



“A Water Solutions Provider”

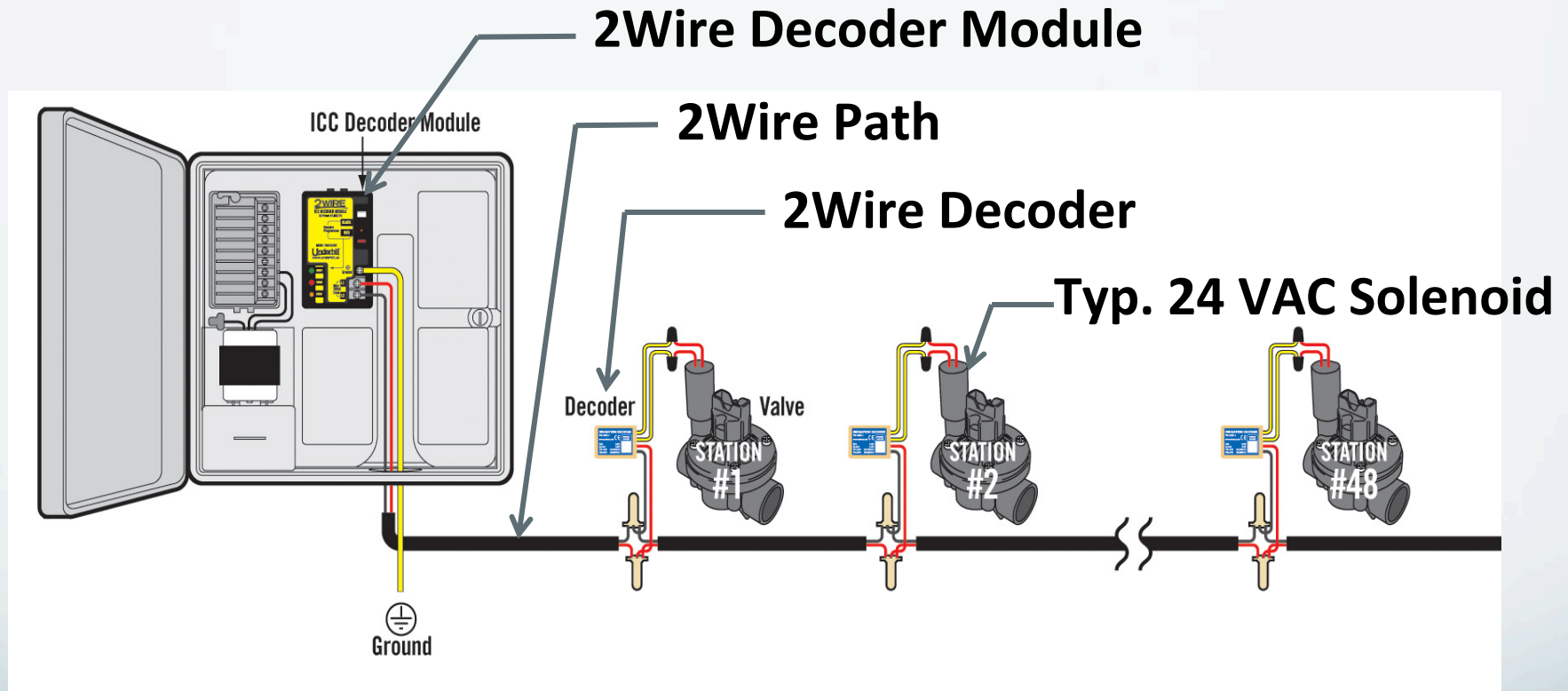
Troubleshooting 2Wire Control Systems



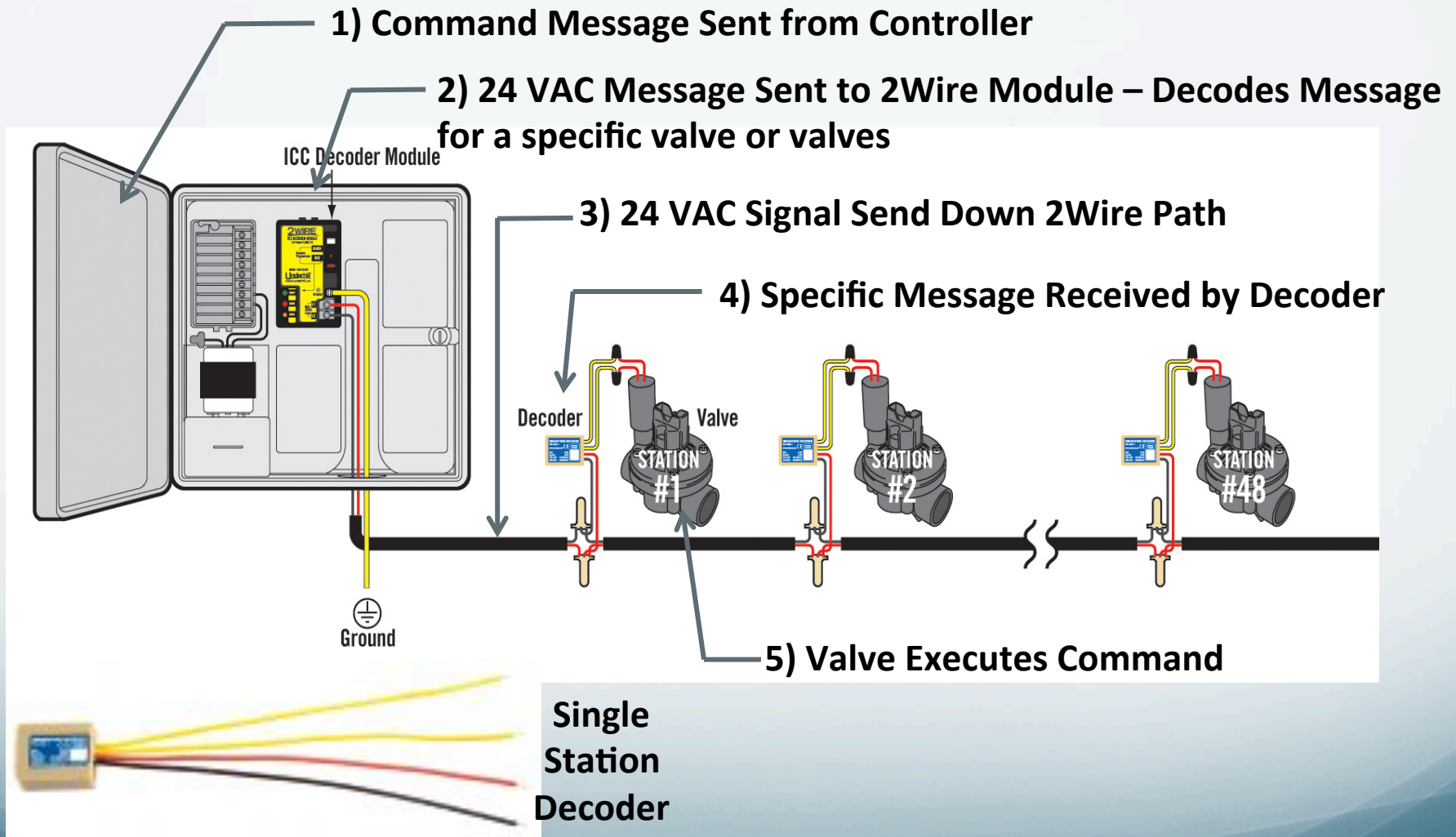
Overview

- Review of Typical 2Wire System Components
- How 2Wire Systems Work
- Typical 2Wire Wire Run Layouts
- Tools for Troubleshooting and their Purpose
- Common 2Wire Faults
- Troubleshooting 2Wire Faults

Typical 2Wire System Components



How 2Wire Systems Work

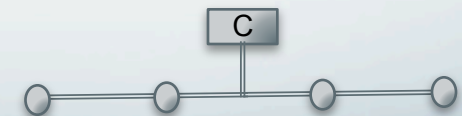
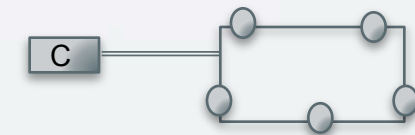
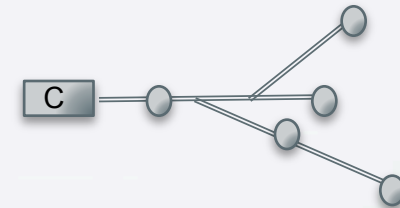


Typical 2Wire Path Runs

- Important to understand how 2Wire paths runs are used
