Chapter 6. Troubleshooting from the Controller

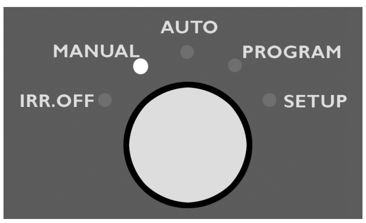
6.1. Running the "Water Test"

The "water test" is a built-in program that will activate all 200 decoders in turn. This way you can walk through the landscape and ensure that all decoders are actually pulling the valves open and water starts flowing.

Procedure 6.1. Running the test program

1. Turn the *mode selector* to MANUAL:

   Figure 6.1. Mode Selector in "Manual"

   Now the display will look like this:

   Figure 6.2. Select program or station in manual mode

2. Push the PROGRAM button, select the Test program (located before program number one) and push the ENTER button.

   Now you'll be prompted for how long each station should be run in the test:

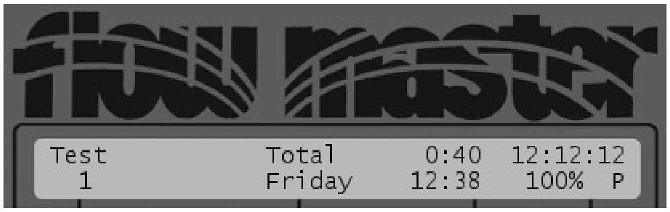
   Figure 6.3. Select station run time in decoder test

3. Use the *item selectors* to set the run time for each station during the test and push the ENTER button.

Now the test program will be scheduled for a run (the TWC NV will only start programs on the top of each minute, so you might have to wait a few seconds for the test to start running   in this case we must wait 48 seconds, and the test will run at 12:13:00):

Figure 6.4. Test program scheduled



4. Once the test starts running, the display will look as when running any other program, showing the remaining run time for the full program and for the currently running station:

Figure 6.5. Test running ok

In this example ST001 has just started running and everything looks OK.

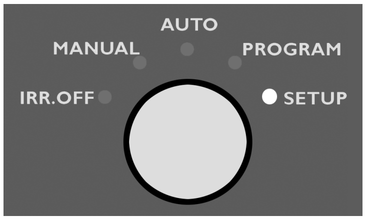
Figure 6.6. Test running, faulty station

An alternative is to run the "Decoder test", which is practically the same thing, except that you move from decoder to decoder manually without the restriction of a fixed run time for each:

Procedure 6.2. Running the decoder test

1. Put the controller in `SETUP` mode:

Figure 6.7. Mode Selector in "Setup"



Now the display will look something like this:

Figure 6.8. Controller in SETUP mode

2. Select 3. Test, then 1. Test of Line Decoders and push the ENTER button.

   Now the display will look like this:

Figure 6.9. Select station run time in decoder test

3. Push the ENTER button to start the test.

   Now you can inspect the valves in the fields one at a time - you simply skip to the next decoder by pushing the ENTER button.

6.2. Testing Programs

The easiest way to test whether a program is running correctly   that is, it activates the correct decoders, master valves and booster pump relays   is to try to run the program manually. Check out Running a program in manual mode [page 38] for instructions on how to do this.

Tip

If you don't want to wait the entire program out just to see that everything activates in the right order, you can decrease the water budget to 1 percent (check Section 4.2.4, “Setting the water budget” [page 29] for instructions) before running the program.

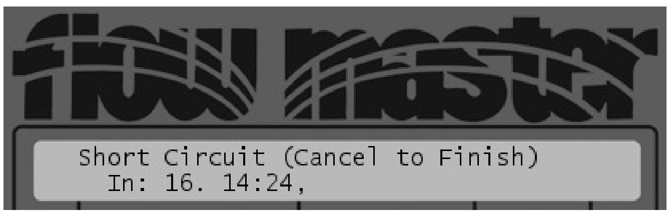
This way you can "follow" the program by walking from decoder to decoder in the terrain as they activate for just one percent of the original run time (at least one minute per decoder).

6.3. Testing the Two-wire Path

When in AUTO or MANUAL mode, the first indication that you might have a short or a fault somewhere on the two-wire path is that the *line activity indicators* (the green and red LEDs on the controller) will flicker, or be not lit at all.

If the TWC NV senses a current leak somewhere, the two-wire path will move to 50Hz mode, meaning that the LEDs will flicker extremely fast . After a while you'll see an indication that a short occurred:

Figure 6.10. Short circuit notice



If the leak is severe (current more than 600-650mA), the LEDs will turn off due to the loss of voltage - this is a built-in security mechanism that prevents the controller from short circuiting However, current will still be running on the two-wire.

