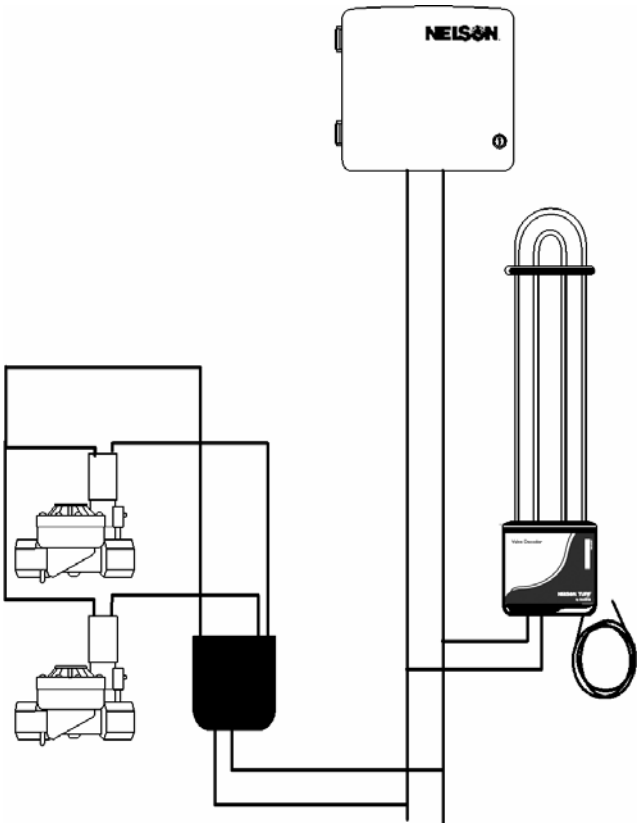


At the “output” side of the 2-Zone Adapter are two black wires and one white wire. The white wire (common) connects to the common conductor on the valves to be controlled by the adapter. The two black wires connect to the “hot” conductor on the valves to be controlled by the adapter. Indicator LED’s are located near each of the output side wires protruding from the adapter. The indicator lamps near the two black wires are energized when current is provided to activate a valve by that wire. The lamp near the white wire is energized whenever there is communication from the controller addressed to the adapter.

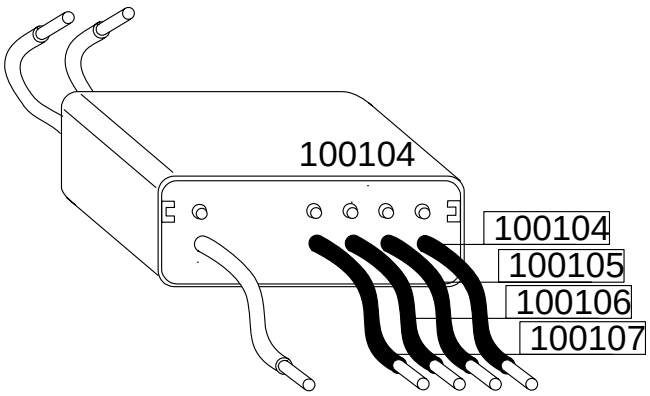


Each adapter has a specific serial number “address” etched on its exterior. The etched serial number is the address of the valve controlled by the black wire most distant from the output white wire on the adapter. The address of the second valve controlled by the adapter is the next successive number. For example, if the adapter serial number is 100104, the address for the valve controlled by the black wire opposite the white wire is 100104. The address for the valve controlled by the black wire next to the white wire is 100105.





At the “output” side of the 4-Zone Adapter are four black wires and one white wire, with corresponding LED’s. The operation of the 4-Zone Adapter is identical to that of the 2-Zone Adapter described above. Continuing the example above, if the 4-Zone Adapter is etched with the serial number 100104, the address for the valve controlled by the black wire most distant from the output white wire is 100104. The address for the valve controlled by the black wire next to the first black wire is 100105. The address for the valve controlled by the next black wire is 100106, and the address for the valve controlled by the black wire nearest the white wire is 100107.



