Chapter 8. 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.

8.1. 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 stations running)**
Power	33-35V	31-34V
Current	0-3mA (no stations attached)	600-650mA

Tip

See Section 7.4, “Testing the Two-wire Path” [60] for instructions on how to do power and current readings in the display of the RKD.

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 stations (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 stations 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.

Active Stations

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

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

Note

These numbers are valid for an running with normal power settings - if you change the power settings as described in Section 7.5, “Increasing Station Power” [63], the numbers will change - the higher power settings, the higher current readings.

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 RKD has lowered the power on the two-wire, and you should go locate the problem in the field (Section 8.4, “When there is a Short Circuit in the Field” [75].)

Note

The current reading can be "normal" in this situation (600-650mA or lower) - this is one of the RKD's safety features.

If the power reading is between 25V and 31V
: This is abnormal. The RKD will keep running normally, but there's a probability you have a short somewhere - you should go locate the problem in the field (Section 8.4, “When there is a Short Circuit in the Field” [75].)

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 8.1, “Scenarios with power readings between 31V and 35V” [69] 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 stations>`. Though no station consumes exactly 0.5mA, the figures even out the more stations 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.

Table 8.1. 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 stations are not connected correctly. Try running the test program (See Section 7.1.1, “Running the "Electrical Test"” [57]).
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 RKD can handle, but you could be looking at problems that dramatically increase under more moist conditions - see Section 8.1.1, “Problems on the Two-wire” [69].
Excessive current (More than +50%)	> 15mA	> 30mA	> 45mA	> 60mA	> 75mA	This is a risky situation that can interfere with the functionality of the RKD, 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 8.4, “When there is a Short Circuit in the Field” [75]), but the current will not be as excessive as when a short occurs.

8.1.1. 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.

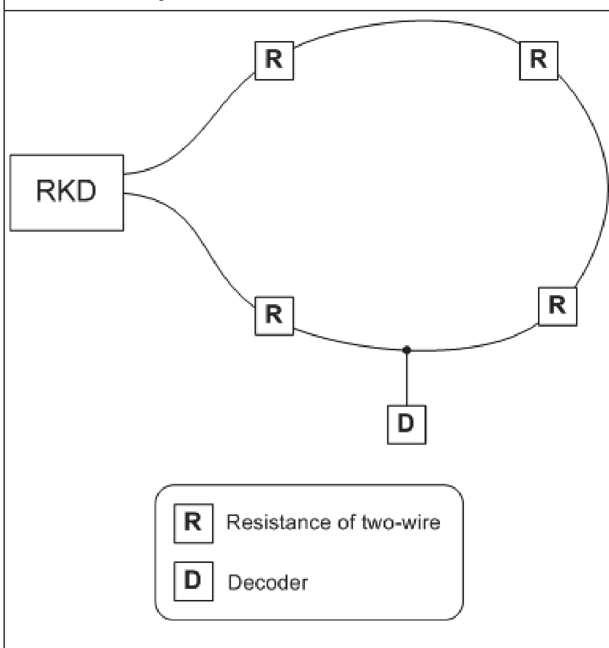
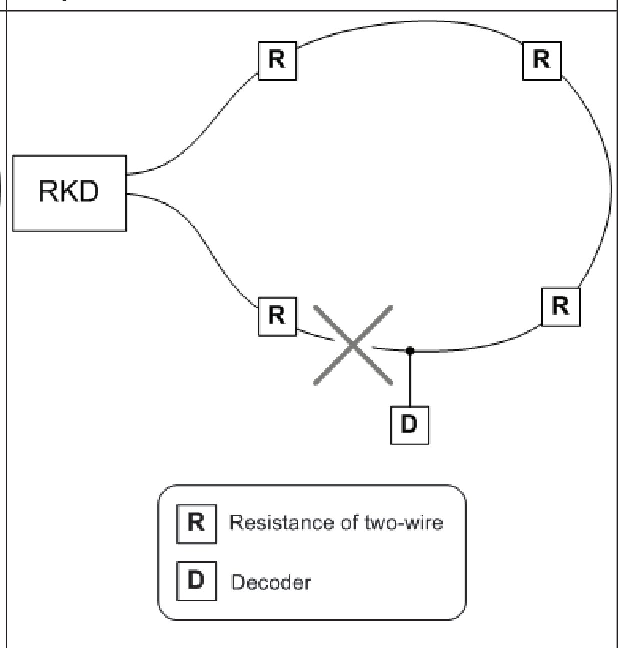
8.2. Dealing with Unstable Stations

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

- The faulty station is not connected and placed in the field according to the instructions in ???.
- You have increased the power used to activate stations (see Section 7.5, “Increasing Station Power” [63].) This means that you need to lower the number of simultaneously running station, or all stations might not work as intended, giving a seemingly random problem depending on which schedule you are running.
- 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, stations seem to fall out randomly. See the previous section (Section 8.1, “Checking Power and Current Readings” [67]) for more details.
- In case you have a loop installation, problems may occur if the loop is broken, as the resistance between a station and the RKD can increase, pushing up the power consumption:

Note

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

<table>
<tr><th>Normal Loop</th><th>Loop Broken</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><td>The resistance between the station and the RKD is 0.75*R</td><td>The resistance between the station and the RKD is 3*R</td></tr>
</table>

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 RKD, just detach one of the two-wires on the controller.

