FEATURE ARTICLE I

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Decoder Systems Discussed

Changes in technology have occurred at a rapid pace in the irrigation business. Here in the Chicago region we see irrigation systems that run the gamut from manual systems that utilize spigots to control the flow of water to top-of-the-line computer- controlled modern systems that can be accessed and controlled via the internet and hand-held radio. In the beginning, irrigation consisted of some type of valve near an area that required water such as a green. Pressure was supplied by elevating the water into a storage device such as a water tower. You could attach a hose to the valve, but even then, some sort of distribution device was still required.

In 1933, a patent was awarded for the initial design of what we now know as the impact sprinkler. Some 20 years later, the idea that thermoplastics could be used to manufacture sprinklers was born. Pumping stations became a viable option for golf courses as well. This eventually led to the development of plastic valves, valve in head sprinklers, and hydraulic and electric controllers. The majority of the development for the components that we now use in modern irrigation has occurred in the last 50 years.

Golf irrigation system components can be loosely grouped into one of three categories: application, distribution, and control. This article will deal primarily with control elements. Satellite control systems are now, and have been, the industry standard in the United States for some time. Satellites are basically locations that house the switches for a number of sprinklers in one spot. The first satellite systems were electromechanical in nature, gear driven "clocks" that kept time and started irrigation by tripping a switch. There are still a number of these electromechanical systems in use in our area today.

Soon thereafter the solid-state electronic controller was introduced. Although water and electricity don't often mix well, it has become commonplace to see these boxes full of expensive electronic equipment stationed out on the golf course where rain, irrigation, lightning, vandalism, and sometimes floodwaters can occur. There is a new option, however, that is becoming more accepted for control of golf course irrigation systems—the decoder system.

Decoder systems have been available from golf irrigation manufacturers for some time, but recent improvements have made them a viable option for reliable irrigation control here in the United States. Decoder systems place the switching device either at the sprinkler or in close proximity to it. The objective of this article is to explore the structure of a decoder system and discuss some of the pros and cons associated with these systems.

Although decoder systems are only now gaining some acceptance here in the United States, the decoder system is really not a new idea. The thought that control could reside at each sprinkler instead of a localized control box (satellite) has been around for a long time. In the United States, in the early '70s, Johns Manville purchased the binar system from Robert Trent Jones. It became one of the first decoder systems made commercially available in the United States. John's Manville sold this system for some time, but had trouble with it, and eventually they stopped selling the product. Since then a number of manufacturers have introduced decoder systems with limited success.

In Europe the decoder system is the standard for irrigation system control. For example, nearly all golf irrigation control systems installed in the British Isles are decoder systems. Even taking into account a difference in the standard of maintenance between the United States and Europe, this is remarkable. These systems seem to function with a degree of success in Europe, but recently we have heard much more about decoder systems here in the United States. Why are decoder systems being brought to the forefront today? In one word the answer is wire, or more to the point, the cost of copper.

STRUCTURE

So what is a decoder system composed of? The following are the primary elements of any decoder system:

- A central computer connected to wire paths via gateway
- One or more wire paths connecting each decoder to the central computer (these wire paths provide communication AND power)
- Decoders that take a signal and respond based upon that signal
- Solenoids that operate the sprinklers
- Grounding points that protect wire paths from surge

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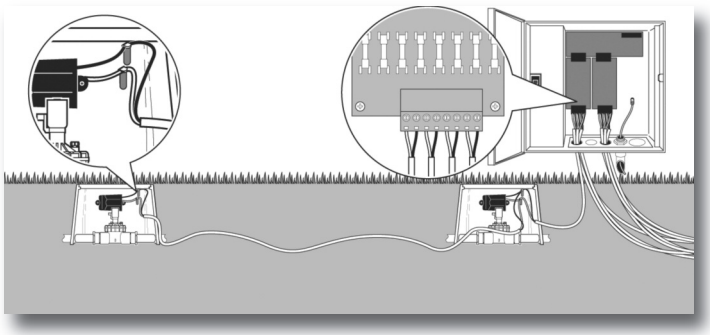
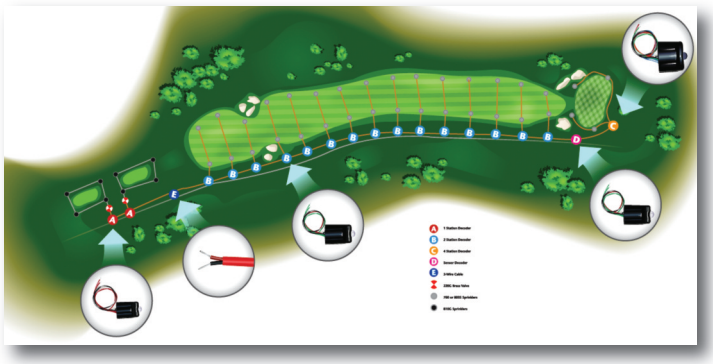