Design Tip
Manifold valves or arrange in adjacent valve boxes in groups of two or four to minimize the expense of zone adapters.

16-Zone and 32-Zone Adapters (Retrofit Installations)

Zone Adapter Specifications:

All Nelson by Acclima zone adapters switch 24 volts ac at up to .75A rms. If the .75A limit is exceeded the adapter switches the power off to the valve and reports a 'shorted valve' condition to the controller. The controller periodically tests the condition and restores service when it notices that the valve has been repaired.

Flow and Pressure Meter

Features

The Nelson by Acclima Flow and Pressure measuring system consists of two modules. One of these is a series 220PV flow transducer manufactured by Data Industrial Corp. These are available in several sizes from 1 inch to 16 inches and beyond. Nelson by Acclima supports units from 1 inch to 16 inches. The second module is manufactured by Nelson by Acclima and is a multi-function device that interfaces to the Nelson by Acclima 2-wire system. It contains a pressure transducer, interface electronics to the flow meter and a valve switch as well as the 2-wire interface electronics.

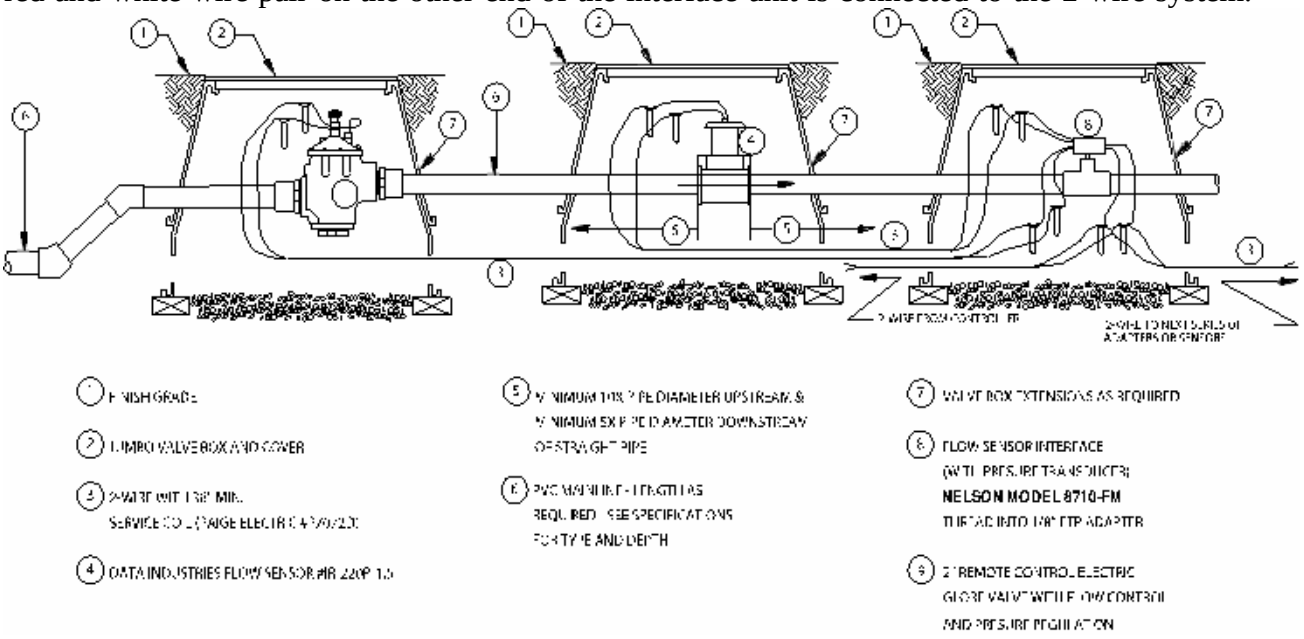
The two modules provide the system with water flow rates, water pressure readings and control over a master valve. The flow readings are used in the controller to:

- Keep track of total water usage
- Detect breaks in the water main. The controller reacts by shutting off the master valve.