- Will help with troubleshooting and understanding recorded values
- Helps if a crude sketch can be recorded for future reference
- Size of wire and length of wire is also important

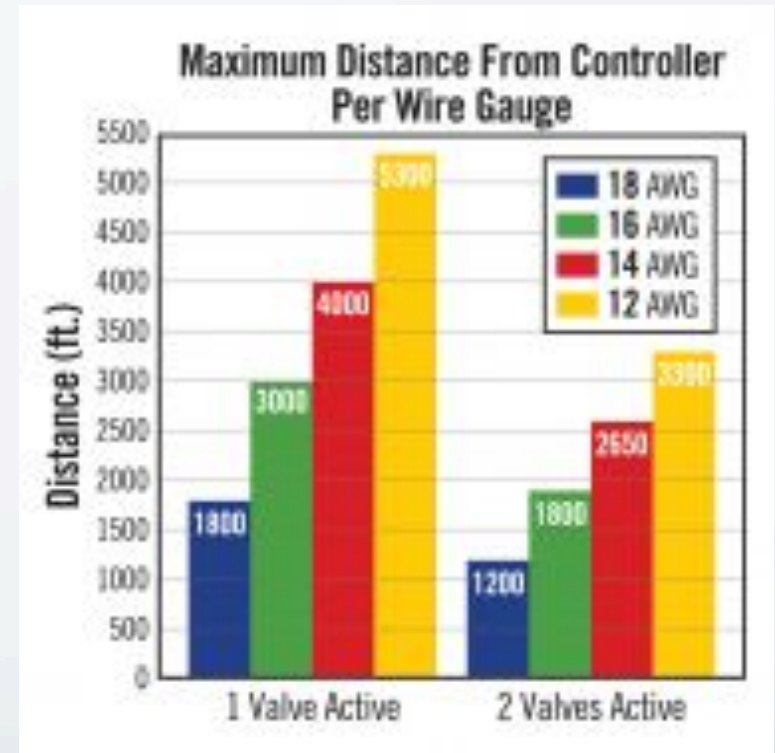
Typical 2Wire Layouts

- “Single-leg” - pattern, starting at the controller to the last valve
- “Fishbone” - pattern, splits off into several branches
- “Looped” - pattern, comes back onto itself
- “Opposing” - pattern, going in two opposing directions from the controller



Recommended Maximum Wire Run

- Wire path lengths are subject to:
 - Wire size,
 - Holding current of solenoids,
 - Number of solenoids operated at the same time
 - Distance signal has to travel.



