Fault Tracing Field Wiring Faults in Almost All Decoder systems

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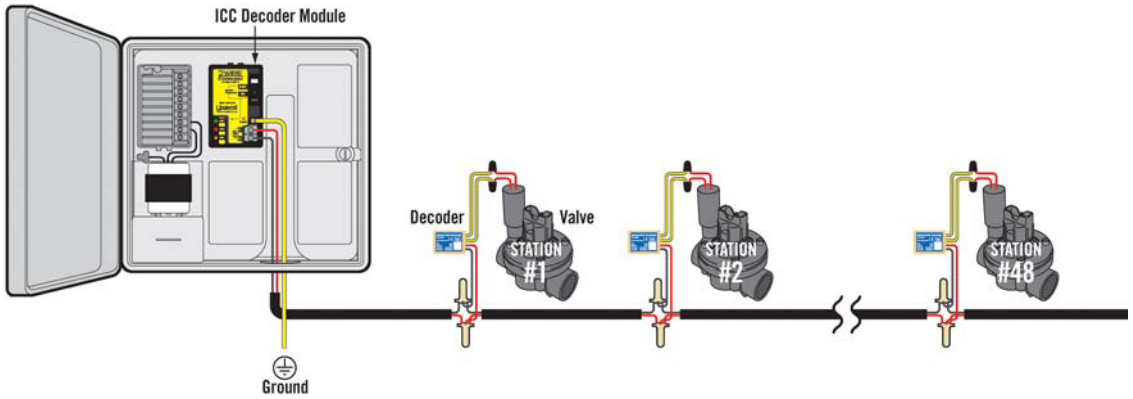
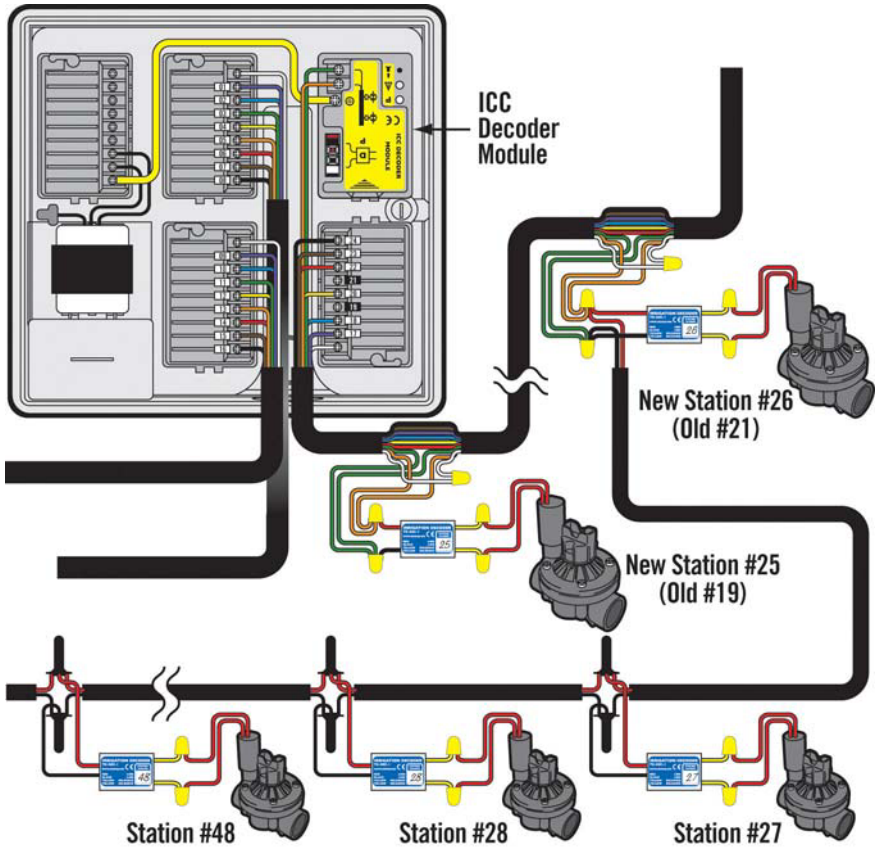
Typical 2 wire decoder system