- Detect excessive flows (breaks or missing sprinkle heads) in zone plumbing. The controller reacts by shutting off the zone and going on to other zones.
- Detect insufficient pressures for effective spray patterns from sprinkler heads.
- Manage multiple simultaneous zone watering.

Installation

The correct installation of the flow and pressure monitoring system is shown in Drawing 6. The first device upstream is the master valve. The Data Industrial Flow Transducer is mounted in its tee 10 pipe diameters downstream from the master valve. The Interface Unit with the Pressure Transducer is mounted in a tee 5 pipe diameters downstream from the flow transducer. The black wire pair from the interface unit is connected to the master valve. The red and black wire pair from the interface unit is connected to the red and black wires on the Flow Transducer. The red and white wire pair on the other end of the interface unit is connected to the 2-wire system.



There is a serial number on the label of the interface unit that needs to be written down for later configuration into the system. It is the address the controller will use to identify and command the flow pressure and monitoring activities.

Specifications

The flow and pressure system provides flow rate readings and total water consumption readings. These are logged by the 8710 EZ PRO MAX controller with each zone turn-on. It is thus possible to track the amount of water applied to any zone over a given period of time.

The pressure transducer provides pressure readings from 0 to 100 psia with .25 psi resolution.

The zone switch provides 24 volts ac at up to 0.75A rms. Older style master valves drawing excessive currents cannot be operated by the interface unit.