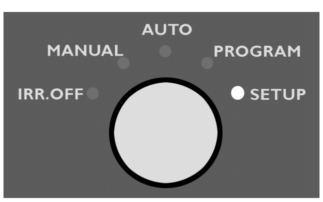
Note

You can make the controller display voltage and current:

Procedure 6.3. Making the controller display voltage/current

1. Put the controller in SETUP mode:

Figure 6.11. Mode Selector in "Setup"



Now the display will look something like this:

Figure 6.12. Controller in SETUP mode

2. Select `3. Test` and push the `ENTER` button.

3. Select `4. Line survey` and push the `ENTER` button.

   Since the line survey was not previously activated, you will see this display with voltage and current readings in the upper right hand corner:

   Figure 6.13. Controller showing line survey data

   Had the line survey been active the controller would have switched back into showing the current time instead.

   Note

   The display will return to showing the time if you power down the controller.

There are two stages of testing the two-wire for shorts: you can run a built-in short test from the controller, and if something seems wrong, you can inspect the two-wire in the field, using a clampmeter.

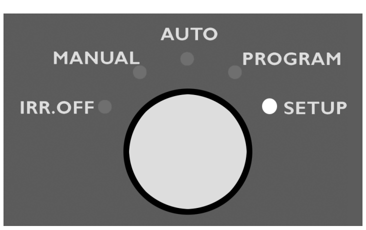
6.3.1. The Built-in Short Test

If you suspect your system to have a short somewhere in the field, you can validate your suspicion by using the built-in short test in the controller. This test won't tell you anything you can't see if you've configured the controller to display voltage and current in the display, but it's the first step in the troubleshooting process:

Procedure 6.4. Running the short test

1. Put the controller in `SETUP` mode:

   Figure 6.14. Mode Selector in "Setup"

   Now the display will look something like this:

Figure 6.15. Controller in SETUP mode

2. Select `3. Test` and push the `ENTER` button.
3. Select `2. Short Finding` and push the `ENTER` button.
4. Inspect the measurements in the display:

   - If the two-wire is ok, the voltage will be relatively high (34-35V), and the current relatively low. In a test setup this is what it looked like:

     Figure 6.16. No short on two-wire path

     The voltage is 35V and the current is 9mA.

     In addition, the *line activity indicator* LEDs will be constantly lit.

   - If there is a short somewhere in the system, the voltage/current relationship is reversed, and you'll see a relatively high current and lower voltage instead:

     Figure 6.17. Short on two-wire path

     Now the voltage is 0V and the current is 229mA   something is causing the system to "eat up" a lot of current.

     In addition, if the voltage is very low, the *line activity indicator* LEDs will both be out.

   - If the voltage is just slightly lower than normal (31-35V) you should consult Table 7.1, “Scenarios with power readings between 31V and 35V” [page 57].)

5. You exit the short finding mode by pushing the `CANCEL` button.

If you find that there's a short in your system, you should try to locate it, using a clampmeter . Check out Section 7.4, “When there is a Short Circuit in the Field” [page 62] instructions on doing this.

Chapter 7. Troubleshooting in the Field

You discover problems with the installation in the field in a number of ways. The following four sections walk you through how to deal with the most frequent scenarios.

7.1. Checking Power and Current Readings

In a healthy system you should see power and current readings for the two-wire path along these lines:

	Idling	**Heavy Usage (many decoders running)**
Power	33-35V	31-34V
Current	0-3mA (no decoders attached)	400-450mA

Tip

See Section 6.3, “Testing the Two-wire Path” [page 50] for instructions on how to do power and current readings in the display of the TWC NV.

To get a more precise idea of how your current reading should be, you should add the standby usage and the usage for any running units, using these rules of thumb:

Standby Usage

When idling, all connected decoders (this includes master valves and booster pumps) will consume around 0.5mA each. This is not an exact number and will vary by 20-30 percent in each direction - it's normal to see idle consumption in the 0.4- 0.65mA range.

So, for example, 20 connected decoders will consume around 8-13mA and 100 units will consume some 40-65mA. Add to this the standby usage of any other devices connected to the two-wire.

Important

These numbers are for regular small decoders with just one valve connection - decoders with four or six valve connections consume around 1mA. If using decoders with several valve connections, remember to adjust for this in the following examples.

Active Decoders

When active, any decoder, controlling a valve, master valve or booster pump, will consume around 15-25mA.

This means that when running just one decoder, a master valve and a booster pump on a system with 100 connected units, you may use around 115-140mA.

Here are a couple of practical scenarios and how to deal with them:

If the power reading is below 25V

The field installation is consuming so much power that the TWC NV has lowered the power on the two-wire, and you should go locate the problem in the field (Section 7.4, “When there is a Short Circuit in the Field” [page 62].)

Note

The current reading can be "normal" in this situation (400-450mA or lower) - this is one of the TWC NV's safety features.

If the power reading is between 25V and 31V
: This is abnormal. The TWC NV will keep running normally, but there's a probability you have a short somewhere   you should go locate the problem in the field (Section 7.4, “When there is a Short Circuit in the Field” [page 62].)