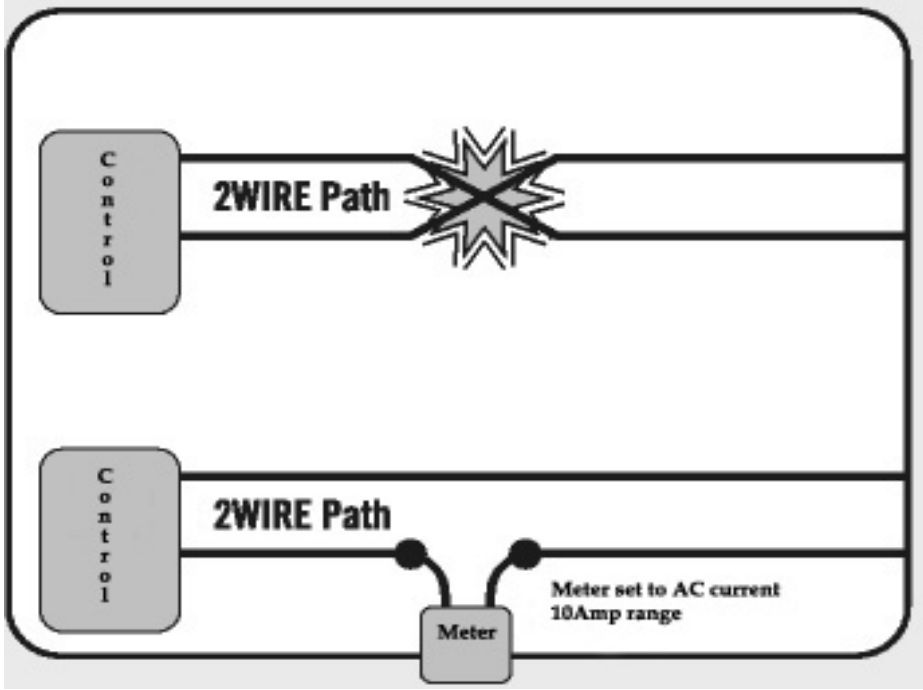


Easy expansion without trenching back to the controller



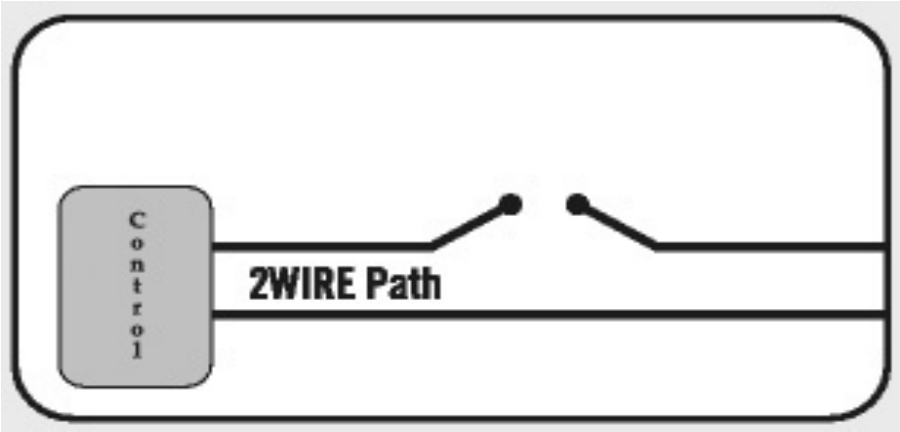
Short circuit on the main 2 wire path

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



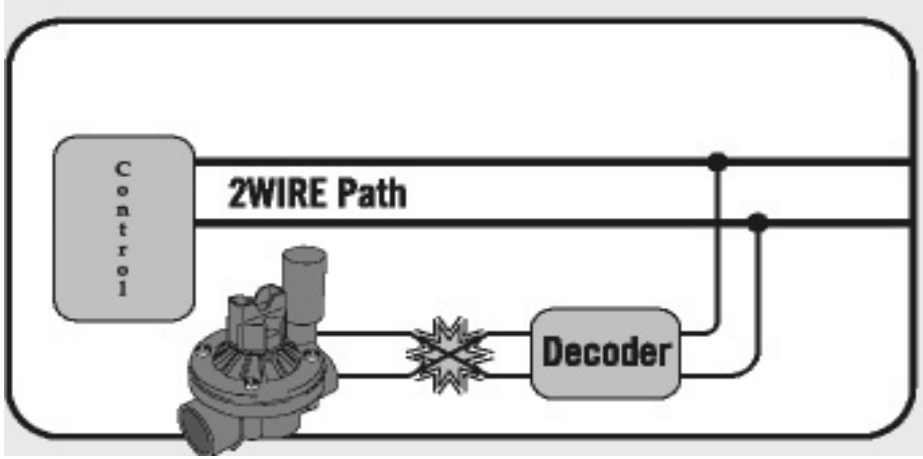
Open circuit in the main 2 wire path