2Wire Troubleshooting Tools

- Different tools are needed to diagnose 2Wire systems
- Investing in these tools will save hours of troubleshooting time in the field and frustration
- Invest in your success as a professional

2Wire Troubleshooting Tools

Digital Clamp Multi-meter

- Single most valuable investment for 2Wire troubleshooting.
- Must be a 'leakage' clamp meter. Ordinary ones are not sensitive enough.
- Allows field measurements to be taken without having to break apart wire splices or remove wire insulation.

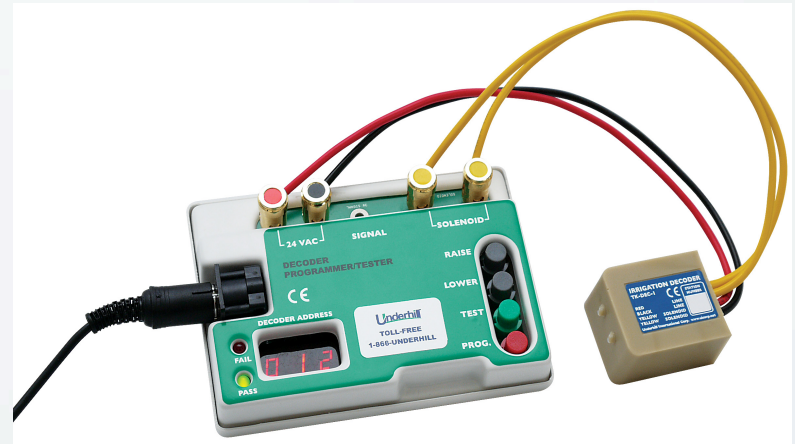


**Underhill p/n
TW-DCM**

2Wire Troubleshooting Tools

Portable Decoder Programmer/ Tester

- The tester may be used to program or test a decoder's station number
- Some 2Wire controllers have a built-in decoder tester/ programmer.
- Available as AC plug-in model or 12-VAC via a car adapter



Underhill p/n
DEC-PRO-115
Or
DEC-PRO-12

2Wire Troubleshooting Tools

Faultfinding Transformer

- This device safely injects 28 VAC down the 2Wire path by circumventing the 2Wire controller.
- Most controllers will refuse to power up a 2Wire path that has more than a certain amount of load or leakage on it. Fuses may blow, software may shut the cable down, or even worse, a drive transistor in the controller may overheat.
- Using this device and a digital clamp meter, current measurements can be collected to determine a fault location



**Underhill p/n
DEC-PSU-115**

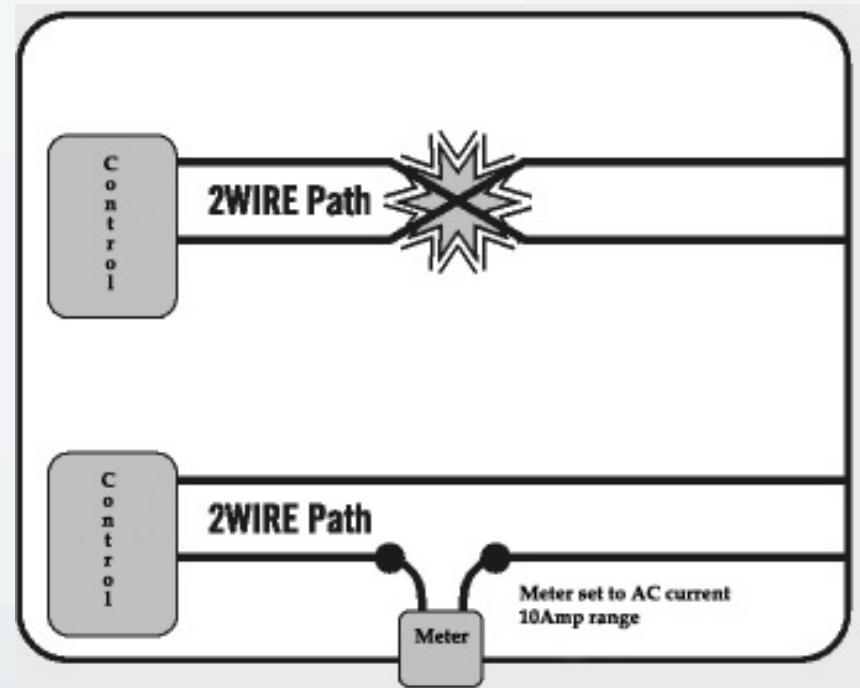
Common 2Wire Faults

- Shorts on the main 2Wire path
- A faulty decoder
- A solenoid that reached end of life
- A failed or failing wire connection

Common 2Wire Faults

Short Circuit on the 2Wire Path

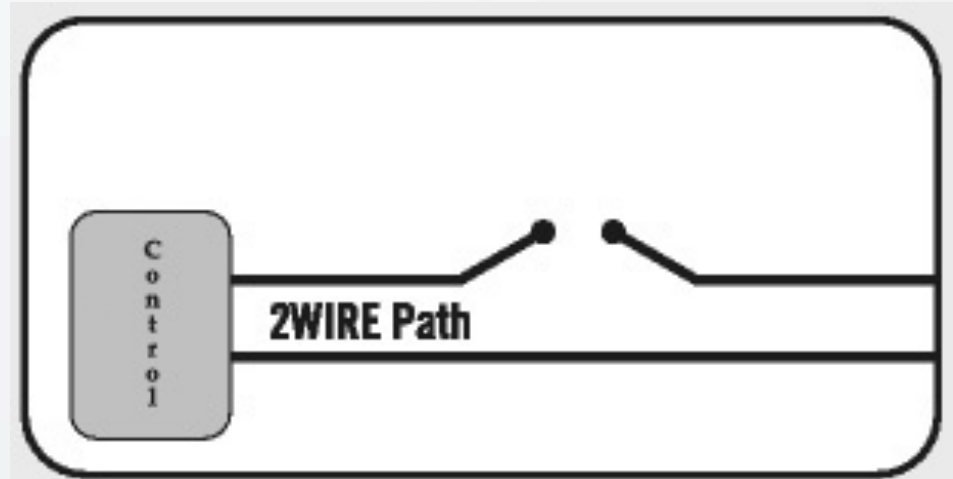
- High currents flow and the controller shuts down to protect itself.
- It is not obvious where the short is.