If the power reading is between 31V and 35V when no stations are running
: In this range you must inspect the current to estimate the health of your system.

Table 7.1, “Scenarios with power readings between 31V and 35V” [page 57] tries to give you an idea of whether or not your system is behaving as expected. You calculate the expected current as `0.5mA x <number of decoders>`. Though no decoder consumes exactly 0.5mA, the figures even out the more decoders you have connected to your system.

Important

Troubleshooting is not an exact science and this is not matrix for exactly determining the health of your system. This table can help point you in the right direction though.

Important

These numbers are for regular small decoders with just one valve connection - decoders with four or six valve connections consume around 1mA. If using decoders with several valve connections, remember to adjust for this in the following examples.

Table 7.1. Scenarios with power readings between 31V and 35V

Current	Current could be in these ranges depending on the number of connected stations:					State
	20	**40**	**60**	**80**	**100**	
Low current (Less than -15%)	< 9mA	< 17mA	< 25mA	< 34mA	< 42mA	It is possible that one or more decoders are not connected correctly. Try running the test program (See).
Normal current (-15% - +20%)	9-12mA	17-24mA	25-36mA	34-48mA	42-60mA	Everything is fine the system is looking healthy.
High current (+20% - +50%)	12-15mA	24-30mA	36-45mA	48-60mA	60-75mA	You might have a problem somewhere on the two-wire causing an excess consumption. This is no more than the TWC NV can handle, but you could be looking at problems that dramatically increase under more moist conditions see Section 7.1.1, “Problems on the Two-wire” [page 57].
Excessive current (More than +50%)	> 15mA	> 30mA	> 45mA	> 60mA	> 75mA	This is a risky situation that can interfere with the functionality of the TWC NV, and you should locate the problem in the field right away. It will typically be a bad connection or a cable left open-ended in the field. Troubleshooting is identical to when locating short circuits in the field (Section 7.4, “When there is a Short Circuit in the Field” [page 62]), but the current will not be as excessive as when a short occurs.

7.1.1. Problems on the Two-wire

It only takes seemingly innocent cracks in the cable insulation or connections to cause big problems: If you remove the insulation on just 1/3 of an inch on a AWG14 cable (both wires) and immerse the cable in water the current can increase by 30mA. If you immerse into salt water the current increases by as much as 170mA.

Obviously this means that just a handful of minor cracks in the insulation can add up to a substantial increase in the current reading, and the problem in detecting these kinds of problems is that they seem to come and go, depending on how moist the soil is.

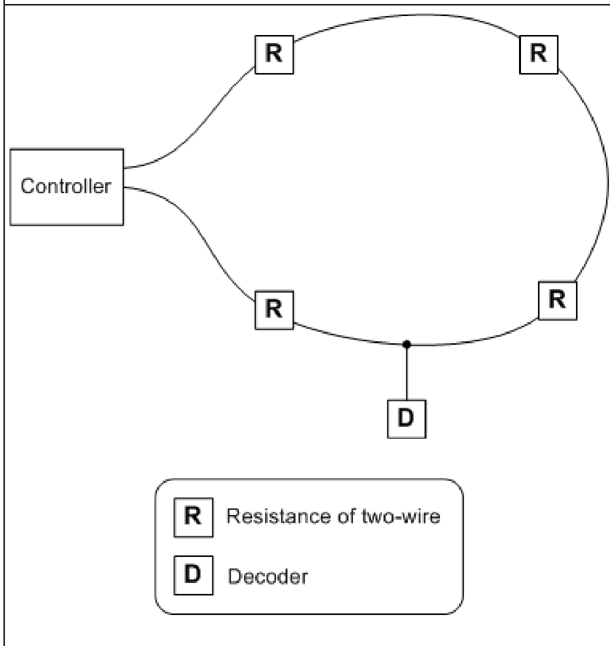
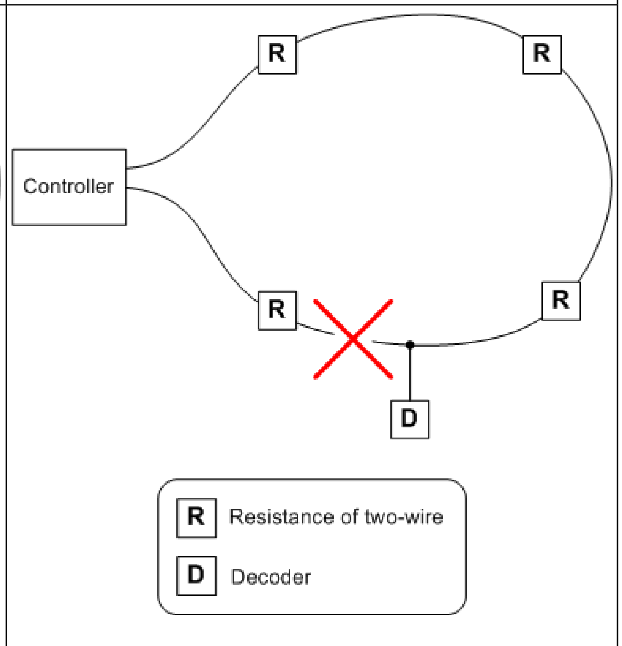
7.2. Dealing with Unstable Decoders