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



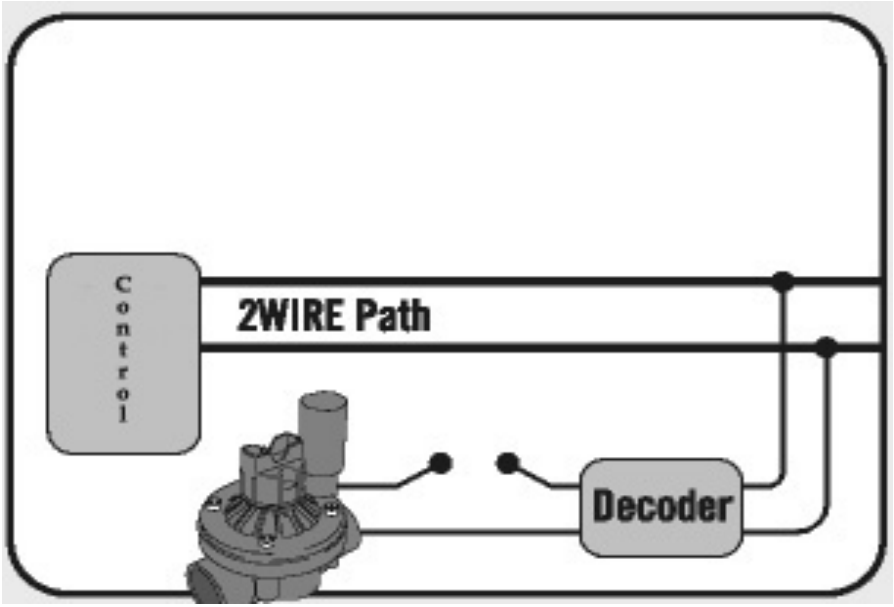
Short circuit solenoid

- Short only shows up when a decoder is operated
- Sometimes stops the system working afterwards due to voltage loss down the main 2 wire path, preventing an off command from reaching the decoder.