Common 2Wire Faults

Open Circuit in the Main 2Wire Path

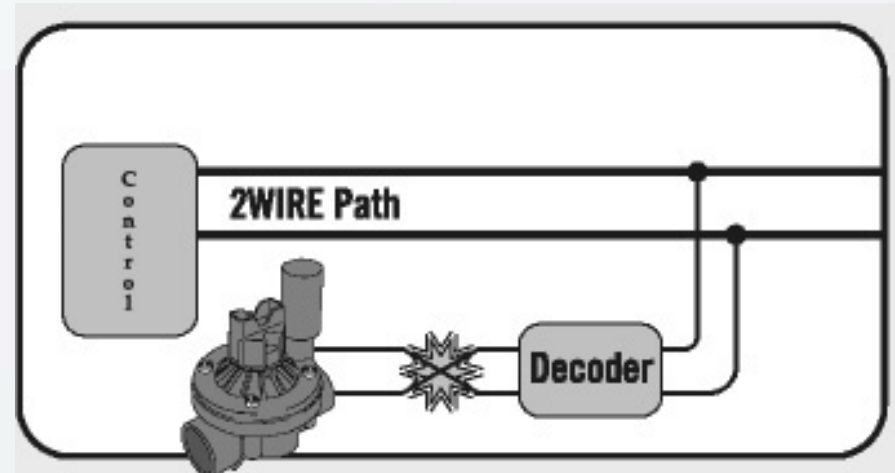
- All decoders up to the open circuit will work, but those beyond will not
- Equivalent to a break in the common line in a multi-wire system



Common 2Wire Faults

Short Circuit Solenoid

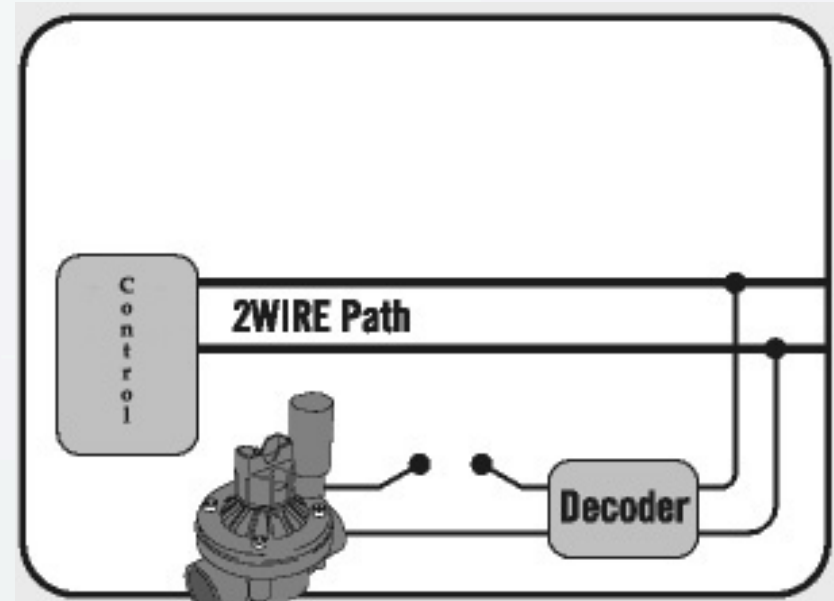
- Short only shows up when a decoder is operated
- Sometimes the solenoid stops the system working afterwards due to voltage loss down the main 2Wire path, preventing an “off” command from reaching the decoder.
- Some 2Wire systems are more clever, will report a fault and not try to turn on the solenoid



Common 2Wire Faults

Open Circuit Solenoid or Dead Decoder

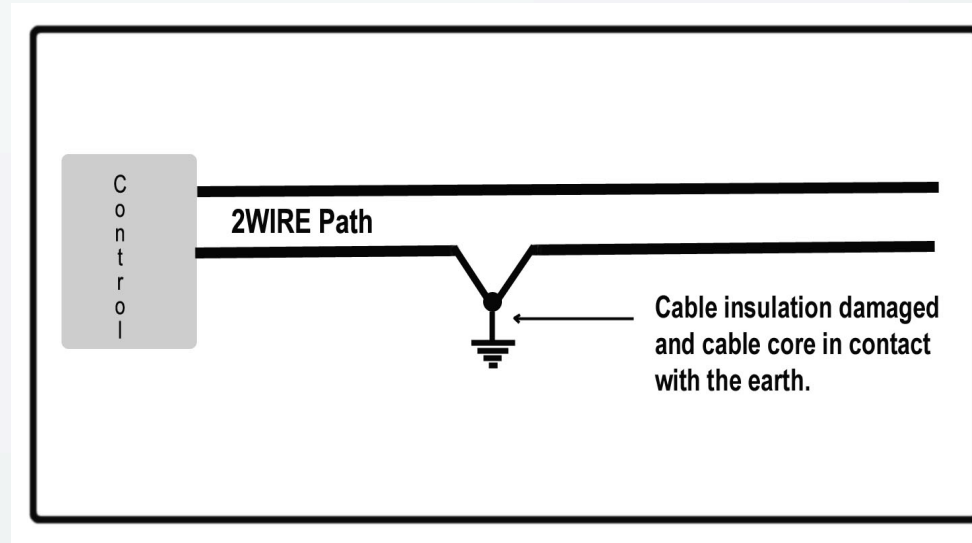
- Station does not respond to any controller commands
- Solenoid is faulty or dead
- May also be a dead decoder



Common 2Wire Faults

Cable Leakage to Earth

- When a cable or wire connection is not well insulated, some electricity can leak to earth. This causes problems for some controllers, either refusing to control at all, or sometimes giving erratic operation, leading to the controller being suspect.
- Earth leakage must be repaired first as it can interfere with the diagnosis of other faults.