If a decoder seems to fail randomly, typical reasons include:

- The faulty decoder is not connected and placed in the field.
- There are leaks in the insulation on your two-wire - when the soil is dry everything works just fine, but when it gets more moist, decoders seem to fall out randomly. See the previous section (Section 7.1, “Checking Power and Current Readings” [page 55]) for more details.
- In case you have a loop installation, problems may occur if the loop is broken, as the resistance between a decoder and the TWC NV can increase, pushing up the power consumption:

Note

We do not recommend using loop installations since troubleshooting these can be a complex process.

Normal Loop	**Loop Broken**
	
The resistance between the decoder and the TWC NV is 0.75*R	The resistance between the decoder and the TWC NV is 3*R

To find out whether your loop is broken, follow this procedure:

1. Open the loop in one end   if the loop goes all the way back to the TWC NV, just detach one of the two-wires on the controller.
2. Perform an "electrical test" as described in ???. This will activate each in turn   if you see decoders failing, chances are that they are on a stretch of the two-wire that has been orphaned by a break of the loop in the field.
3. If everything is still OK, close the loop and open it in the other (detach the opposite two-wire of the one you just tried) end and re-run the test.

If the same decoders keep failing, you should look at the instructions in the following section, Section 7.3, “Dealing with Failing Decoders” [page 59].

7.3. Dealing with Failing Decoders

More often than not, what seems to be a faulty decoder is really a problem on the two-wire between the decoder and the TWC NV, since this is the most vulnerable part of your system.

The approach to troubleshooting failing decoders vary a bit depending on whether you just have one, or several failures   the following two sections talk about each scenario.

7.3.1. A Single Decoder Fails

If the failing decoder has just been installed, did you remember to enter the right address for it? See Section 4.1, “Configuring field decoders” [page 19] for instructions.

If the failing decoder has been known to work, perform the electrical test (???) on the decoder in question and follow these guidelines:

If there's little or no reaction from the decoder	1. Put the TWC NV in "Short Mode" (see Section 6.3.1, “The Built-in Short Test” [page 51]), go to the decoder in the field and perform these tests: • Check wires and connections between the two-wire, the decoder and the solenoid (See Figure 7.1, “Checking Connections” [page 60].) • Short circuit the two-wire at the decoder and use a clampmeter to check if power is still OK - if this is the case, the problem is in the decoder or solenoid, and not on the two-wire between the decoder and the TWC NV (See Figure 7.2, “Testing the path to a decoder” [page 60].) • Detach the solenoid and measure the resistance of the solenoid itself. Compare this to another solenoid of the same type (the resistance is typically 20-60 ohms.) If the resistance is significantly higher, try replacing it. **Note** Some solenoids come with a diode on one of the wires. This is to indicate that the solenoid is polarized and the connection of the wires to the solenoid is significant. Thus you can try to swap the two wires around and see if it makes a difference.

	Others will have red and black wires, indicating the polarity black is minus, red is plus.
If the decoder fails with to high power reading	• Check the two-wire between the solenoid and the decoder for cracks in the insulation or bad connections. • Detach the solenoid from the decoder and measure the resistance of the solenoid itself. If the resistance less than expected, it might be damaged by lightning or it might have a leak. Try replacing the solenoid.