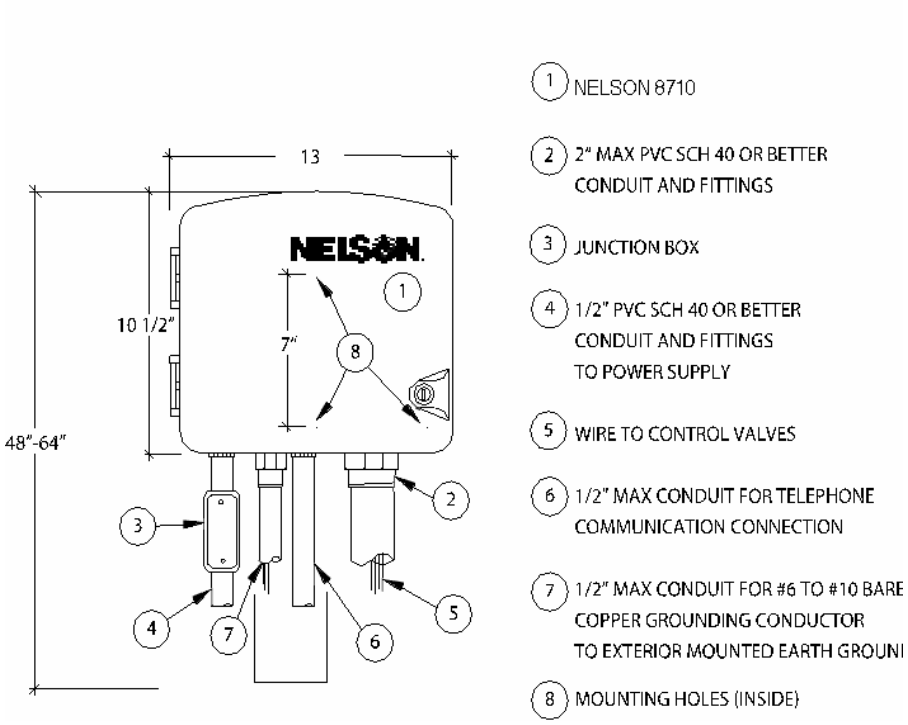
Controller Specifications

Installation Considerations

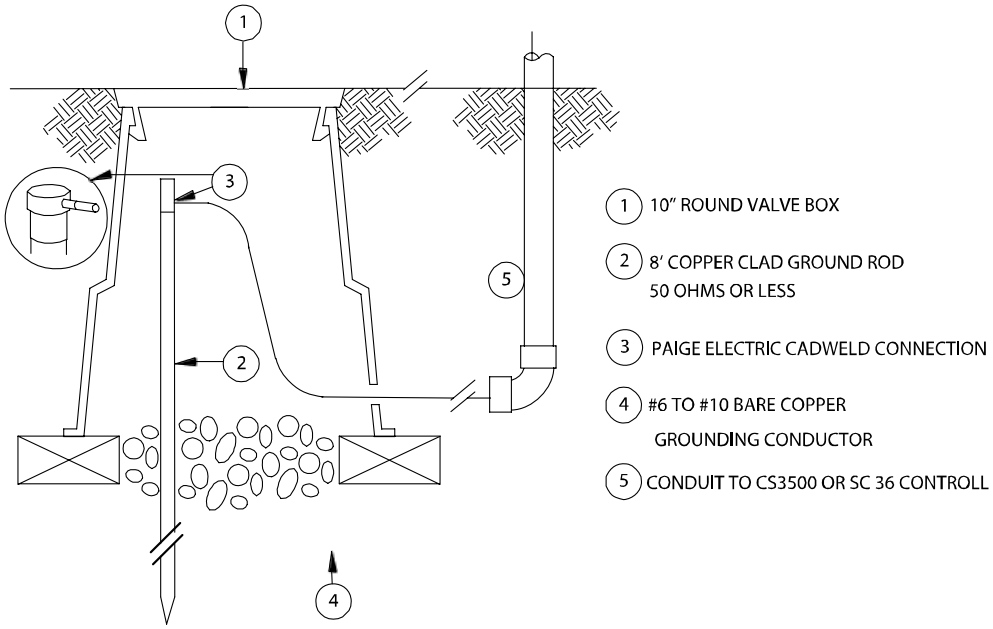
The 8710 EZ PRO MAX controller is designed for indoor or outdoor installation. The enclosure is watertight when the door is closed and UV resistant. The controller should be mounted where there is access to a grounding rod, a phone line (for the 8710 EZ PRO MAX), the valve wiring (or 2-wire network for the 8710 EZ PRO MAX), and 117 volt ac power.

The enclosure must not be exposed to direct afternoon sunlight in excessively hot areas. The maximum internal temperature limit is 70 degrees C (158 F). The heat differential from outside to inside may be as high as 20 degrees C. If the enclosure is to be mounted inside another enclosure in direct sunlight in hot climates, ventilation should be provided to keep the enclosure temperature to 50 degrees C (122 F) or less. Permanent damage to the LCD display can occur if these limits are not observed.

Controller installation should be done in compliance with Drawing 7 or Drawing 8.



DRAWING 7



DRAWING 8

Power Requirements

8710 EZ PRO MAX: 117 volts ac +,- 10% 60 Hz 60 VA Max.
8710 EZ PRO MAXE: 230 volts ac +,- 10% 50 Hz 60 VA Max

Sensor Loading

8710	12 sensors max
8736	36 sensors max
8724	24 sensors max

Valve Loading

8710 64 zones max - up to 4 operating simultaneously plus 1 master valve

Remote Control and Communications

The 8710 EZ PRO MAX has an internal modem for remote communications with a Personal Computer. Software is available for remote control, performance observation and remote maintenance. Wireless remote operation is also supported using an RF or Cellular Modem.