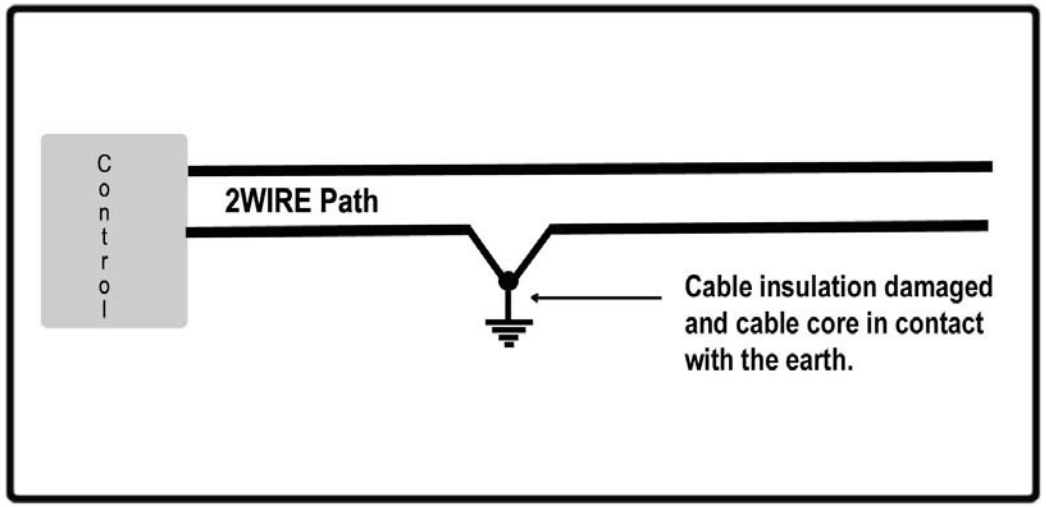
Open circuit solenoid or dead decoder

- Station does not respond
- Can also be a dead decoder



Cable leakage to earth

- When a cable or joint 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.



Current Clamp Multimeter

- Single most important tool the fault-finder can own
- To be of use, must be a ‘leakage’ clamp meter. Ordinary ones not sensitive enough

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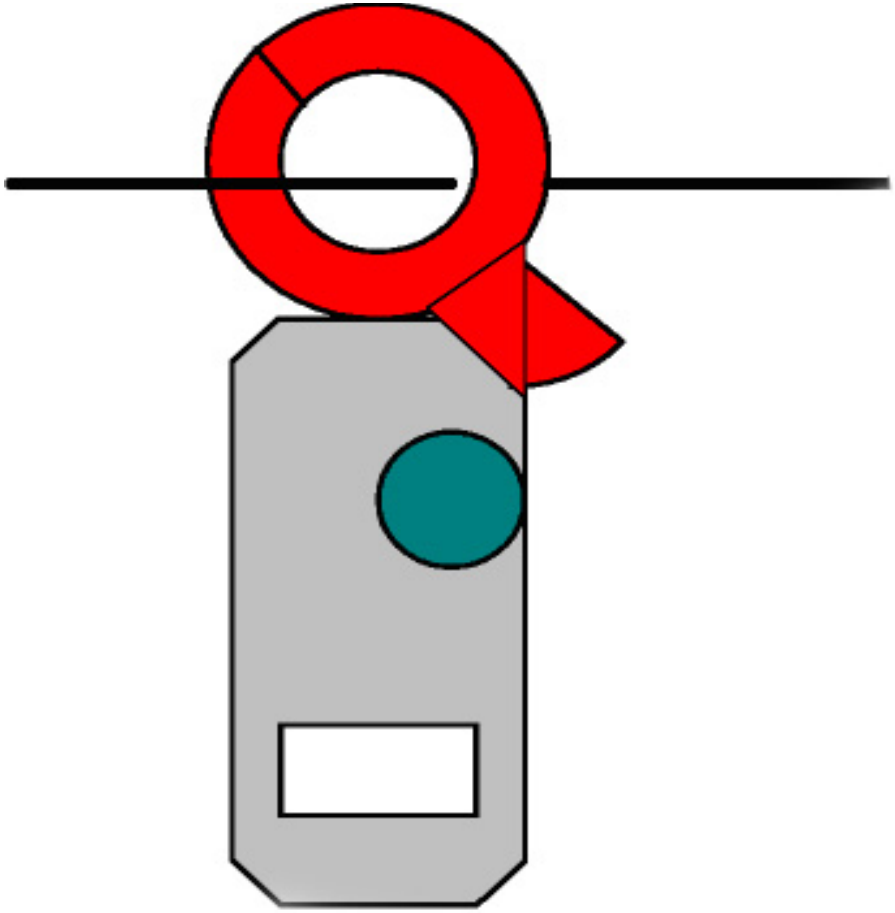
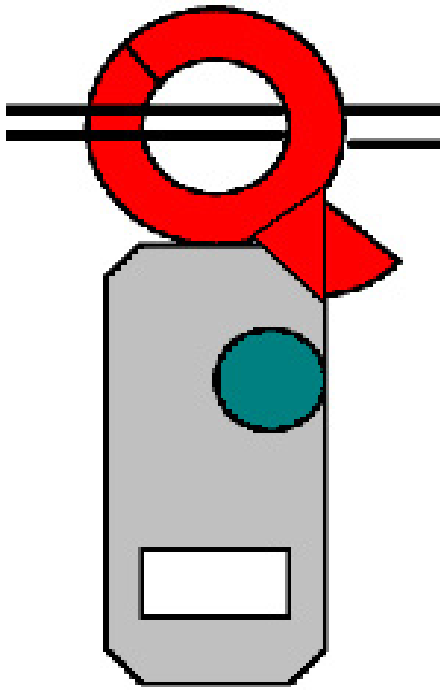
How to measure a current without breaking the wire

- Currents are measured by opening the red jaws by pressing the red trigger with the thumb and clamping the jaws around the wire.