Figure 7.1. Checking Connections

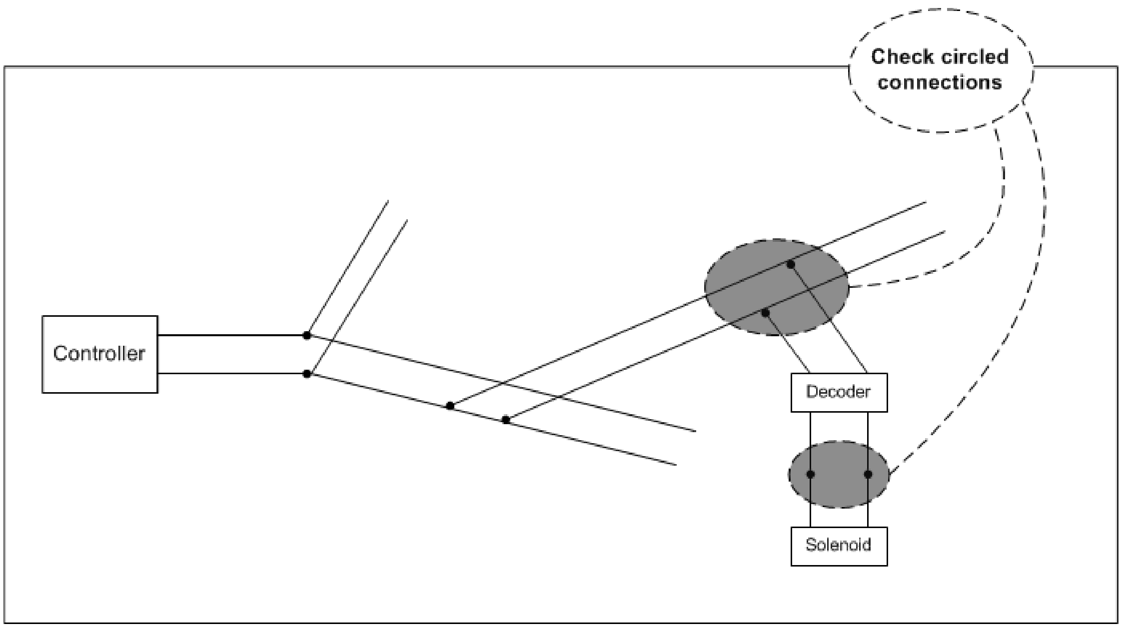
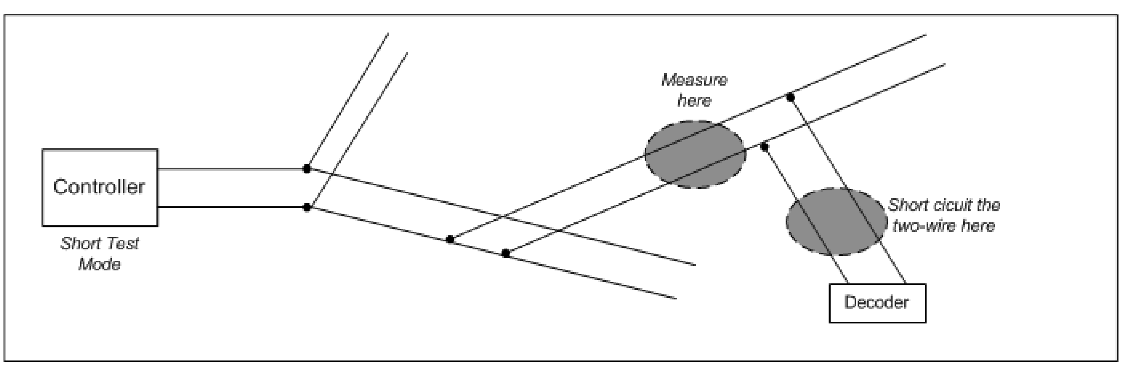


Figure 7.2. Testing the path to a decoder



7.3.2. Several Decoders Fail

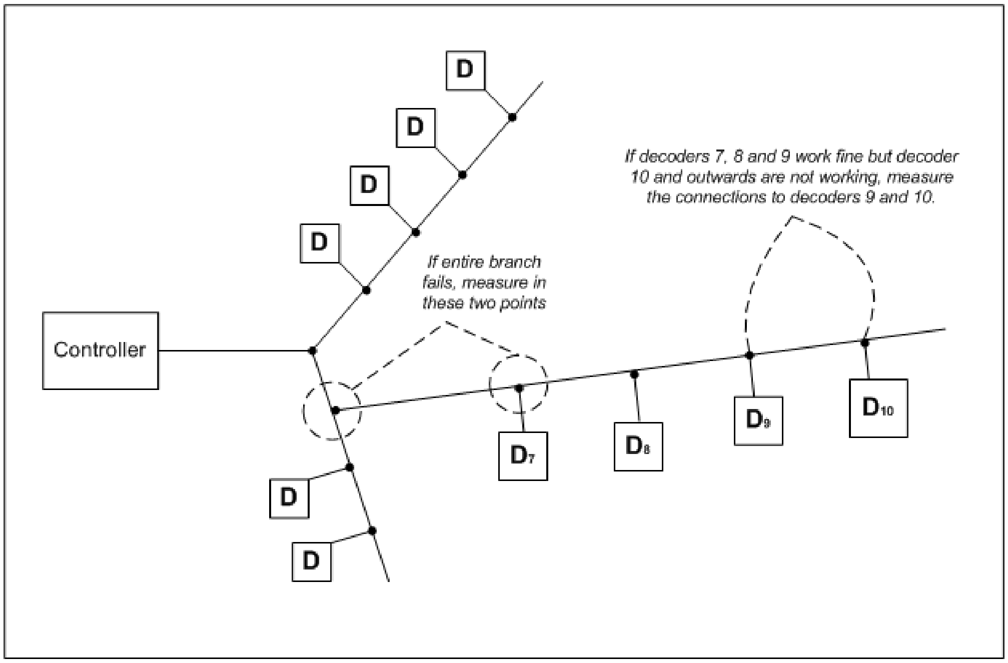
Here is a checklist if multiple decoders fail:

- If two decoders have identical addresses (this can happen if you have decoders from different factory batches, since each batch gets addresses assigned from a fixed number range,) you can get a rather confusing behavior in the system. Imagine the following scenario:
  - We consider two decoders, **M** and **N**.
  - You have configured decoder **M** to have the ID "ST20".
  - Decoder **N** should have been called "ST21", but by mistake you configured this to be "ST20" as well.

