

# The Paige Irrigation Wiring Guide for Decoder Systems

## Background:

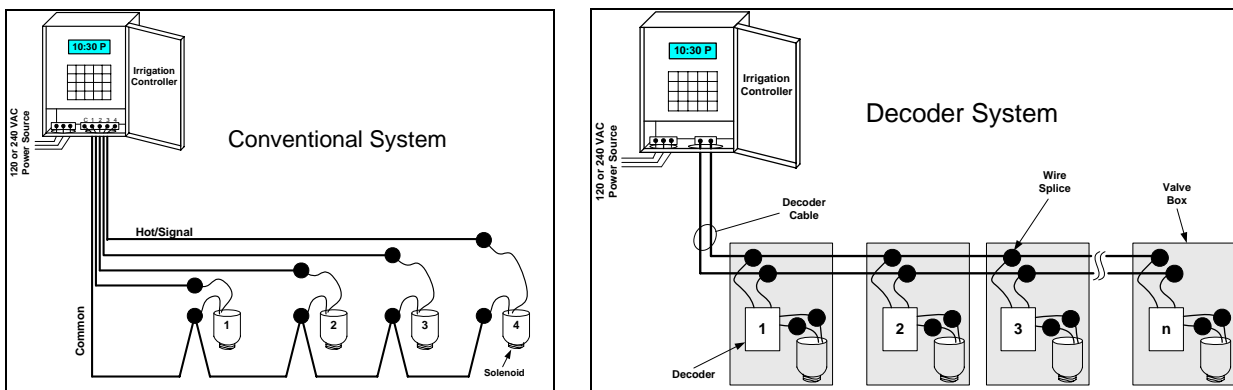
The decoder system was first introduced to the irrigation industry in the late 1960s. It was invented by the world renowned golf course architect, the late Robert Trent Jones, Sr. The first system was installed in Mr. Jones' personal golf course, Coral Ridge Country Club, in Ft. Lauderdale, Florida. The product was commercialized by John's Manville Irrigation as the Binar<sup>®</sup> System in the early 1970s. Rain Bird introduced their version of the decoder system, Multipath<sup>®</sup>, in the mid 1970s.

These products proved to be unreliable for many reasons:

- Off-the-shelf wires and cables were used and they were not robust enough. The Binar<sup>®</sup> Cable was developed by Paige Electric to solve this problem. This became Rain Bird's "Maxi<sup>®</sup> Cable" for central control system communication circuits. Today, Maxi Cable is also used in Rain Bird's decoder system. Reliable cables are now available from Paige Electric for all manufacturers' decoder systems, as discussed below.
- Connectors were not so good. The 3M Company has since developed and provided the DBY-6 and DBR-6 connectors to solve this problem.
- Electronic components were not nearly as reliable as they are today.
- Massive failures were caused by lightning and power surges. This problem still exists today with modern systems and earth grounding and lightning protection must be done properly to ensure reliability.

## Decoder versus Conventional Systems:

Here are the wiring diagrams for conventional and decoder systems:



## Pros and Cons of Decoder Systems:

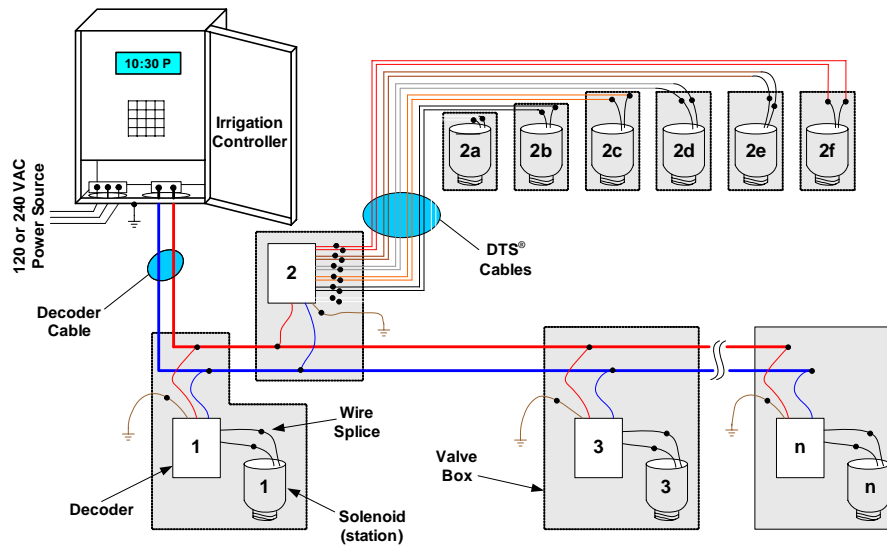
There are significant tradeoffs between the reduction of wire and the addition of many other components. Here is a summary of these tradeoffs:

Issue	Comments
Amount of wire	Wire quantity is reduced in decoder systems and replaced with decoders. Decoders contain electronic components which are susceptible to lightning damage. This tradeoff can have significant consequences on the overall reliability and maintenance of the system.
Easier to expand decoder systems	Wires for additional valves are run from the nearest decoder or cable, not from the controller.
Less damage from vandalism	True, unless the decoders and wires inside a valve box are vandalized.
Manufacturers recommend grounding grids for decoders every 300' to 1000'	In theory, all decoders should be grounded. The electronic components of decoders are just as susceptible to lightning damage as controller components. All decoders should be connected to a ground grid a few feet away, just like a controller. Unfortunately, compromises are often made to fit budgets. Generally speaking, when lightning strikes, grounded decoders have a higher probability of survival than those that are not. Some manufactures recommend that none of the decoders be grounded.
Supplemental watering during inspection of grounds	Golf course superintendents and property managers usually walk the grounds to inspect the condition of the turf and the landscape. In systems with multiple controllers, the individual can easily make program adjustments and supplemental watering at each controller. This is much more difficult to do with decoder systems since everything is hidden. Even if the manager has a system that uses radio communication, it is tough to do these tasks because it is difficult to remember the identity of every valve.
Wire burial depth	The National Electrical Code® requires that wires carrying more than 30 volts have a minimum of 24" of cover while wires having 30 volts or less require a minimum of 6" of cover. Conventional irrigation systems operate at 24 volts and can be buried at a depth of 6". Most decoder systems usually operate at voltages between 30 and 40 volts and must be installed at a minimum depth of 24".
Wire splices and connectors	There is more than twice the number of splices in a decoder system than in a conventional system.
Troubleshooting	Troubleshooting of decoder systems is not as easy as it may seem. The average landscape maintenance contractor is not familiar with these systems and troubleshooting is usually done by trained professionals at expensive labor rates. Cables are cut in several places during the troubleshooting process, which is usually done by trial-and-error. Re-splicing of these cables is usually rushed and seldom done correctly. It is easier to replace components in a controller than to replace decoders below ground.
"Simple wiring"	The installation of decoder system is not as simple as it sounds, because more than double the number of splices is required. For example, a decoder that controls 6 solenoids requires 27 splices and several more valve boxes (see decoder #2 in the wiring diagram below.) And the wire splice is the weak link of any electrical circuit.

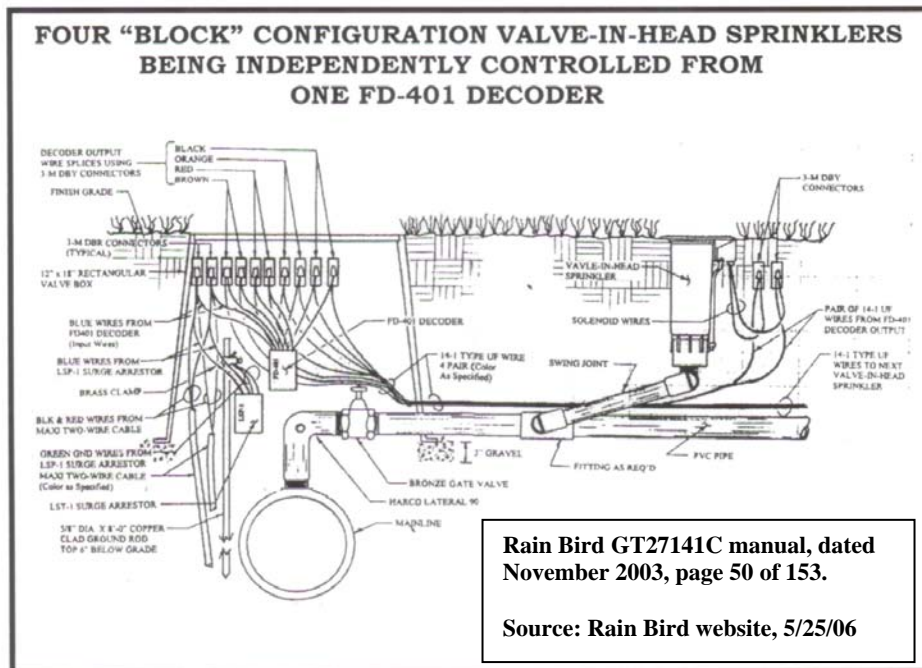
## Decoder System Wiring Diagrams:

The following is a typical wiring diagram showing the various connections. Note that a decoder that controls a single solenoid valve uses five wire splices (or four if not grounded) compared to a conventional system that requires only 2 at the solenoid. And since the splice is the weak link of the electrical circuit, special attention must be paid to it.

Note that decoder #2, which controls six solenoid valves, requires 27 splices, 15 of which are inside a single valve box.



The following wiring diagram from a leading manufacturer of decoder systems shows the complexity of the wiring inside a valve box of a decoder installation. The average landscape maintenance contractor is not qualified to troubleshoot these kinds of systems.

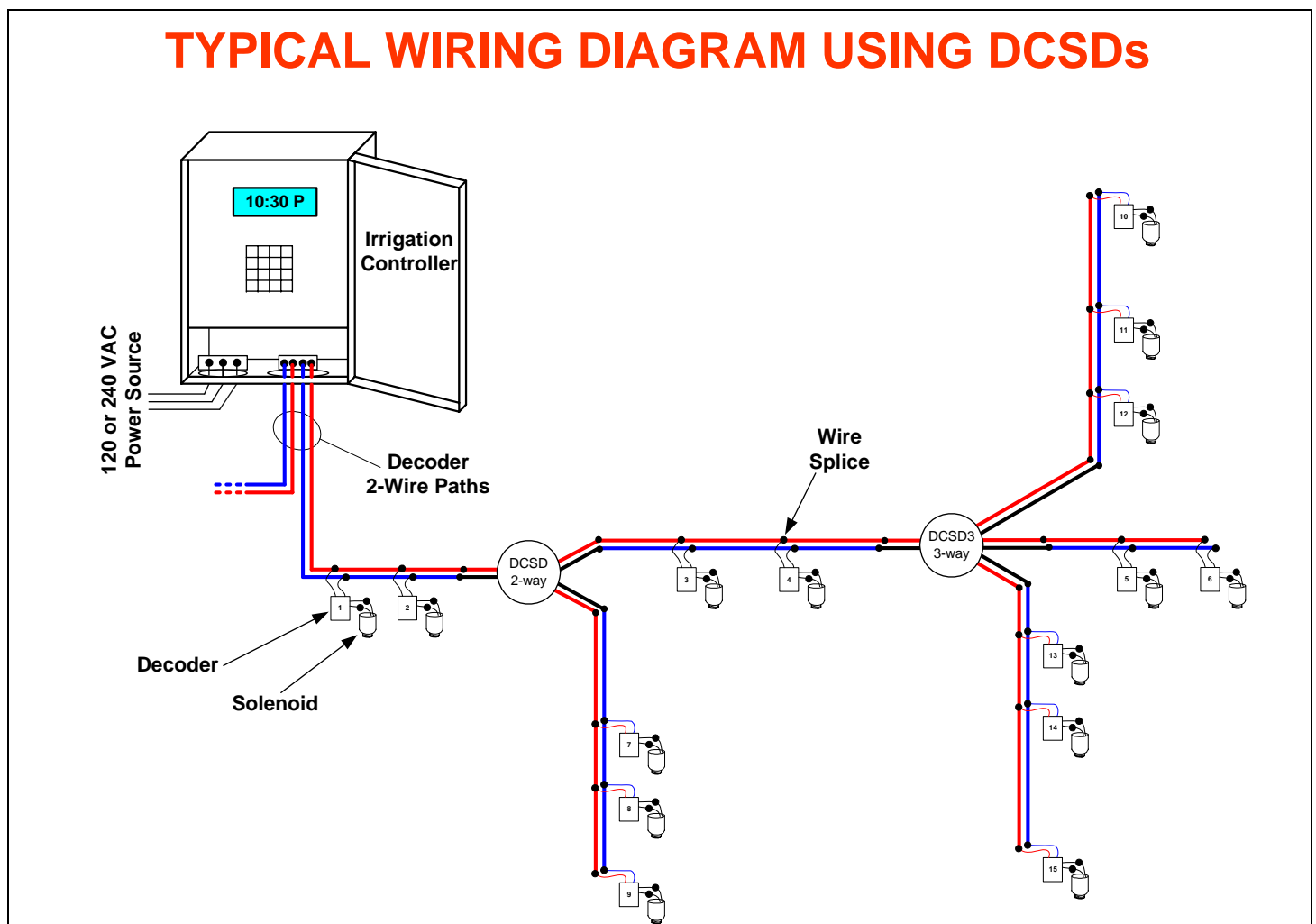


## Decoder Cable Switching Devices (DCSD):

Although today's controllers are able to perform diagnostic routines to help troubleshoot faults in the wiring circuits, sometimes the problem is just too complicated. When this happens, the maintenance person resorts to trial-and-error methods in an effort to isolate the problem. Trial-and-error methods usually cause cables to be cut and splices to be undone. By the time the fault is isolated, the cable is cut-up in many locations.

To reduce the number of cable cuts, it is advisable to install DCSD's in strategic locations where the 2-Wire paths split. It also helps to install them half way along very long cable paths. By so doing, cable sections can be connected and disconnected with a flip of a switch.




The wiring diagram below shows a typical installation:



### Paige Electric Cables for 2-Wire Paths:

There are many types of decoder cables, as required by the manufacturers of “2-Wire” decoder systems. The following is a summary of these, by major manufacturer:

**Table 1 - Decoder Cables (2-Wire Paths)  
Selection Guide**

Mfr.	Image	Paige Electric		AWG & No. of Conductors	Colors	
		Part No.	Spec No.		Conductors	Outer Jacket
Hunter		170116RB	P7313	14/2c	Red & Blue	None
		170109B		12/2c		Blue
		170801BU	P7354D	14/2c		Gray
		170801GY				Orange
		170801OG				Purple
		170801PR				Tan
		170801TN				Yellow
		170801YL				Blue
		170802BU		12/2c		Gray
		170802GY				Orange
		170802OG				Purple
		170802PR				Tan
		170802TN				Yellow
		170802YL				Blue
		170802BU				Gray
Rain Bird		180115	P7072D	14/2c	Red	
		180126			White	
		180127			Black	
		180114			Orange	
		180116			Blue	
		180118			Yellow	
		1801181		Purple		
		1801182		Brown		
		1801151		Pink		
		1801183		Gray		
		180117		Green		
		180161		Red		
		180160		Black		
		180165	Orange			
		180162	Blue			
		180163	Yellow			
		180168	Purple			
		180166	Brown			
		180167	Gray			
		180164	Green			
Toro		170116BKWT	P7313	14/2c	Black & White	None
		170800	P7350D			Red
		170800BK				Red & Black Stripe
		170800GN				Red & Green Stripe
		170800YL				Red & Yellow Stripe

## Paige Electric Decoder-to-Solenoid Cables:

The wiring inside a valve box can be very complicated. DTS Cable colors can be chosen to match the colors the decoder output wires to minimize the confusion. The following table shows the colors of DTS Cable required by major decoder manufacturer and model number.