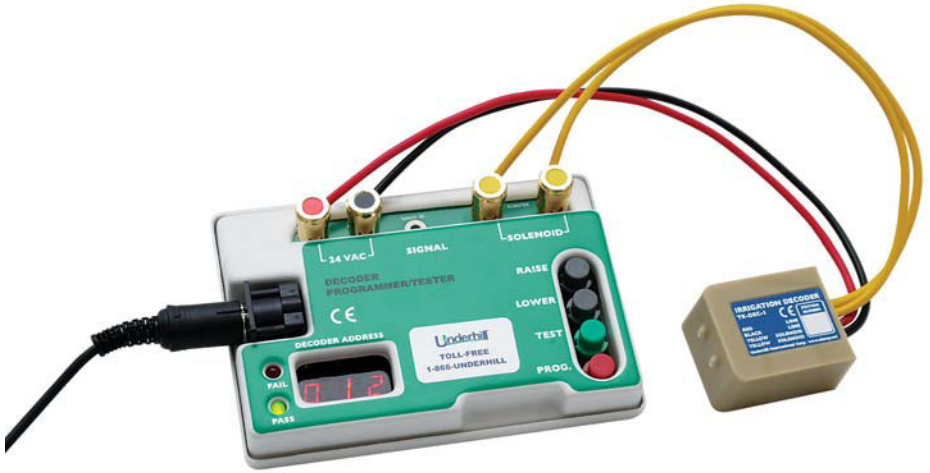
Normally place the clamp around just one of the wires, not both.

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



Testing a decoder

- All decoder manufacturers offer a decoder tester
- The tester may be used to enter the decoder's station number before installation
- To be of use, the tester has to be low cost or not enough will be available for each crew



Fault tracing short circuits

- Most controllers will refuse to power up a 2-wire 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. If at any time, faults are suspected, or the controller behaves erratically, it is best to test the wiring to the decoders using a power transformer (as illustrated) and a current clamp meter.