When you:	The following happens:	Because:
Try to activate "ST20"	**M** and/or **N** might fail to open.	Since both decoders think they're "ST20", they'll both try to open. If you're lucky, there's enough current on the two-wire to pull open both, but depending on the current and the resistance in the solenoids, one or both can fail to open.
Try to activate "ST21"	Both **M** and **N** fail to open.	None of the decoders react to "ST21" since they both think they are "ST20."

- If you're dealing with a new installation, and the failing decoders seem to be spread randomly in the field, you could be looking at solenoids with built-in diodes - on this type of solenoid it is significant which one of the wires in the cables are connected to what (see Section 7.3.1, “A Single Decoder Fails” [page 59] for more details.)
- If the failing decoders are located on the same dead end branch of your two-wire, chances are that the connection to the branch is faulty. If all decoders from a point on a branch and outwards fail (decoders 9 and 10 in the illustration below), measure the connection to each decoder until you reach the point of failure.

Figure 7.3. Checking a branch



If all connections seem ok, the two-wire itself might be damaged - things to look for along the two-wire:

- Any signs of digging in the ground? Wild animals and staff under equal suspicion here.
- Has any other kind of machinery been at work and unknowingly penetrated the two-wire?
- Check all transitions where the cable runs from underground to over ground, from soil to pipes etc.

Important

If you replace a stretch of the two-wire, make sure to remove the old part completely, as the old piece of cable might interfere with the current in the new cable.

7.4. When there is a Short Circuit in the Field

A "clean" short circuit in the field   direct connection between the two wires in the two-wire path with zero Ohms resistance - will cause the TWC NV to put up the following warning:

Figure 7.4. Short circuit notice

Note

In addition to this warning, you'll see that the *line activity indicator* is constantly lit instead of blinking as it normally does. If the short is very severe the *line activity indicator* may stop working all together (Check out Figure 3.3, “Controls on the TWC NV front plate” [page 14] if you don't remember what the *line activity indicator* is.)

But you can't always be sure that the TWC NV will be able to detect a short circuit in the field if the short is in the far end of the cabling, the controller may just experience it as heavy usage. However, the current reading will always reveal a short as the current will be significantly higher than normal (Could exceed the expected value with 100mA or more.)

Typically a short circuit in the field is either a problem with the two-wire itself (cracks in the insulation, bad connections etc.) or consequences of lightning striking the system, damaging decoders, solenoids or other electronics attached to the two-wire.

7.4.1. Using a Clampmeter

In order to use a clampmeter, you need physical access to the individual wires in your two-wire cable - just measuring on the entire two-wire will not work.

Procedure 7.1. Using a clampmeter for short finding

1. Follow the first two steps of Running the short test [page 51] and select "Clampmeter (50/60Hz)."
2. Set the clampmeter to "50 Hz mode" or equivalent. Setting it to "Wide Range" or similar modes might not work out.
3. Now start measuring the two-wire from the controller and out. You measure the two-wire by placing the clampmeter around one of the wires in the two-wire path. When the measurement on the clampmeter is substantially lower than what you see in the controller display, you've passed the point of the short.

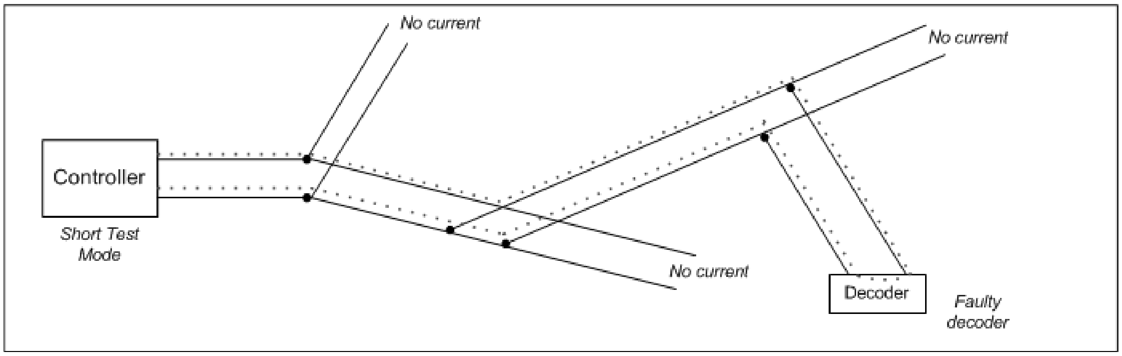
7.4.2. Locating the Short

Before trying to locate the short in your system, make sure you have the following:

- A clampmeter.
- An "as-built" drawing (or equivalent knowledge) of the cable layout for the two-wire path. Notably you need to know of all branches and loops.

