INTRODUCTION TO

TROUBLESHOOTING 2-WIRE CONTROLLED IRRIGATION SYSTEMS

A Training Series for Professionals
Who is Armada Technologies?

• Founded in 2004
• Based on 40 years in the Test Industry
• NOT irrigation professionals! (That means you know more than I do about water and light)
• We do know LOTS about Testers.
OBJECTIVES

- Technical Terminology
- System Types
- Troubleshooting Goals
- Tools Available
- How to Use the Tools
PRODUCT GROUPS USED

WATER AND LIGHTING SYSTEM TEST & MEASUREMENT

LOCATING BURIED WIRING AND VALVES

TROUBLESHOOTING BURIED WIRING

Copyright © 2014 Armada Technologies
IRRIGATION SYSTEM TYPES

• Multi-wire (Wire-per-valve plus common)
• Two-wire (Single control+power)
Clocks or controllers fire valve solenoids that release water into sections of pipe feeding watering zones.
Many newer, long distance, many-valve system designs often use a smart controller, 2-wire data link cable and ‘decoders’ to fire valves.

Two-conductor 12 - 14 Gauge Direct Bury Cable
Some Two-wire System Vendors

- Tucor
- Toro
- Hunter
- Baseline
- Weathermatic
- Rainbird
In a 2-wire system a single cable can control many valves.
Valve Box

Valve

Decoder

Ground Plate

Courtesy Hunter Industries
Buried Wiring for Conventional Multi-wire vs. Two-Wire Systems

Diagrams from Tucor

'STAR' or 'HOME RUN'

'DAISY-CHAIN'
Using electronic testers to eliminate suspects:

Start by eliminating the controller or water supply as the source of the problem.
TROUBLESHOOTING

As with any type of irrigation control system, start from the source of power and work outward

1. Controller
2. Field Wire
3. Decoders
4. Valve Solenoids
FIND THE WIRE PATH

Pro800D Locator

Good Range
Direct & Antenna Connect

CHECKING DECODER CONNECTIONS

Pro93
True RMS Clampmeter

High Sensitivity
True Power Reading
Type Recommended by Sys Mfgs
Not Carried by Other Suppliers

Pro400
TDR Wire Radar

Measure cable length
Find distance to splices
Spot opens and shorts

FIND THE WIRE DAMAGE

GFL3000 Ground Fault Locator

Fast, Precise Damage Location
General Use

Pro30

Easy-to-use, Multi-purpose, clampmeter and multimeter

True RMS reading for LED lighting, easy to use

Pro90

Hi Sensitivity and True RMS reading For 2-wire irrigation and LED lighting

Pro91

Pro93

Advanced Features

METER SELECTION GUIDE
Copyright © 2014 Armada Technologies
TYPICAL USES FOR A METER: Checking an Irrigation Controller Zone with the Test Probes

<table>
<thead>
<tr>
<th>CONDITION?</th>
<th>RESISTANCE READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short circuit</td>
<td>1 – 10 ohms</td>
</tr>
<tr>
<td>Open circuit</td>
<td>“OL” – Too big to read</td>
</tr>
<tr>
<td>Partial Open (Bad Splice)</td>
<td>70 – 150 ohms</td>
</tr>
<tr>
<td>Normal solenoid</td>
<td>20 – 60 ohms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VOLTAGE READING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Clock Output</td>
</tr>
</tbody>
</table>
Clampmeters can measure electrical current by just closing the spring-loaded jaws over a wire. This is especially useful in testing lighting systems and 2-wire irrigation systems.

Pro93 ‘Leakage’ Meter
Can read AC currents of less than 1 mA (milliampere)
2-Wire Control Links are Chains of Smart Valve Solenoids Wired in Series, Each Identified by an ID Number

A bad splice or single wire break can take down whole groups of watering zones.
To Begin With, You Need to Know the Route of the Buried Cable and Locations of Valves

- 2-wire Controller
- Pro800 Hi-Power Locator
- Decoder
- Valve
- Decoder
- Valve
- Decoder
- Valve
Locating Buried Cables and Pipes is Part Science, Part Art.

Modern electronics have made it simpler and less expensive.
The Parts of the Locating Process.

