



FOOLPROOF ELECTRICAL TROUBLESHOOTING

By Tim Wilson
IA Education Director

Picture yourself in this situation—you are out on a repair job and you are sure it is a wiring problem. You have been working on it for about three hours now and you still can't figure out what's wrong. Your boss calls on the radio to find out if you are done yet and, when you tell him the situation, he says, "Don't mess with it any more, just run a new wire out to the valve." How many times has this happened to you?

In this article you will learn how to quickly identify a wiring problem, without ever leaving the controller! Running a new wire will no longer be your only option. In addition, you will learn how to properly use an Ohmmeter to diagnose wiring and solenoid problems.

This is written for the experienced irrigator and assumes a basic knowledge of irrigation system operation. Also, we are just dealing with AC systems.

Let's begin by simplifying what can go wrong with the electrical side of an irrigation system. There are only three things to look at: controller, field wiring and solenoid valve. That's it! Now let's break it down a little further in regard to repairs you can easily make. The trick to troubleshooting is to systematically eliminate one problem at a time until only one thing is left, and there is your problem! Too often we find ourselves walking all over the job chasing down what we "think" the problem is, only to start all over again chasing down another path. If you follow a systematic and proven system of troubleshooting you will cut your repair time by more than half.

THREE SCENARIOS

The following three scenarios illustrate that troubleshooting involves determining if the problem is the controller, field wiring or the solenoid.

We are ready to walk through three scenarios to see how to put this knowledge to good use.

Scenario 1

Problem: You are told by the customer that none of the valves are coming on. You get your tools and go to the controller. First check for the obvious:

- Is there water to the system?
- Is the controller plugged in?
- Are the valves in question even programmed to run?

Having dispensed with the obvious, we will begin by checking the controller. Here are the steps to follow:

Solution: Put your meter on AC voltage and check the wall socket to see if the incoming high voltage is correct. It should be around 110 VAC – 130 VAC.

If that reading is normal, go to the terminal board and turn on a couple of valves in a row, and check with your voltmeter for correct output voltage. It should be between 23 VAC and 28 VAC, more or less. In this scenario let's say that you read 10 VAC on all of the valve stations that you check. What we have just done is checked out the transformer and the controller. We now ask ourselves, "Is 10 VAC normal?" The answer is NO. Now we take off the faceplate of the controller and trace where the wires first leave the transformer and check the voltage again. Once more we read 10 VAC. Therefore we have a bad transformer!

Now, before you get too excited, it must be said that it is rarely ever the controller that is the problem. We just lucked out on this one!

Many times we find a problem and assume that is the one and only problem with the system and then are disappointed when we fix it and the system still doesn't work.

Scenario #2

Problem: In this scenario the customer tells you that two valves are not coming on at all and the controller blows a fuse when another valve is activated.

The beginning steps are always the same (regardless of what the customer tells you!). First check for the obvious. Having dispensed with the obvious we will begin by checking the controller.

Put your meter on AC voltage and check the wall socket to see if the incoming high voltage is correct. It should be around 110 VAC – 130 VAC. In this case, again, it is normal.

Now go to the terminal trip and check out a few stations with your voltmeter by activating some stations and check out the voltage readings. In this case you read 25 volts, which is in the normal range. This tells us the transformer is working.

Now we will ohm out the field wires and solenoids. Turn your meter to ohms and make sure the controller is in the off position. Starting with valve one, touch your black lead to the common terminal post. At this point your meter is sending a small amount of current through the circuit, down the hot wire to the solenoid and back to the controller on the common wire. It will display the resistance in ohms on your meter.

There are three types of problems that can occur with field wiring—shorts, broken wires and bad splices. Each one of these will give a particular ohm reading. A normal reading should be between 20-60 ohms.

Be careful about overusing the term short. Short defines a very specific problem. With a short the current from the meter will be taking a "shortcut" back to the controller, therefore you will get a low ohm reading, somewhere around 1-10 ohms.

Broken wire. With this type of problem the current from the meter has no way of returning to the meter because of the break. So you will get an "Infinity" reading. Different meters will display this in various ways. Your meter (digital, of course) might read OL for Open Line. Another meter might display a blinking 1000k. Check your manual on your specific meter.

One has to be careful with digital meters at this point. To display a reading in the thousands or millions digital meters will display a small 'k' for thousands of ohms of resistance or a small 'm' for millions of ohms of resistance. For example, you might read 13.5m, which means 13,500,000 ohms of resistance! Or it might read 256k, which means 256,000 ohms of resistance! The point to remember is that if you are taking ohm readings and you get a small k or m on the display, the problem is a broken wire.

Bad splice. With a bad splice the current from your meter is making it through the circuit and returning to the meter, but with so much resistance that the valve can not operate. This is a typical culprit of "valve chatter." A typical reading from a bad splice is higher than normal but lower than a broken wire. If you remember, normal was about 20-60 ohms. Therefore, your ohm reading will be around 70-150 ohms. It can vary either way based on the solenoid type, wire size and length of wire run.

Now we will return to troubleshooting Scenario #2, where two valves are not coming on and the controller is blowing a fuse when a third station comes on. As we ohm out each valve (from the controller!) we get the following readings:

Station 1 – 33 ohms (normal)

Station 2 – 47 ohms (normal)

Station 3 – 95 ohms (bad splice)

Station 4 – 29 ohms (normal)
Station 5 – 1.3m ohms (broken wire)
Station 6 – 52 ohms (normal)
Station 7 – 4 ohms (short)
Station 8 – 27 ohms (normal)

Which are the two valves that are not coming on and which is the station that is blowing the fuse on the controller? Remember 20-60 ohms was considered normal. Therefore, stations 2, 2, 4, 6 and 8 have no electrical problems. 1-10 ohms is a short (which causes fuses to blow and reset switches to trip), infinity, OL, or an 'm' or 'k' reading is a broken wire.

We are done at the controller. Now we will walk out to valves 3, 5 and 7, since they are the problem valves. Cut the wires from the field and ohm out the solenoid right at the valve. Note the following readings on stations 3, 5 and 7 at the valve:

Station 3 – 35 ohms
Station 5 – 40 ohms
Station 7 – 4 ohms

Why do 3 and 5 have normal readings at the valve? Because the problem is in the field wiring, not the solenoid. We have eliminated the controller and the solenoid as the source of the problem. Station 3 has a bad splice in the field wiring and station 5 has a break in the field wiring.

For station 7, the problem is not in the controller or the field wiring, but in the solenoid at the valve. The solenoid is shorted out.

Scenario 3

Problem: In this scenario the customer tells us that valve 4 is not coming on. We go through all of the previous checks all the way down through ohming out the valves from the controller. Everything checks out so far. This is a four-station controller and the ohm readings are as follows:

Station 1 – 26 ohms
Station 2 – 48 ohms
Station 3 – 30 ohms
Station 4 – 36 ohms

So the question is, where is the electrical problem?

Solution: Nowhere. There is no electrical problem with this system! Valve 4 may very well not be coming on but the problem is mechanical not electrical. Trust your readings. If your checklist tells you there is no electrical problem, don't keep looking for one!

You might want to re-read this a couple of times to catch all of the tricks of the trade. Remember to always troubleshoot in sequence. In troubleshooting, many times it is useful to identify first what the problem isn't.

Reprinted from the April 1999 issue of IA.