The overall rule of thumb when looking for a short is that the current will move from the controller directly to the short and back. This means that you can **"follow the current"** and eventually be led to the short:

Figure 7.5. Faulty decoder



Note

If your installation loops back to the TWC NV you must open the loop, or you won't know which way the current is running around the loop and troubleshooting will be almost impossible.

Note

We do not recommend using loop installations since troubleshooting these can be a complex process.

Troubleshooting falls into three phases and the following three procedures explain how you should go about locating the problem. Walking through each procedure in turn should ensure efficient troubleshooting: Phase I: Checking for Problems at the Controller [page 64], Phase II: Locating a Faulty Branch in the Field [page 65], and Phase III: Performing a "Binary Search" on a Faulty Branch [page 66].

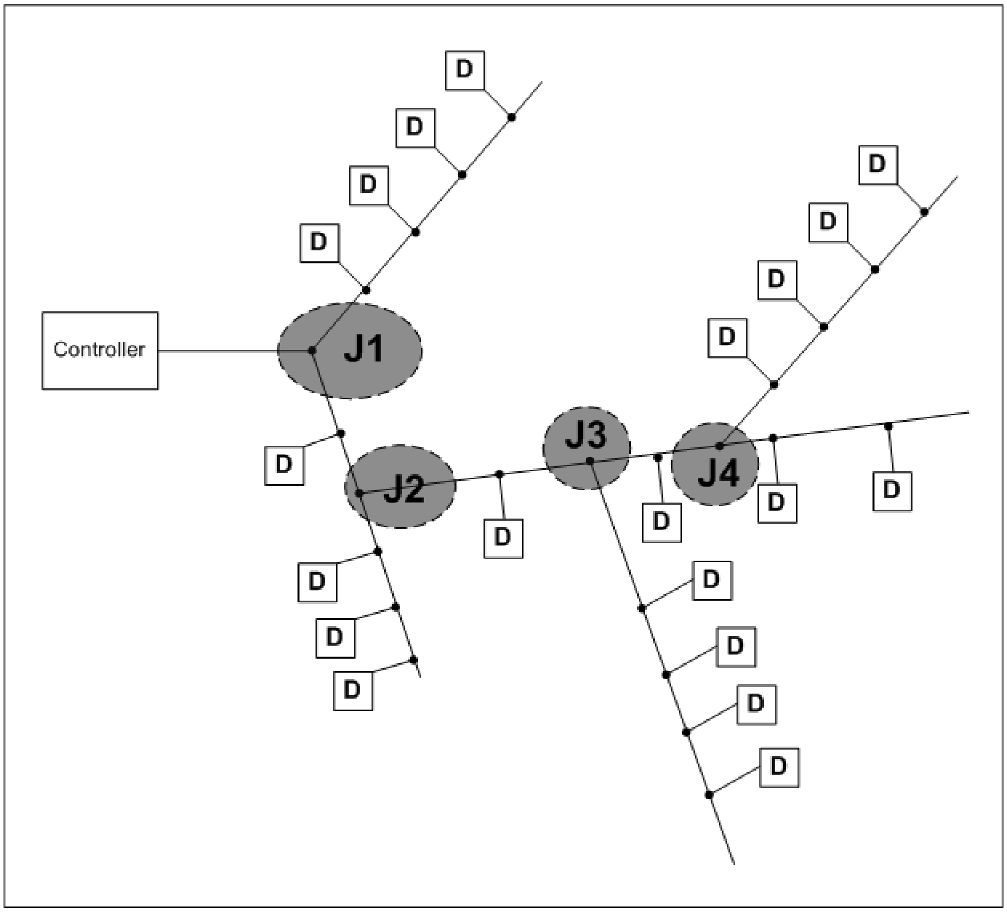
Procedure 7.2. Phase I: Checking for Problems at the Controller

1. Measure the current at the point where the two-wire path is connected to the controller. Measure on both wires in the two-wire path. Note down your readings as you'll use these for comparison if you need to locate a faulty branch in the field (Phase II: Locating a Faulty Branch in the Field [page 65].)

   - If one of the cables connected to the TWC NV loops back to the controller, you must open the loop before measuring.
   - If more than one non-looped cable is connected to the TWC NV, you can already now determine which cable holds the short - it will be the one with the highest current reading.
   - If more than one non-looped cable seem to hold a short, detach all of them and connect and fix one cable at a time.
   - If there is a significant difference between the reading on the two wires in a two-wire, the one wire might have a leak to earth or to the chassis of the TWC NV.