Shown is an example of a typical wire path, and connections to sprinklers, and a block valve



Possible hole design for a decoder system including block valves, single and multi station decoders, and communication/power line

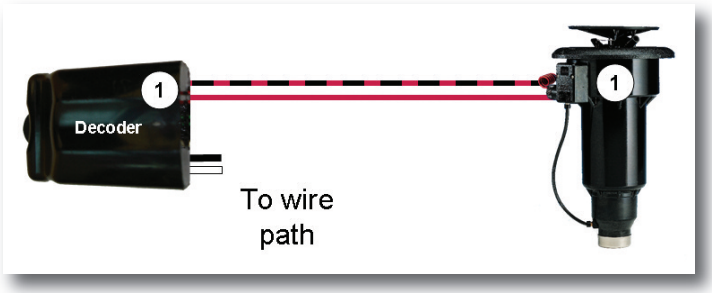


Illustration of a single station decoder

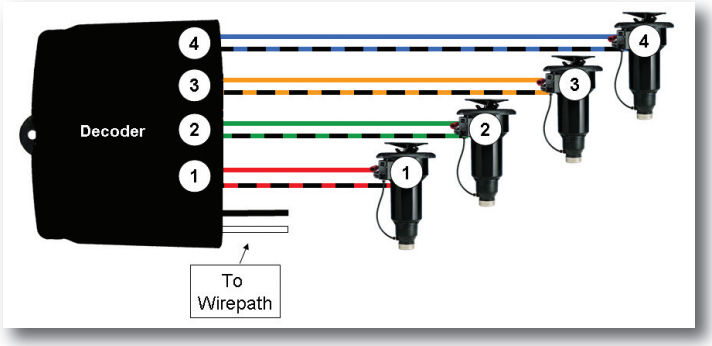


Illustration of a typical multi (four) station decoder

The structure of a decoder system can be visualized as a two-lane country road leading off into the hills—this is the wire path—two parallel wires. On one end of the road is the central control system, a computer that is attached to a gateway which creates an interface between the operator and the irrigation system. At regular intervals this control system sends pulses of electricity (you can visualize these as cars) down the wire path in search of a given address. At any point on this wire path you can place a unique address (a decoder). When one of the cars finds the proper decoder it can then relay the message sent by the central computer. The wire path has complete freedom to branch or go in any direction provided it does not exceed a given distance from the central computer, and that a given path doesn't exceed a maximum number of decoders. For instance, if the maximum distance any decoder can be from the central computer is three miles, and the maximum number of decoders on that wire path is 50, then you have the option of having one three-mile-long wire path with 50 decoders all located at the end, or 50 three-mile-long wire paths each with one decoder leading off in every direction, or any other configuration that falls within the confines stated. This gives complete freedom to add decoders anywhere along the line. What this creates is tremendous flexibility in terms of addition of decoders.

Multiple station decoders are also available. Multiple station decoders give you the option of operating a number of stations from a single decoder—each station with its own address. Decoders are often located underground either next to, or attached to, an irrigation head and many are direct buried as well. Of course the challenge in burying decoders is remembering where they are located and diagnosing problems should they occur.

There are two types of decoder systems in the golf irrigation market—those that operate completely on AC power, and those that operate utilizing some combination of AC and DC power. An AC system operates much the same as what we are all used to with satellite systems. The central computer sends a signal to a given decoder, which in turn applies a charge to the solenoid in order to turn it on. In order to remain on, an AC decoder requires constant electrical input. This necessarily limits the number of solenoids each wire path can operate while utilizing a given wire size. The number of solenoids that can be operated at once can be increased by increasing wire size.

AC/DC systems are the same as AC systems until you reach the decoder. At that point the voltage is changed into direct current and applied to the solenoid in a short burst—a special type of solenoid called a DC latching solenoid is used. Each solenoid has a magnet that holds the plunger open once the current has been applied. At this point, there is no longer any need for current to be applied to the solenoid. Since no constant electrical input is required, it is possible to turn on an almost limitless number of solenoids at once, effectively removing the electrical limitation on the number of stations that can be operated at one time. This also makes it possible to run a large number of stations without changing the size of the wire for the wire path. Especially in the case of systems with large numbers of stations this can be important.