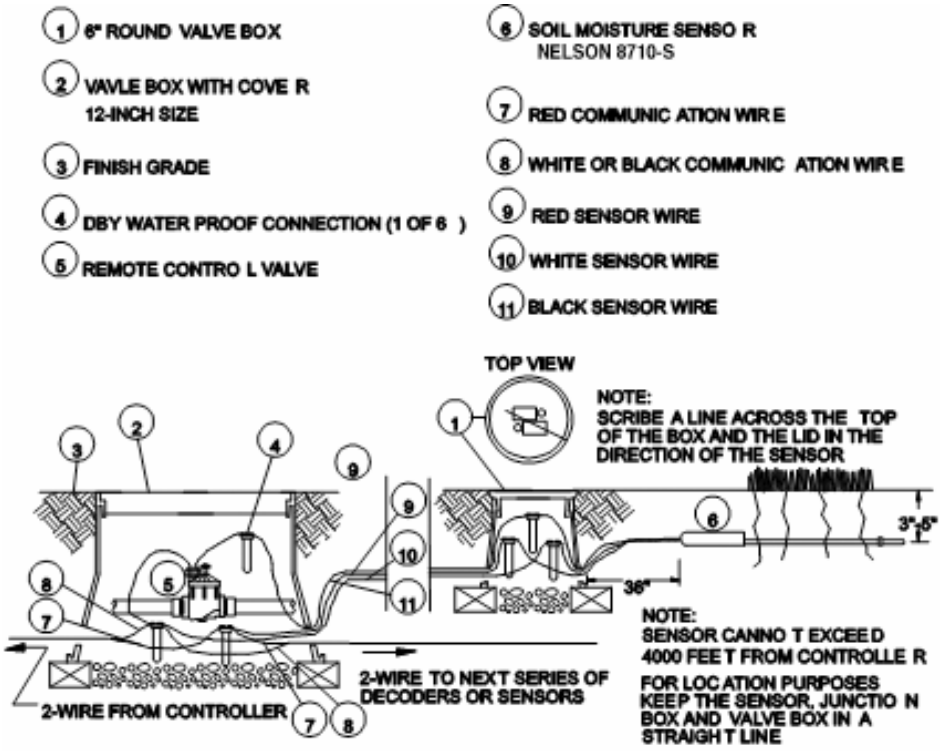
The 8710 EZ PRO MAX supports a Nelson by Acclima Radio Interface Module providing compatibility with DCI-interfaced maintenance radios. The module plugs into the auxiliary port of the controller and mounts to the plastic 'bench' inside the controller wiring compartment. A

DCI connector is brought out through the controller wall so that the radio receiver can be plugged into the controller without opening the door. See Drawing 9 for details on the installation of the Radio Interface Module.

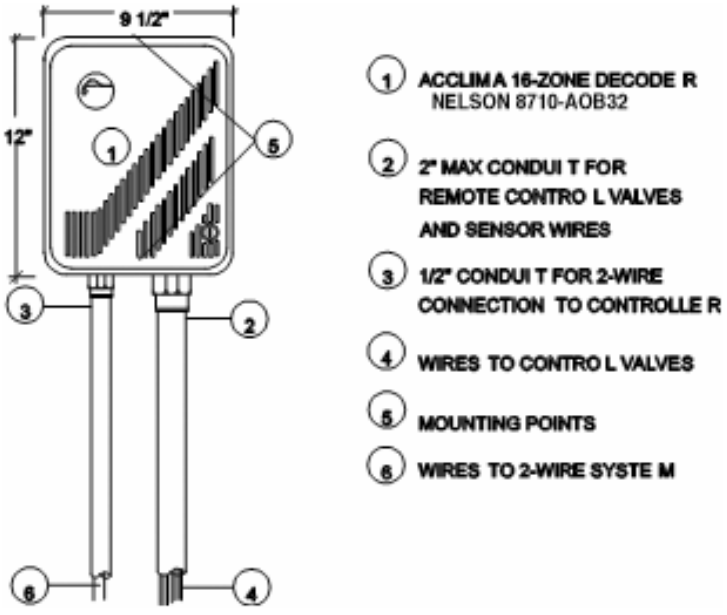
Currently the 'Commander' radio system is supported. Since the DCI connector pin-outs for these radios are different, the type of radio must be specified when ordering the interface.