2. Perform an "electrical test" as described in Section 7.1.1, “Running the "Electrical Test"” [57]. This will activate each in turn - if you see stations 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 stations keep failing, you should look at the instructions in the following section, Section 8.3, “Dealing with Failing Stations” [71].

8.3. Dealing with Failing Stations

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

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

8.3.1. A Single Station Fails

If the failing station has just been installed, did you remember to assign an ID to it? See Section 5.2, “Configuring Stations” [23] for instructions.

If the failing station has been known to work, perform the electrical test (Section 7.1.1, “Running the "Electrical Test"” [57]) on the station in question and follow these guidelines:

If there's little or no reaction from the station	1. Put the RKD in "Short Mode" (see Section 7.4.1, “The Built-in Short Test” [62]), go to the station in the field and perform these tests: • Check wires and connections between the two-wire, the station and the solenoid (See Figure 8.1, “Checking Connections” [73].) • Short circuit the two-wire at the station and use either the Current Tracker or a clampmeter to check if power is still OK - if this is the case, the problem is in the station or solenoid, and not on the two-wire between the station and the RKD (See Figure 8.2, “Testing the path to a station” [73].) • 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. • Take the station to the controller and perform a direct test before replacing it (see Section 5.2.1, “Testing a Station” [26] for instructions.)
If the station fails with to high power reading	• Check the two-wire between the solenoid and the station for cracks in the insulation or bad connections. • Detach the solenoid from the station 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. • Take the station to the controller and perform a direct test before replacing it (see Section 5.2.1, “Testing a Station” [26] for instructions.)

Figure 8.1. Checking Connections

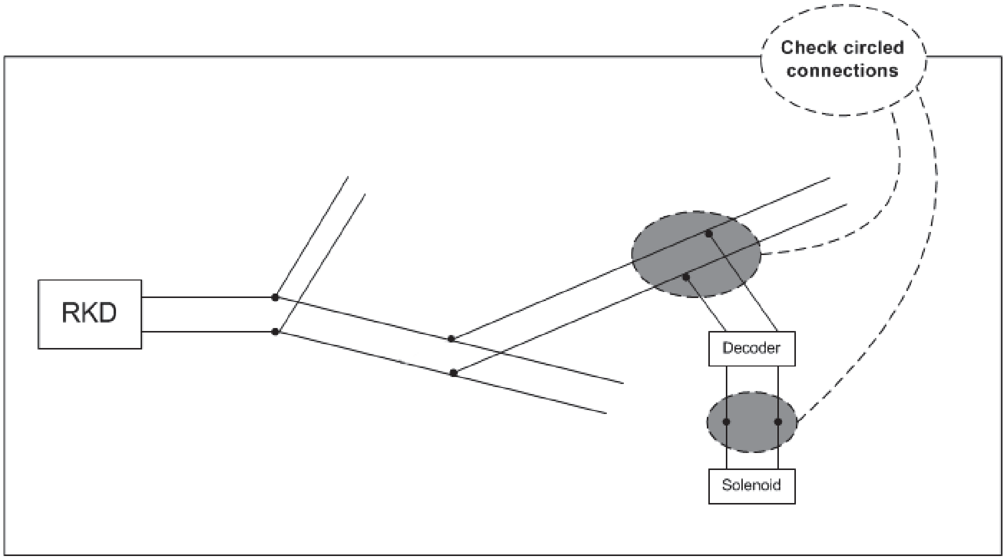
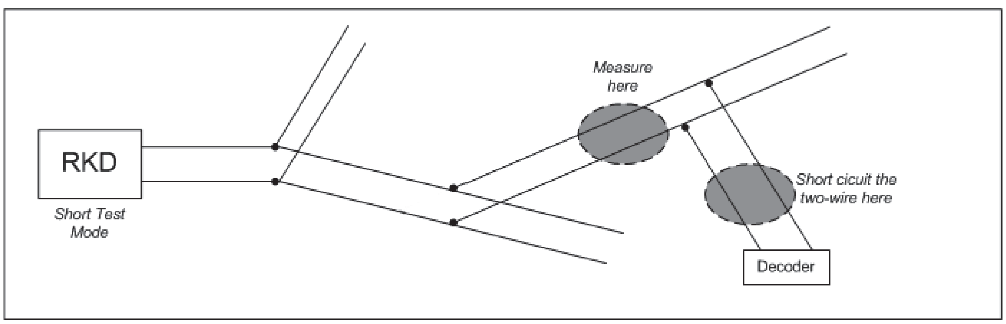