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ADVANTAGES OF DECODER SYSTEMS

Flooding

There are a number of situations for which decoder systems are especially well suited. Golf courses that have flooding on a frequent basis are an excellent place for decoder systems. If all the wire splices within a decoder system are properly protected with waterproof wire splices, a decoder system can be impervious to water. Almost everything in a decoder system can be submerged completely without losing function. As more and more golf courses are built on less than ideal sites, this feature of decoder systems may become more important.

Vandalism

Since decoders are located beneath the surface of the turf, they are also an ideal solution in areas that experience a lot of vandalism. Golf courses that struggle with vandalism often devote a significant portion of their irrigation budgets to repair and replacement of satellites. The vast majority of expenditures due to vandalism can be avoided with the installation of a decoder system. Decoders can also provide an aesthetic and playability benefit, as most decoder systems have no above ground structures—nothing to see, nothing to play around, run over, etc.

Piecemeal Installation

Decoders can also be an excellent application for systems that need to be installed in stages. Since decoders can be added at any time and at any point along the wire path, a decoder system can be installed in pieces, provided it is possible to start from the central controller and work out from there. This offers tremendous flexibility in adding pieces to the system as you go. For grow-in situations this can be the ideal solution to hole-by-hole construction of the irrigation system.

Cost Savings

Perhaps the primary advantage of a decoder system is the cost savings that can be realized. A decoder system can require as little as a third of the wire that is needed for a typical satellite system. As wire prices continue to increase, this can be a significant factor when considering a new irrigation system. There are a number of factors that influence the savings that can be realized by installing a decoder system: the number of sprinklers that the system requires, the type of system you are using (AC or AC/DC), whether or not a bonding wire is used, and the number and design of the wire paths. At present, this savings can be $50,000 or more, creating a significant monetary incentive to choose a decoder system.

One factor that can significantly affect the price of a decoder system is the presence or absence of a bonding wire. Some irrigation consultants, designers, and others advocate the use of a bonding wire; others do not.

A bonding wire is a 6-gauge bare wire that is installed six inches underground over the wire path. This wire is tied to the grounding points of the wire path and creates a net of protection above the wire path that is meant to intercept lightning surge and carry it to ground before it reaches the wire path. A bonding wire can add a great deal to the cost of the system and significantly reduce the difference in price between decoder systems and satellite systems.

CONS

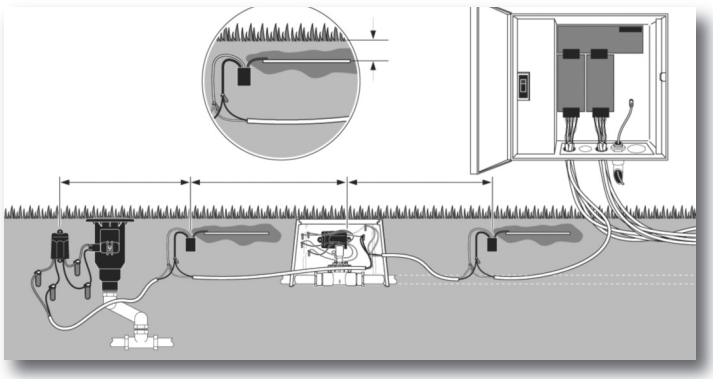
Location

Just like all irrigation systems there are some negatives associated with decoder systems. Many of the issues associated with decoders systems stem from their location underground. From upgrading, to diagnosing problems, to checking wire splices, the work on a decoder system often begins with digging, or at the very least, with opening a valve box. Decoders can be difficult to change, locate, and repair—all because of their location.

Lightning

Perhaps the biggest issue with decoder systems is lightning. Long continuous wire paths associated with a decoder system are often susceptible to lightning. In the case of satellite systems—replaceable surge protection units and grounding are the primary weapons against lighting. Satellites provide an excellent "stopping point" for surge in a typical system. If a lightning strike occurs between a sprinkler and a satellite, then surge is arrested at the satellite. If a strike occurs on the power or communication lines between satellites, this is also arrested at the satellite by replaceable surge units.

Typical decoder systems use other weapons to combat surge and in slightly different ways. At regular intervals along the wire path, grounding sites are placed. These sites consist of a ground plate or rod installed in the soil. Between the wire path and the grounding site, a surge unit is installed. This unit allows normal communication activity to occur on a daily basis, but when a large surge is applied to the wire path, the unit sends that surge to ground. Grounding points are installed at frequent intervals to assure that any surge that enters the system is close to a grounding point so that the rest of the system is protected. Decoders are being produced with internal surge protection as well, to help protect decoders from lightning. Decoder systems are becoming more effective at arresting surge on the communication line but can still be prone to damage.