Downloadable Drawings

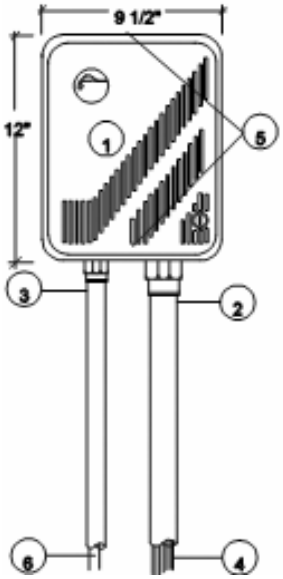
Drawing 1: Sensor Wiring at Valve Box



Drawing 2: 32 Zone Adapter Installation

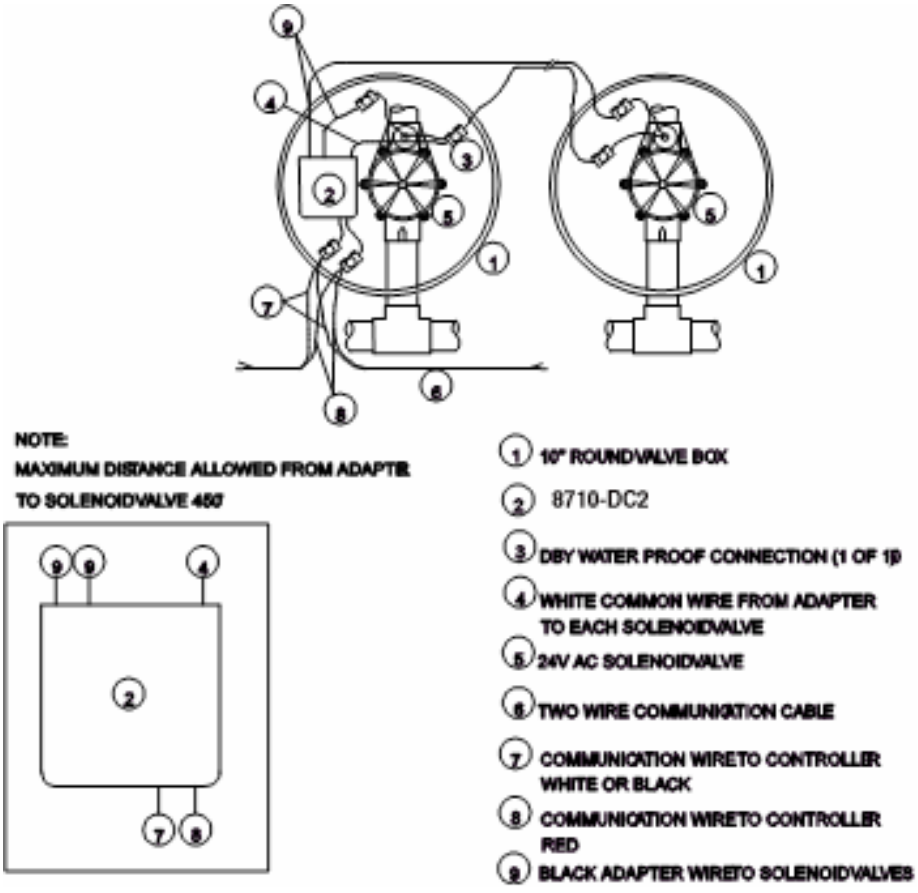


Drawing 3: 16 Zone Adapter Installation



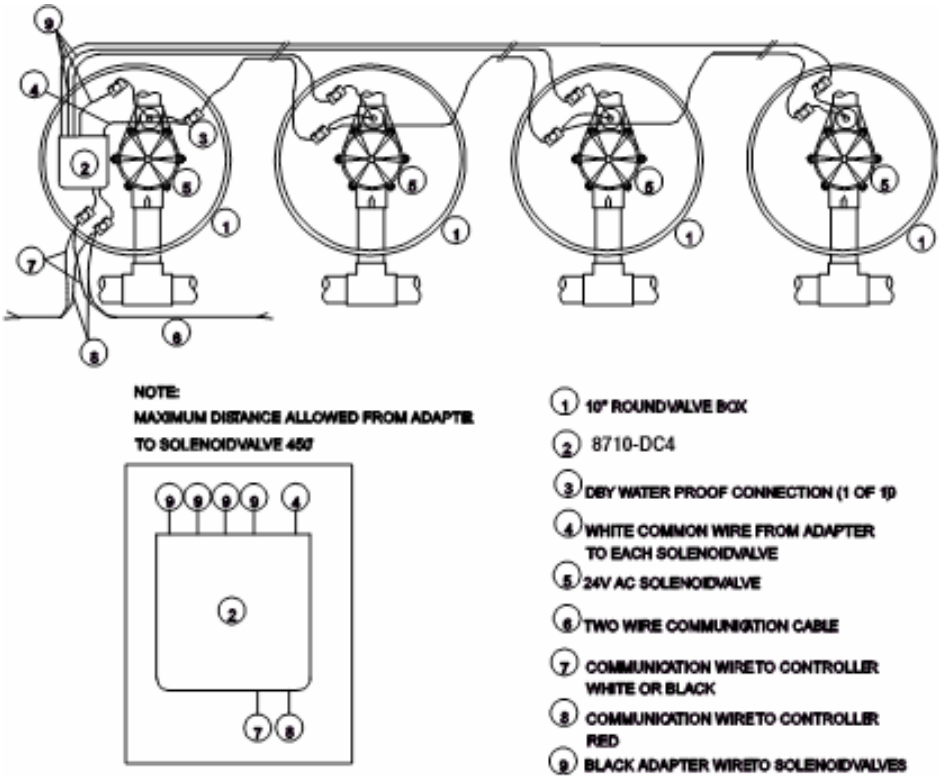
1. ACCLIMA 32-ZONE DECODE R
   NELSON 8710-AOB16
2. 2" MAX CONDUI T FOR
   REMOTE CONTRO L VALVES
   AND SENSOR WIRES
3. 1/2" CONDUI T FOR 2-WIRE
   CONNECTION TO CONTROLLE R
4. WIRES TO CONTRO L VALVES
5. MOUNTING POINTS
6. WIRES TO 2-WIRE SYSTE M