Methods to Troubleshooting 2Wire Faults

- Using the right tools
- Implementing the “Halving Method”
- Troubleshooting 2Wire Faults

Troubleshooting 2Wire Faults

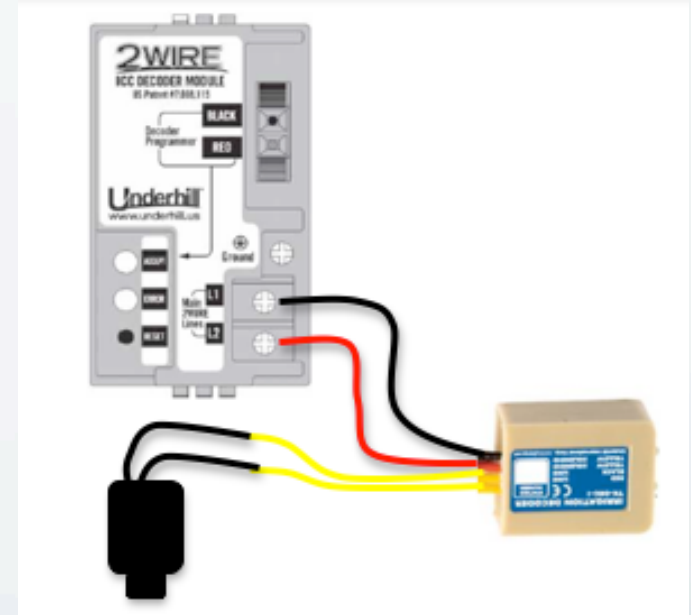
Start by Using the Right Tools

- We drive our cars with sufficient oil and gas, so why not apply the same principle to support a 2Wire system?
- Recommended tools:
 - Digital Clamp Meter
 - A known working solenoid
 - A spare working decoder
 - Some spare lengths of wire
 - Faultfinding transformer
 - DBRY's wire connectors

Troubleshooting 2Wire Faults

Check a Decoder

- Pull a suspected faulty decoder and bring it back to the controller or 2Wire Converter
- Connect the red and black wires to the L1 / L2 terminals (temporarily disconnecting the existing 2Wire path).
- Connect the 2 (qty) yellow wires to a known working solenoid and operate that station manually.
- If the solenoid “buzzes” the decoder is operable, if it doesn’t replace it.



Troubleshooting 2Wire Faults

Check a Solenoid

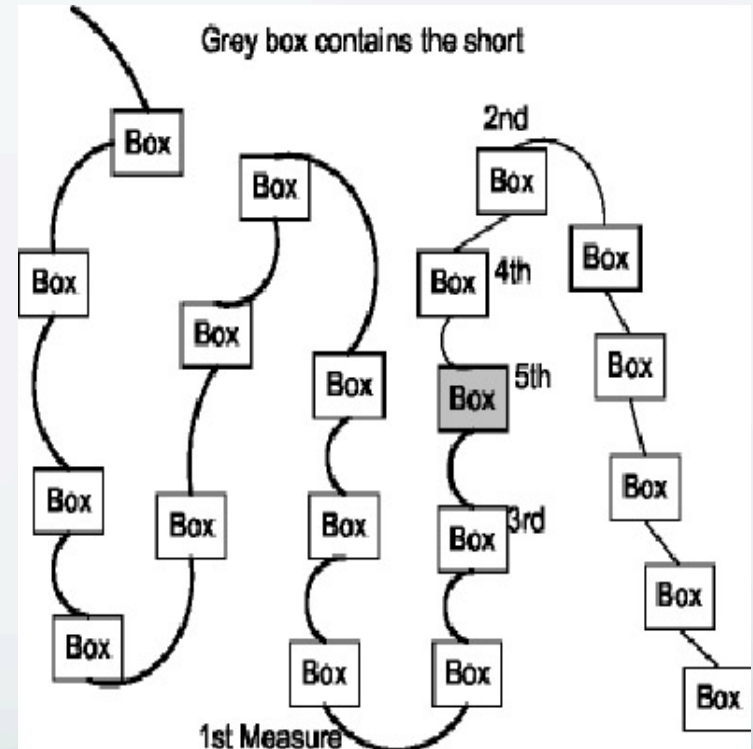
- Before re-installing the previously removed decoder, conduct an Ohms resistance test on the solenoid.
- If the Ohm resistance is above 85 ohms, the solenoid might have to be replaced.
- Compare this measurement against a known working solenoid for verification.