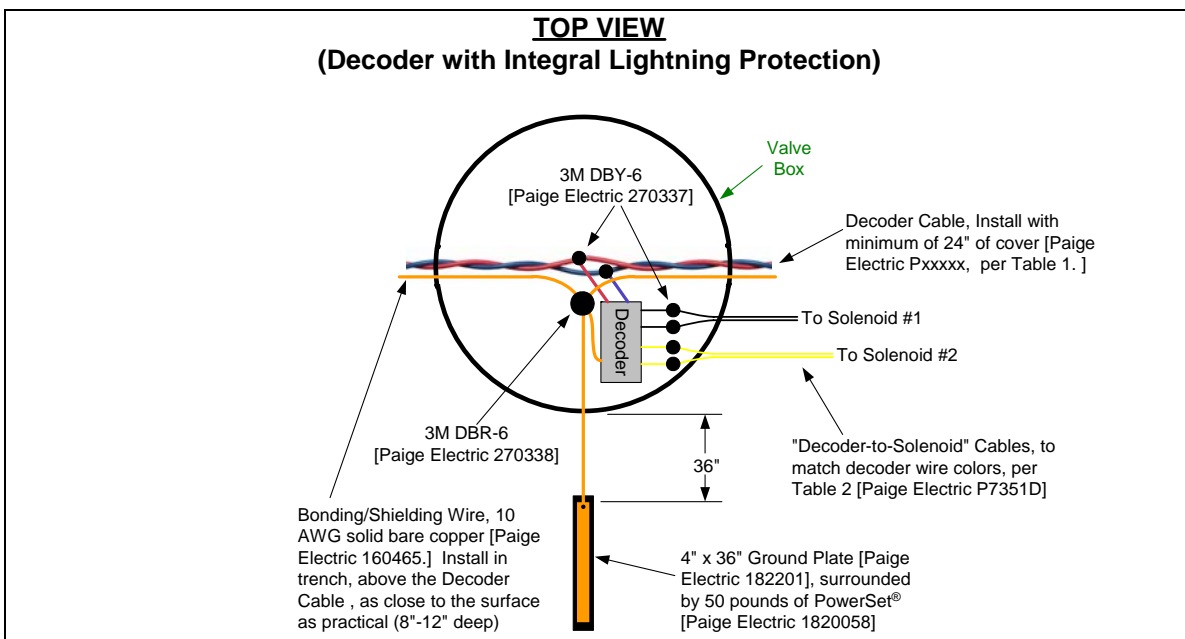


The DTS Cable has one wire whose insulation is smooth and the other wire has raised ridges. This is ideal for systems requiring polarization, like the Toro system that utilizes latching solenoids. The two wires are separated by tearing them apart.

Table 2 - Decoder-to-Solenoid Cables (DTS Cables), Specification P7351D Selection Guide												
Mfr.	Mfr. Model	No. of Solenoids	DTS Cable Color & Paige Electric Part Numbers									
			Red 170803RD	Blue 170803BU	Brown 170803BN	Gray 170803GY	Green 170803GN	Orange 170803OG	Black 170803BK	Yellow 170803YL	White 170803WT	Purple 170803PR
Hunter	ICD-100	1								X		
	ICD-200	2								X	X	
	ICD-300	4					X			X	X	X
	ICD-400	6					X	X		X	X	X
Rain Bird	FD-101	1										X
	FD-102											X
	FD-202	2			X							X
	FD-401	4	X		X			X	X			
Toro	DEC-1	1	X									
	CDEC-1											
Toro	DEC-2	2					X	X				
	CDEC-2											
	DEC-4	4	X	X			X	X				
	CDEC-4											

## Lightning Protection, Grounding, Bonding and Shielding:

In decoder systems, the lightning protection/arresters are either built into the decoder or external, depending on the manufacturer. Without lightning arresters, the decoders are vulnerable to lightning damage. In order for these arresters to discharge lightning energy efficiently, they must be grounded. It is important to maintain the same voltage at all points of the two wire path in order to minimize lightning damage. The technique known as “bonding” is used to accomplish this by using a 10 AWG solid bare copper wire to interconnect all the decoder ground grids. This bonding wire can be used to “shield” the two wire path from lightning energy by placing it directly above the decoder cable. Here are typical recommended grounding grids for decoder systems with internal and external lightning arresters:



## **Cable Splices:**

In order for the wire connections to comply with the 2005 edition of National Electrical Code® Articles 300.5 (Underground Installations) and 110.14 (Electrical Connections), in wet or damp locations, the connector must be listed under specification “UL 486D” if installed in a valve box. It must be listed under specification “UL 486D-Direct Burial” if buried in dirt. This requirement applies to all electrical connections in wet or damp locations, regardless of voltage. The 3M DBY-6 and DBR-6 are listed as “UL 486D-Direct Burial” and meet these requirements for all underground installations.

## **Cable Burial Depth:**

Most decoder systems operate at voltages between 30 and 40 volts. The 2005 edition of the National Electrical Code®, Article 300-5, requires that wires and cables subjected to voltages higher than 30 volts are to have a minimum cover of 24 inches.

If the voltage on the cable is 30 volts or less, only 6 inches of cover are required. Of course, the proper depth should be selected in order to protect the cables from mechanical damage from maintenance such as aerefying of soils.

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