Drawing 4: 2 Zone Adapter Installation

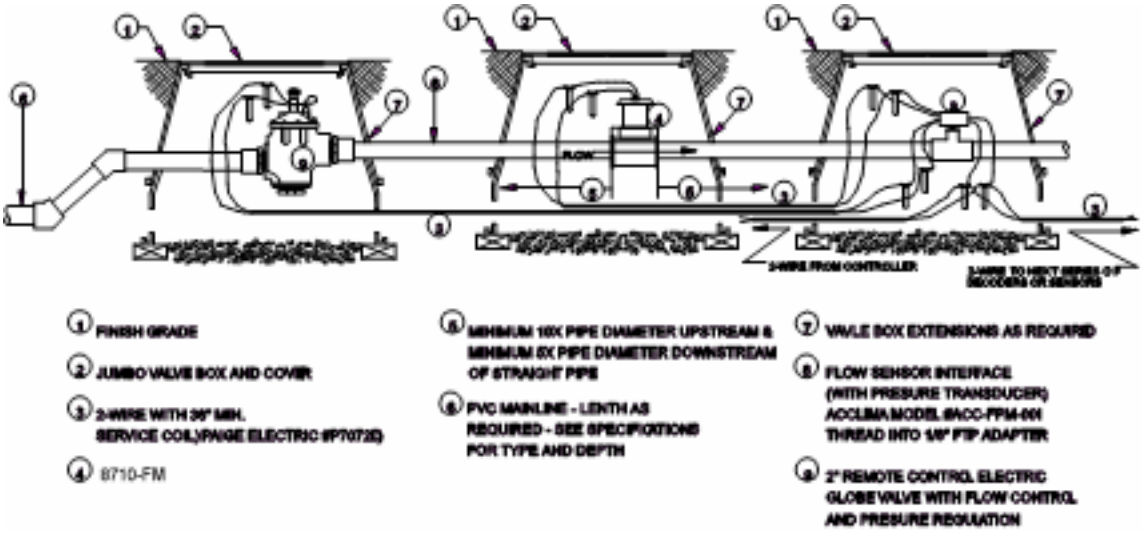


1. 10" ROUNDVALVE BOX
2. 8710-DC2
3. DBY WATER PROOF CONNECTION (1 OF 1)
4. WHITE COMMON WIRE FROM ADAPTER
   TO EACH SOLENOIDVALVE
5. 24V AC SOLENOIDVALVE
6. TWO WIRE COMMUNIGITION CABLE
7. COMMUNICATION WIRETO CONTROLLER
   WHITE OR BLACK
8. COMMUNICATION WIRETO CONTROLLER
   RED
9. BLACK ADAPTER WIRETO SOLENOIDVALVES

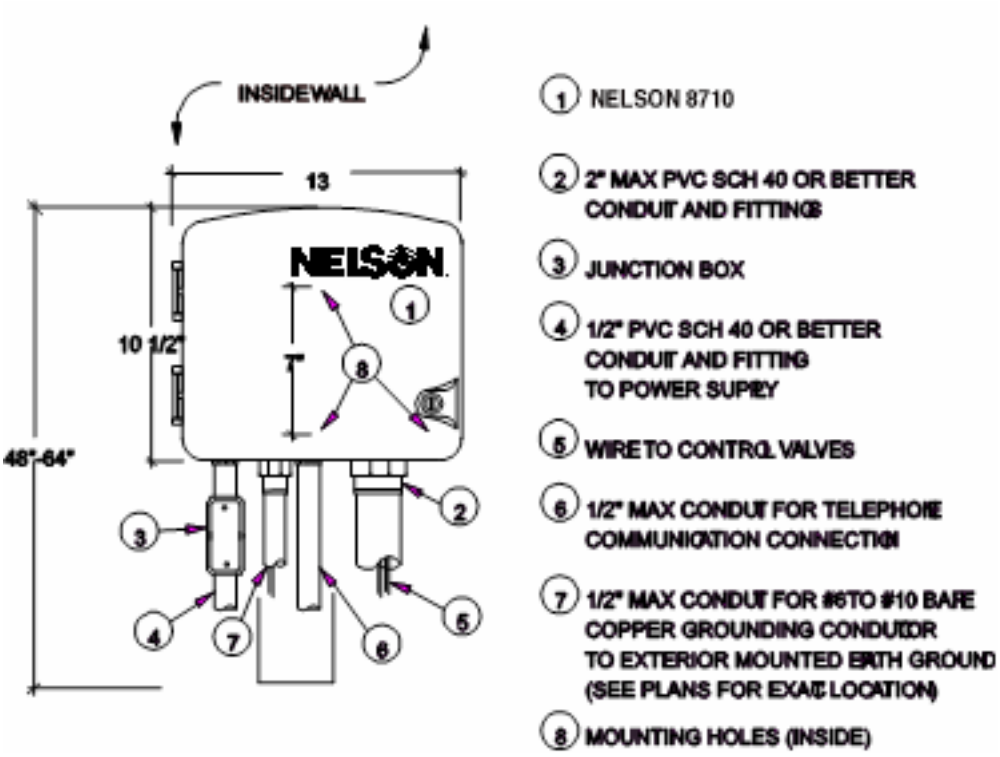
Drawing 5: 2 and 4 Zone Adapter Installation



Drawing 6: Flow and Pressure Meter Installation



Drawing 7: 8710 EZ PRO MAX Controller Installation



Drawing 10: Controller Grounding Installation