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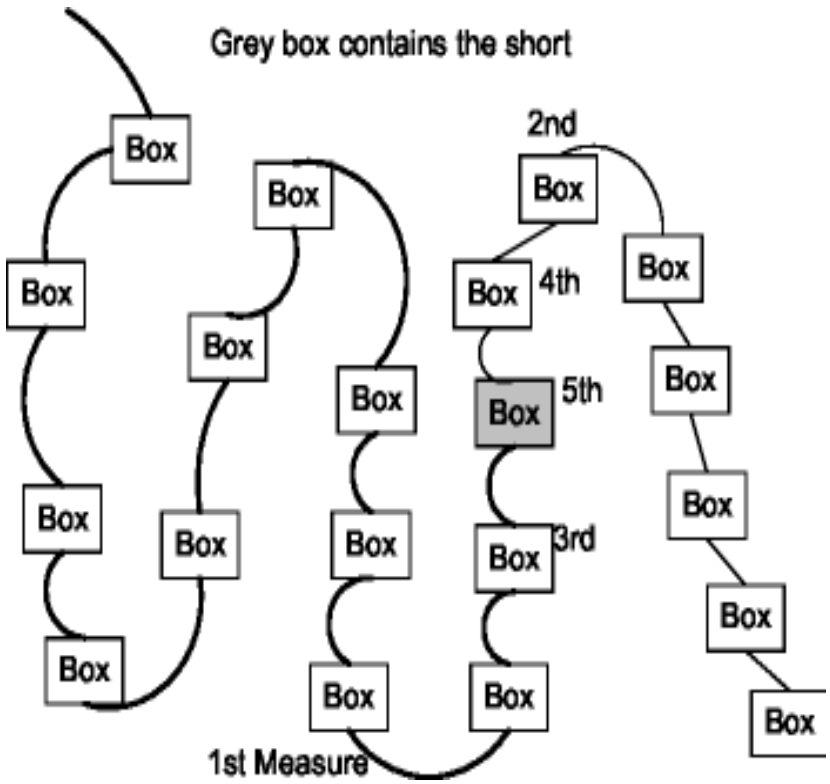
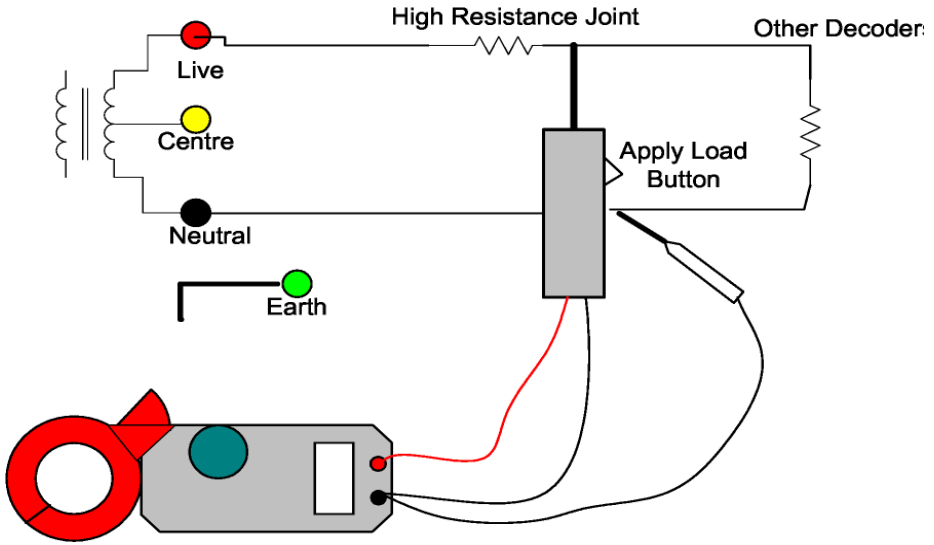
Beyond the short, the current will be much less

- In the figure below, the thick connecting lines 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 current clamp over just one of the 2 wire path wires.



Fault tracing high resistance joints

- Connect the transformer live and neutral to the 2 wire path
- Go halfway down the line, expose the wiring joints
- Measure voltage across the line, with and without a solenoid load
- 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