2. If all readings in the previous step seem OK, or maybe even a bit lower than expected, you could be looking at at error in the controller itself. To find out if this is the case, detach all two-wire paths connected to the controller and check the power and current reading: If it is around 32-35V and 0-3mA the controller is OK - otherwise it is defect.

Procedure 7.3. Phase II: Locating a Faulty Branch in the Field



1. Measure in Junction 1 (J1.)

   - If you get no readings from either branch, the problem is on the part of the two-wire leading back to the TWC NV - perform a binary search on this part of the cable (See Phase III: Performing a "Binary Search" on a Faulty Branch [page 66] for instructions.)

   - If your readings on one of the branches are the same as when measuring at the controller (This is the first thing you do when troubleshooting the two-wire   see instructions in Phase I: Checking for Problems at the Controller [page 64]) you move on further out one branch at a time, measuring in every fork you meet (J2, J3, J4 etc.) until you locate the faulty branch.

   ### Important

   If you reach a branch that is looped back to the two-wire elsewhere, make sure to open the loop before measuring, or you won't detect the faulty branch.

   - If you have a decoder attached to the junction itself, make sure you measure on that as well, as the decoder and not the two-wire could be the problem.

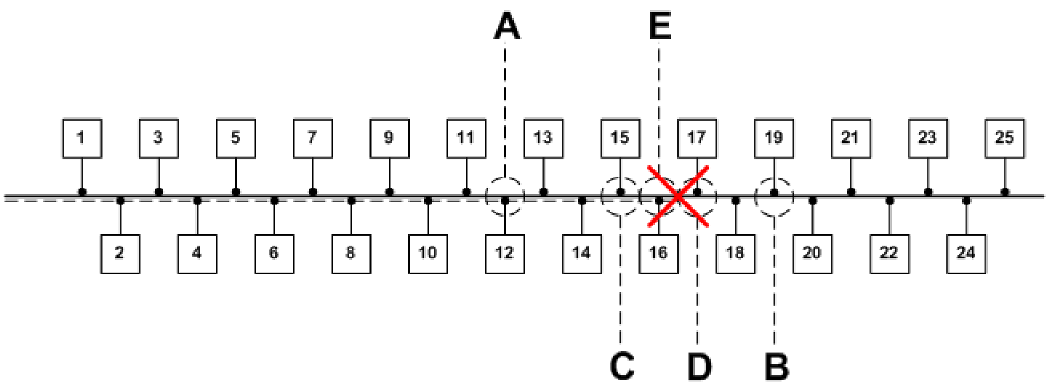
   - If you get readings on both branches after the junction but they are significantly lower than at the controller, you have problems on the two-wire on both the stretch from the controller to the junction, and further out as well. Detach the junction and start by finding the problem on the stretch from the controller - then attach the junction again and work on each branch.

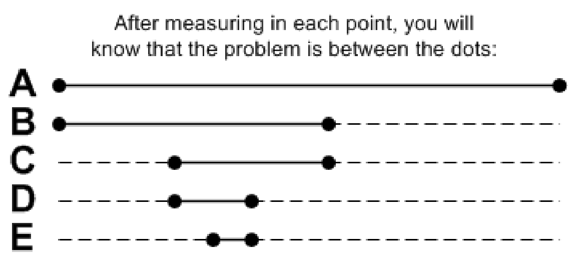
2. When you locate the faulty branch, move on and perform a binary search on the branch as explained in Phase III: Performing a "Binary Search" on a Faulty Branch [page 66].

Procedure 7.4. Phase III: Performing a "Binary Search" on a Faulty Branch

A binary search can help you locate a problem on the two-wire in a structured manner. The concept of a binary search is this: Find a point on the cable where you know for sure current is running. Find another point where there is little or no current. Now measure in the middle between these two points. If you measure current in the middle, you know for sure that there is no problem between the middle and the point where you know current is running - the problem must be in the other half, and you can now repeat this approach at the other half.

Looking at the graphic below we imagine that current is running at decoder 1, but no current is running at decoder 25. To start the binary search we measure in the middle, at point A:





1. You measure in point A and find that the current is running. Now you know that the problem is somewhere between decoder 12 and 25.

2. You measure in point B and find no current. This means that you're in the "dead" half of the cable   the problem is somewhere between decoder 12 and 19.

3. You measure in point C and find that the current is running. The problem must be between decoder 15 and 19.

4. You find no current in point D   the problem is narrowed down to between decoder 15 and 17   just one more reading will tell you for sure where the problem is.

5. Since you find the current in E to be OK, the problem must be between decoder 16 and 17.

6. If you don't want to replace the entire cable between decoders 16 and 17 (it might be a longer stretch,) you can perform a new binary search on the cable itself, using a clampmeter.