Troubleshooting 2Wire Faults

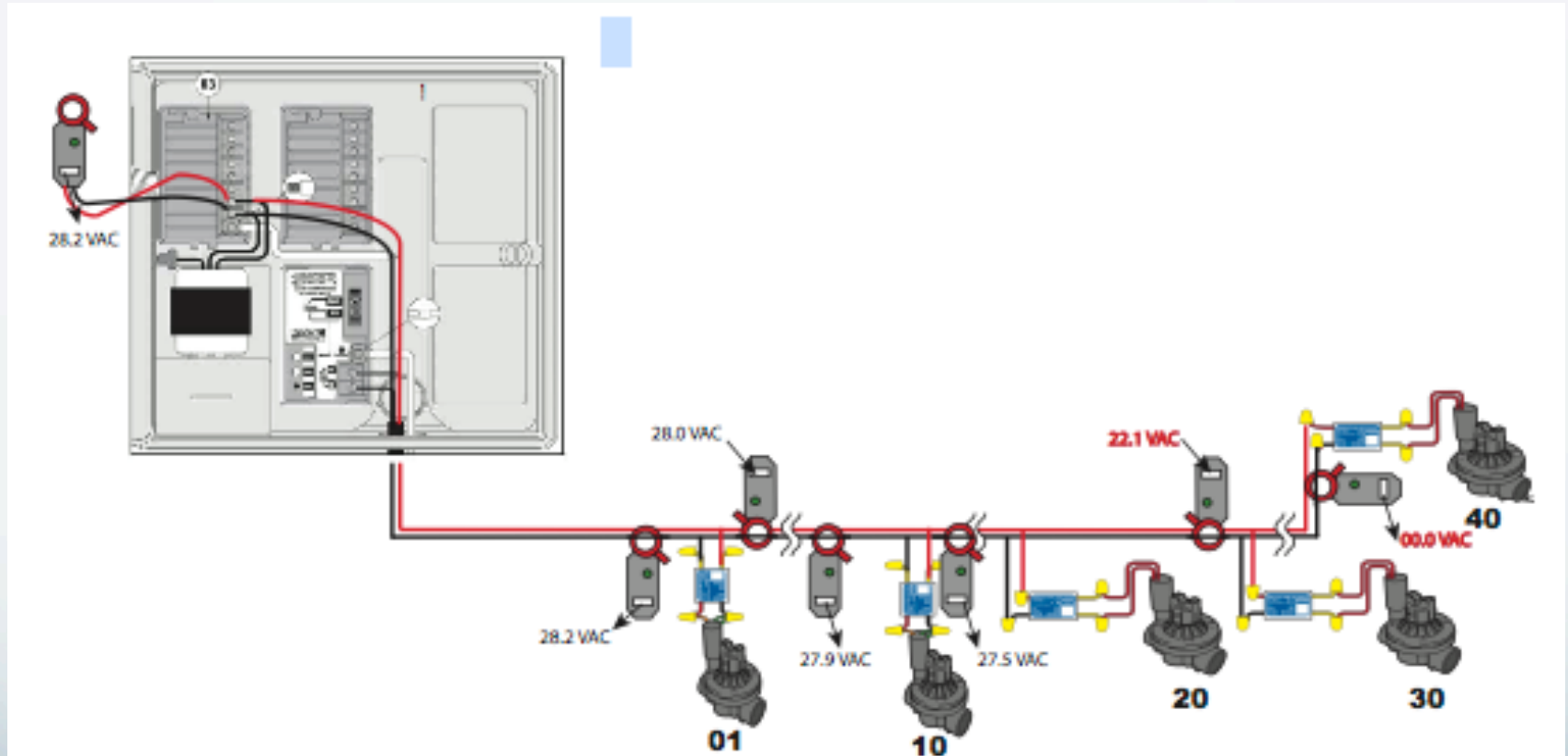
The “Halving Method”

- Usable for any type of cable fault. Shorts, opens, high resistance joints or cable leakage to ground.
- Using a digital clamp meter measure and record half way down the 2Wire path.
- Decide which half the problem is located.
- Go half way on the problem half and repeat
- Using this technique, 20 valves can be covered in just 5 measurements.. See diagram.



Troubleshooting 2Wire Faults

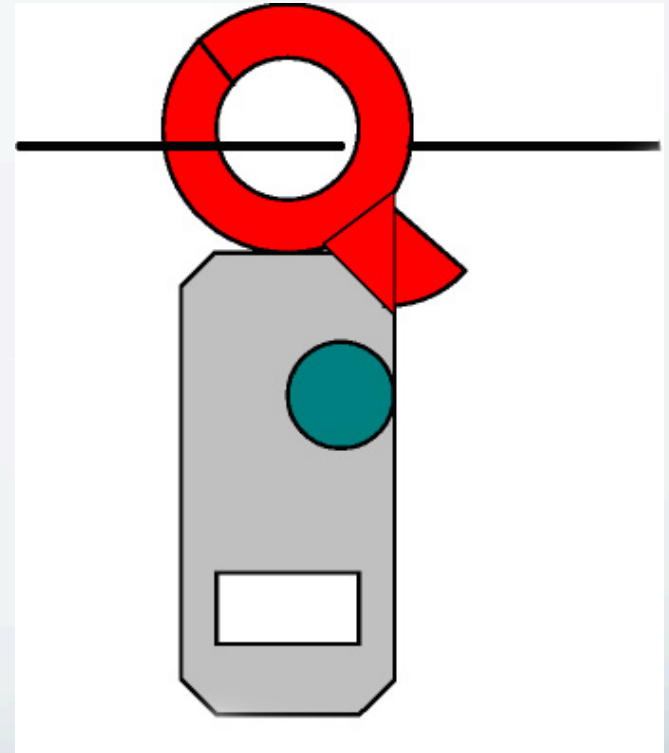
The “Halving Method”