Decoder installation illustrating gateway and surge installation

When lightning damage does occur, decoder systems can be difficult to diagnose. Manufacturers of decoder systems have built diagnostic capabilities into the central computer software, and these tools can be useful for initial diagnosis. These tools differ according to manufacturer, but can allow users to check communication with an individual decoder and determine operability of solenoids. This works quite well if a given decoder is completely dead. Problems arise when decoders are not working properly and create "noise" on the communication line.

Anyone who has a satellite system is familiar with modem failure and how this can compromise communication to other satellites that are not impacted. When this occurs in a decoder system, no other communication can take place on that wire path. This means that none of the sprinklers on that wire path can communicate with the central and none of them will operate. In this case, it can be very difficult to determine which of the decoders is causing the problem.

One weapon often used to deal with this problem is switches. Switches are installed at opportune points that allow the user to isolate certain parts of the wire path. This at least gives a service technician the ability to turn off certain parts of the path so you can determine which portion(s) of the path has the decoder that is causing the problem. Obviously this can be a time consuming and frustrating process in the heat of summer. There are some other tools that can be used to diagnose problems with decoder systems, but in any case, it can be a difficult and time consuming process.

Decoders are often installed right at the sprinkler head—one decoder per sprinkler head. This type of arrangement is an excellent way to decrease the impact of lightning on decoders by eliminating the impact of surge from the output side of the decoder. When multiple station decoders are used, stations must be located at some distance from the decoder. This arrangement can be slightly more cost effective because you can operate several sprinklers with a single decoder; however, the decoders are then more vulnerable to lightning as they are exposed to lightning from both the input and output sides of the decoder. Some manufacturers are starting to provide internal lightning protection within their decoders to deal with these surge issues; however, many designers still insist upon a single decoder per sprinkler to head off problems before they begin.

Redundancy

Another issue that may cause some concern with decoder systems is the lack of redundancy. Many modern satellite systems rely on communication wire to operate the satellites. The wire degrades over time, especially at splice points. Decoder systems have greater reliance on the communication/power cable than any other system because there is no redundancy. Consider that it is often difficult to maintain communication with 20 modems in a typical satellite system. With a decoder system you must maintain communication with hundreds of individual decoders.

In most decoder systems when the central computer is down the only way to operate sprinklers is manually at the sprinkler head. Some systems do offer "access points" that allow the user to tap into a com line and operate heads using handheld units hard wired to the communication line, but this only works if power is still being provided to the sprinklers by the communication line, and the line is free for communication.

Other manufacturers offer decoder satellites as well, but this removes some of the aesthetic benefits of having a decoder system, and it still won't work if the communication/power line has been compromised. In other words, a decoder system is either working completely or it is not; there is very little middle ground.

In some satellite systems, programs are stored in the satellite's memory so that they can be run with or without the central computer. Many of these same systems have stand alone modes and can be programmed in the field. If all else fails, you can still operate most satellites utilizing the internal switches—none of these options are available with decoder systems. Just as in decoder systems, satellite systems still must have power, but satellite systems give you a number of options beyond manual activation of sprinkler heads.

Wire Splices

The large number of wire splices present in any decoder system can also be a problem. Each sprinkler that is installed has, at the very least, four wire splices; two on the communication line and two on the solenoid. When you add in grounding points and switches, the number of wire splices is extensive. Multiple station decoders have even more splices. As wire splices have become more durable and reliable this issue has become less important, but it will always be one of the drawbacks of decoder systems as splices tend to degrade over time.

Upgradability

Once installed decoders are inherently difficult to replace. In a satellite system, once the equipment has been installed, it is relatively easy to replace a satellite. This becomes necessary when technology has advanced to the point where added features are desired or if the satellite has been destroyed. Some manufacturers even have satellites with upgradable firmware to allow almost instant upgrades. Upgrading decoders means replacing each unit, a lengthy and time consuming process because of their underground location.

One other interesting side note on decoders is that many operate on more than 30 volts of AC power. This brings decoder cables into another category under the national electric code. At this level these cables require 24 inches of cover at a minimum. Cables carrying less than 24 volts, like those in a typical satellite system require only 6 inches of cover. In addition, the compound in 3M DBYs and DBRs is not rated for 30 volts, so 3M's DBY6 and DBR6 are required. This increases the cost of installation and maintenance as well.

At present, decoder systems still constitute a very small percentage of the total number of irrigation systems in the United States. As technology improves and decoders gain acceptance, this percentage will undoubtedly change. Decoders are an excellent solution in certain circumstances. For more information please visit the web site of Paige Electric Company (www.paigewire.com) or contact your local irrigation distributor. **-OC**