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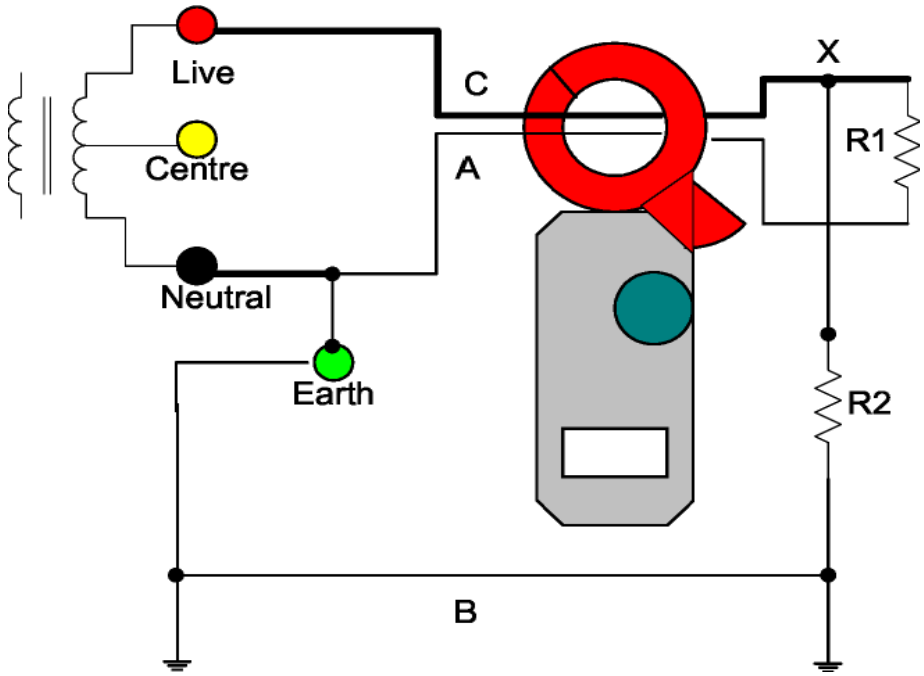
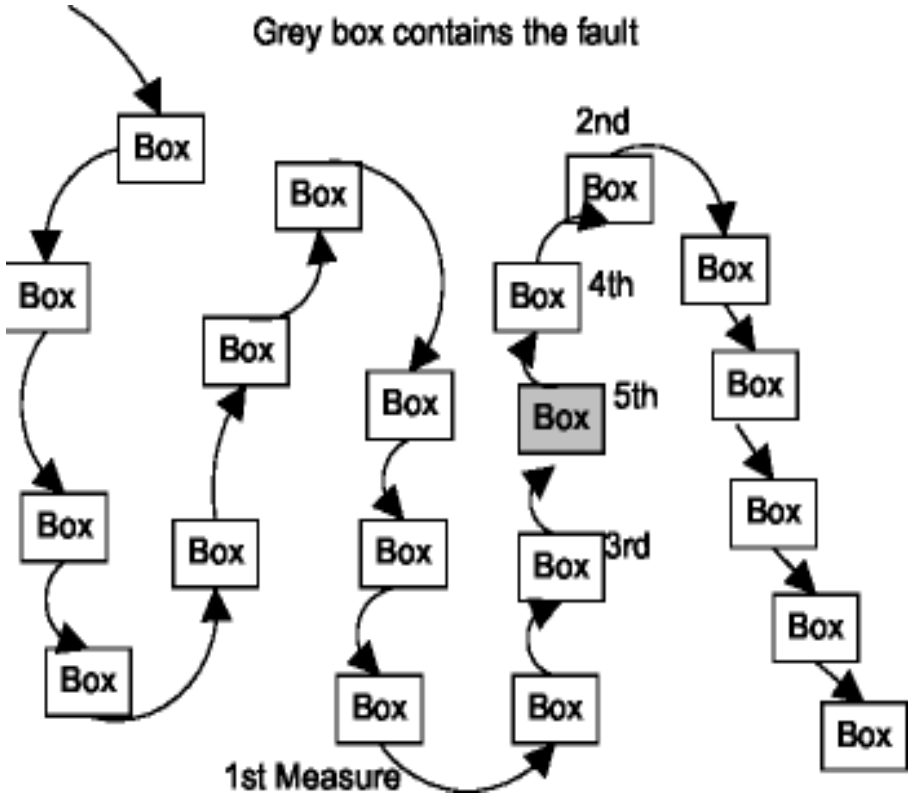
Tracing leakage to earth

- The transformer and the clamp meter can be used to easily find earth leakage. With one side of the transformer 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.



Finding the location of earth leakage

- The ‘halving procedure’ can be used to minimize the number of measurements made to pinpoint the fault.
- In the diagram, the clamp meter will read much lower when past the grey box.



Phantom Earth Leakage

- When placed over the whole field cable, the current clamp 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 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.
- 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.

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The ½ Hour Field Wiring Check

1. Remove the field wires from the controller, connect the transformer instead
2. Measure the 2 wire path's current with all decoders connected. Does the measured current = the sum of all the decoder currents?
3. Earth one side then the other of the transformer, place clamp meter over the whole cable to measure the total earth leakage. Look for less than 30mA.
4. Go to the far end of the 2 wire 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.
5. Tidy up the exposed joints!
6. You may then conclude the whole 2 wire path is good or bad in less than ½ hour!
7. Disconnect the transformer, reconnect the controller.

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Conclusions

- If the wiring system passes all the above tests, it is safe to reconnect the controller and proceed with a station decoder test. Obviously for multi 2 wire 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 these low cost test equipments and simple procedures it is usually possible to clear a fault in less than half a day, sometimes just half an hour.

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