Troubleshooting 2Wire Faults

How to Use a Clamp Meter

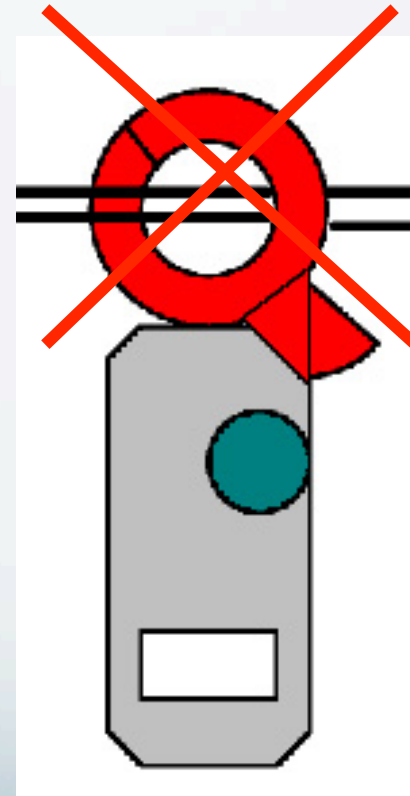
- Currents are measured by opening the red jaws by pressing the red trigger with the thumb and clamping the jaws around the wire.
- **Note:** Make sure to keep the digital clamp meter at least 1 foot away from a portable power supply and/or solenoid



Troubleshooting 2Wire Faults

Proper Use of a Clamp Meter

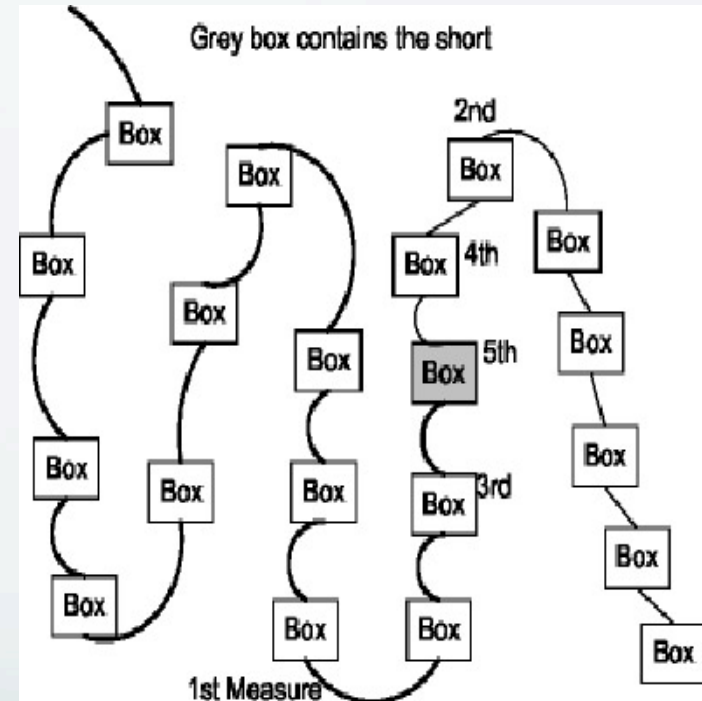
- It is important to understand that if both flow and return wires carry the same current and are placed inside the jaws, *the clamp meter will read zero*



Troubleshooting 2Wire Faults

Beyond the short, the current will be much less

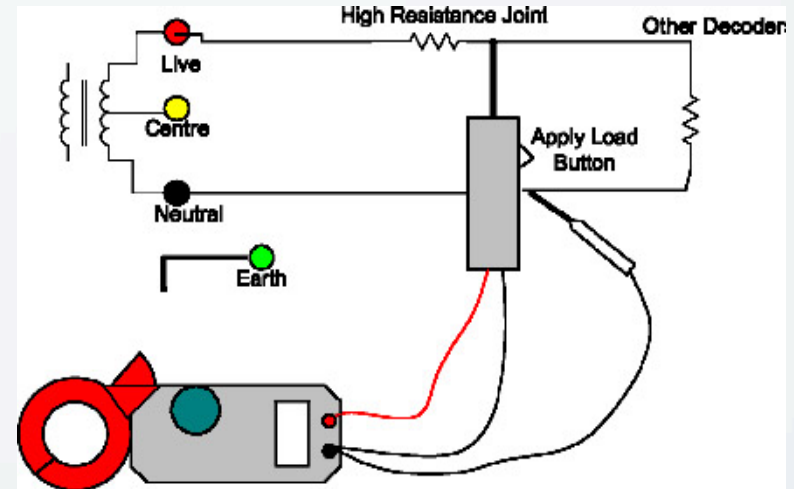
- The thick lines in this figure are indicate higher than normal currents measured. Once you are past the short, the currents will either fall to near zero (if the voltage is cut off downstream) or go back to near normal.
- To measure the short circuit currents, place the digital clamp meter over just one of the 2Wire path wires. Measure AC volts.



Troubleshooting 2Wire Faults

Fault tracing high-resistance wire connections

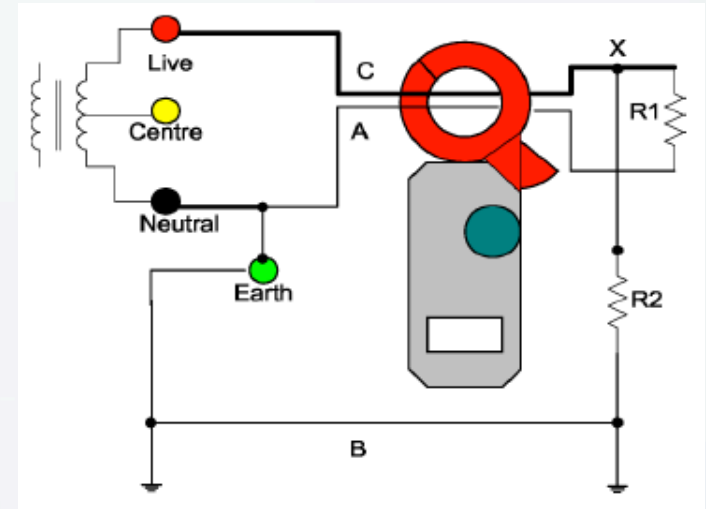
- Connect the faultfinding transformer to the live and neutral 2Wire path
- Go halfway down the line, expose the 2Wire path
- Measure voltage across the line, with and without a solenoid load
- The picture right, shows a push-button solenoid load simulator. A spare solenoid will do just as well.
- A volt drop more than 3 or 4 volts under load indicates a high resistance joint upstream. Go halfway down the faulty half and repeat
- Using the halving technique you can cover 20 boxes using 5 measurements