- Receiver
- Antenna
- Transmitter
- Ground Stake
- Head of Traced Cable
Locator Features and Uses

- Transmitter Power (range & depth)
- Transmitter Frequency (range)
- Signal Connection – Direct or Magnetic (cable access)
- Receiver Antenna – Peak or Null (spot location)
- Depth Measurement (spot location)
Locators put their ‘tag’ signals on by directly connecting to the wires, clamping a transformer jaw around a cable or by broadcasting a field into the ground.

- **Clamp Method**: Direct connection to the wire or cable is the best.
- **Broadcast Method**

*Radiodetection*
Cable Locating Tips

• Size up the situation, look around for signs that will give you clues about cable routes.

• Make a sketch of the area and notes on the equipment you see.

• Look for locating marks like flags or paint, and be prepared to make your own marks.

• Whatever you are told about what is in the ground and where it goes, be skeptical.

• Remember as you start to locate that success is 50% science and 50% art (experience).
Do yourself a favor -- take notes and make a sketch of what you find.
Splices are the weakest link in the field system.
The General Process

**Controller**
 Controller On - Built-in Diagnostics check  
Field wire powered – 30 to 36 volts, or 24 Vac test power unit

**Field Wire**
 First disconnect and check resistance  
Each wire to ground greater than 500 kilohm  
Across wire pair greater than 100 kilohm  
With controller on or in troubleshooting mode  
check total powered loop current in each of the 2 wires

**Decoders**
 Locate cable path  
Locate valve boxes  
Spot check power current passing through the box and going to the local decoder.

**Valve Solenoids**
 With water on do a manual bleed  
Resistance check solenoid 20 – 80 ohms  
Use Pro48 tester for solenoid operation check.
The Key to Finding Open Circuits or Shorts is a Sensitive AC Clamp-meter
You Have to Power the Field Cable to Use a Clampmeter

2-wire Controller (puts out about 35 V)

Test Power Unit (puts out about 24 Vac)

Decoder

Valve

Decoder

Valve

Decoder

Valve

Copyright © 2014 Armada Technologies
You Can Use the Power Unit and Clampmeter to Check for Faults

With the test power connected to the wires the clampmeter around both wires should show zero current.

The current between either wire and ground should be less than 50 mA.
Zone apparently not working: Basic Troubleshooting

- Controller Powered On
  - Volts to Field Cable OK?
    - Y: Troubleshoot Clock AC power, fuse
    - N: Disconnect the Field Cable
      - Test Currents/Leakage at the Control Cable
        - N: Excess Main Current?
          - Y: Check for Pair Short or Bad Decoder
          - N: Excess Current in One Leg?
            - Y: Check for Cable Damage or Wet Splice
            - N: Low Main Current?
              - Y: Check for Break or Open Splice
              - N: Locate cable path
  - Troubleshoot Specific Zone Faults
    - Operate valves with bleed
    - Check valve solenoid resistance
    - Locate cable path

Copyright © 2014 Armada Technologies
Near the Controller, Currents Should Be the Sum of the Decoder Currents

0.5 to 5.0 mA each
When a Zone is Activated, Total Current Should Be the Sum of the Decoder Currents Plus one Solenoid (about 200 mA)
Pro93 Clamp-meter
Measuring Points in a Valve Box

A: Valve resistance
B: Main power In
C: Decoder power
D: Main power Out

Checking electrical power flow and cable continuity means measuring electrical currents.
Finding a Break or a Nick in the Insulation.

The GFL3000 A-Frame isolates breaks in buried cable insulation.
CHECK DISTANCES & FIND WIRE DAMAGE

Pro400 TDR “Wire Radar”

- Measure cable length
- Find distance to splices
- Spot opens and shorts

Example display: A valve solenoid 100 feet down the cable with a splice at 75 feet.
The Pro400 “Wire Radar” Examples

Once the cable correction factor ‘Vp’ is set, you can read distances down the cable by moving the cursor.

Short circuit 50 feet down the cable.

Cable open at 100 feet, splice visible at 75 feet.
Demo Videos are on DVD and can Be Seen at www.armadatech.com
Questions.