Troubleshooting 2Wire Faults

Tracing Leakage to Earth

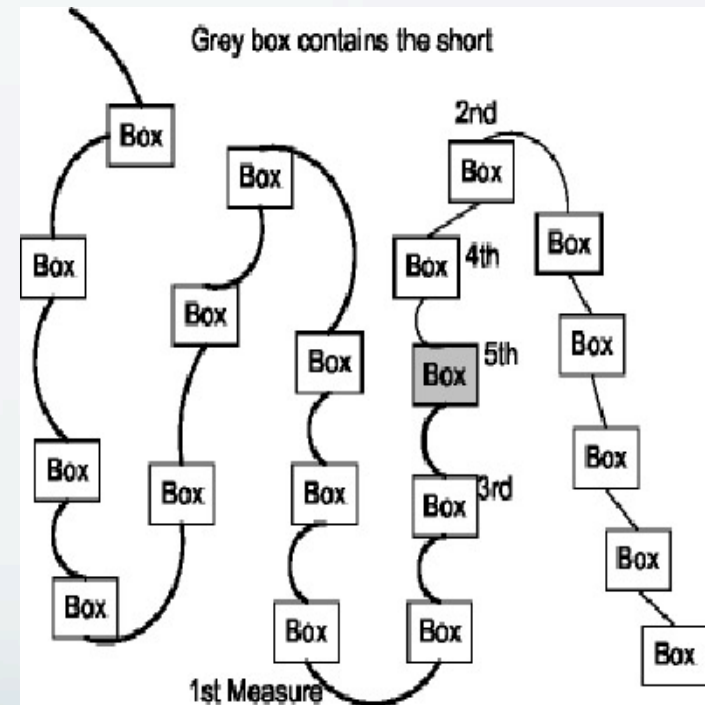
- The faultfinding transformer and the clamp meter can be used to easily find earth leakage. With one side of the transformer grounded (earthed), leakage currents can flow back through the ground causing unequal currents in the main 2 wire path.
- In the diagram, point X represents a leakage point to earth through some value of resistance R2. R1 is representative of a quantity of decoders. Current flows 'out' of the transformer through C and splits at X to flow 'back' through A and C. The resistors R1 and R2 are effectively in parallel and see almost all the transformers voltage. The clamp meter will read the difference between the currents in A and C which is equal to that flowing in B.



Troubleshooting 2Wire Faults

Finding the Location of Earth Leakage

- With one side of the faultfinding transformer grounded, the clamp meter is placed around the whole of the main 2Wire cable.
- In this diagram, the digital clamp meter will read much lower when past the grayed station no. marked '5th'.



Troubleshooting 2Wire Faults

Phantom Earth Leakage

- When placed over the whole field cable, the digital clamp meter will measure the current imbalance among the conductors. This is caused by some current flowing through the ground back to the transformer (one side of which will be deliberately earthed). However, another reason is 2Wire path cable “loops”.
- Field cables are sometimes “looped” and connected back to themselves to lower their resistance, which means less voltage drop when solenoids are on. The currents for the decoder/solenoid can flow in both sides of the loop. If however one wire in one side of the loop is broken or has a high resistance joint, the current in it will favor the good side of the loop. We then have a situation where the total currents when measured in a cable are not equal and opposite. This will show up as a phantom leakage current which can be quite large.

Troubleshooting 2Wire Faults

Phantom Earth Leakage cont'

- The symptoms are as follows:
 - The 'leakage current' stays substantially the same if the earth connection is removed from the transformer.
- Resolving the problem:
 - Break the loop (or loops). After breaking, the good half will have nearly full volts on it, the bad substantially less. If in doubt use the load probe or a spare solenoid.

Troubleshooting 2Wire Faults

Field Wiring Check

- Remove the field wires from the controller, connect to the faulting transformer
- Measure the 2Wire path's current with all decoders connected. Does the measured current = the sum of all the decoder standby currents?
- If too high, a faulty decoder, if too low, some decoders disconnected.
- Earth one side then the other of the faultfinding transformer, place clamp meter over the whole cable to measure the total earth leakage. Look for less than the controller manufacturer's quoted maximum figure .

Troubleshooting 2Wire Faults

Field Wiring Check Cont'

- Go to the far end of the 2Wire path, expose its joints and measure the voltage across it, with and without a solenoid load. A volt drop under load of no more than 3 or 4 volts indicates no bad joints in the main 2 wire path.
- Tidy up the exposed joints!
- You may then conclude the whole 2Wire path is good or bad in less than ½ hour!
- Disconnect the transformer, reconnect the controller.

Troubleshooting 2Wire Faults

½ Hour Cable Check

- If the wiring system passes all the above tests, it is safe to reconnect the controller and proceed with a station decoder test.
- For multi 2Wire path controllers, the electrical tests must be repeated for each path. If any test fails, carry out the appropriate faultfinding procedures in the previous sections.
- With low cost test equipment and simple procedures it is usually possible to clear a fault in less than half a day, sometimes just half an hour.

Need Additional Technical Assistance

Call Underhill Technical Support

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Or email

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