Figure 8.2. Testing the path to a station



8.3.2. Several Stations Fail

Here is a checklist if multiple stations fail:

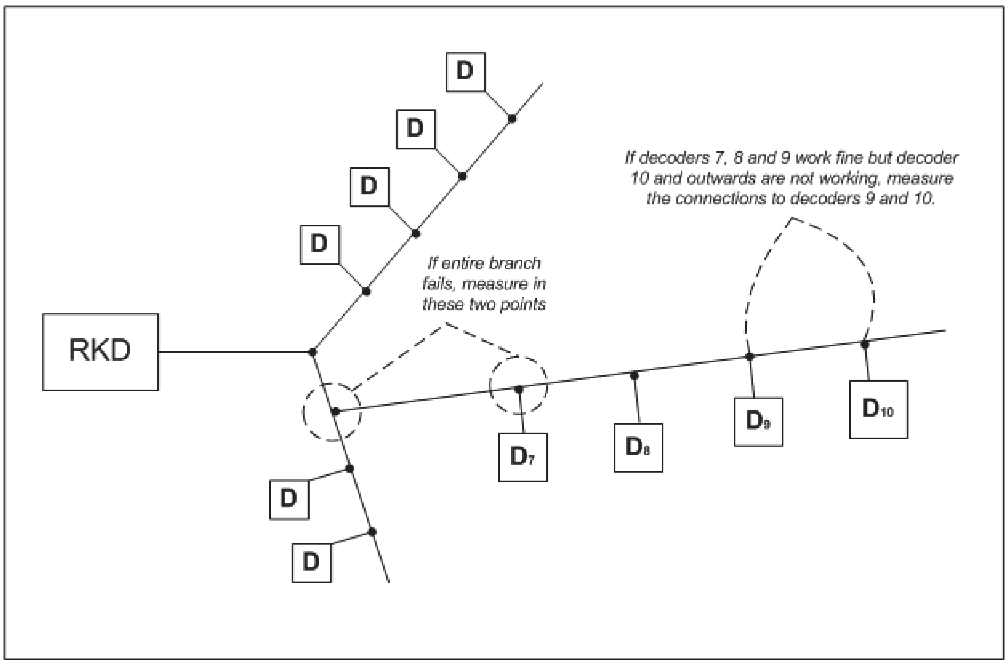
- If two stations are configured with identical IDs (see Section 5.2, “Configuring Stations” [23],) you can get a rather confusing behavior in the system. Imagine the following scenario:
  - We consider two stations, **M** and **N**.
  - You have configured station **M** to have the ID "ST20".
  - Station **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 stations 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

When you:	The following happens:	Because:
		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 stations react to "ST21" since they both think they are "ST20."

- If you're dealing with a new installation, and the failing stations 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 8.3.1, "A Single Station Fails" [71] for more details.)
- If the failing stations are located on the same dead end branch of your two-wire, chances are that the connection to the branch is faulty. If all stations from a point on a branch and outwards fail (stations 9 and 10 in the illustration below), measure the connection to each station until you reach the point of failure.

Figure 8.3. 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.

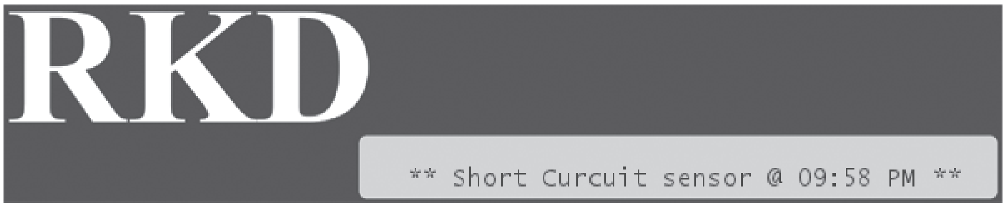
Important

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.

8.4. 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 RKD to put up the following warning:

Figure 8.4. Short 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 4.3, “Controls on the RKD front plate” [17] if you don't remember what the *line activity indicator* is.)

But you can't always be sure that the RKD 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 stations, solenoids or other electronics attached to the two-wire.

Either way, you will need a Current Tracker (purchased separately), or a regular clampmeter (current leakage meter). Both are good troubleshooting tools but have different strengths and weaknesses:

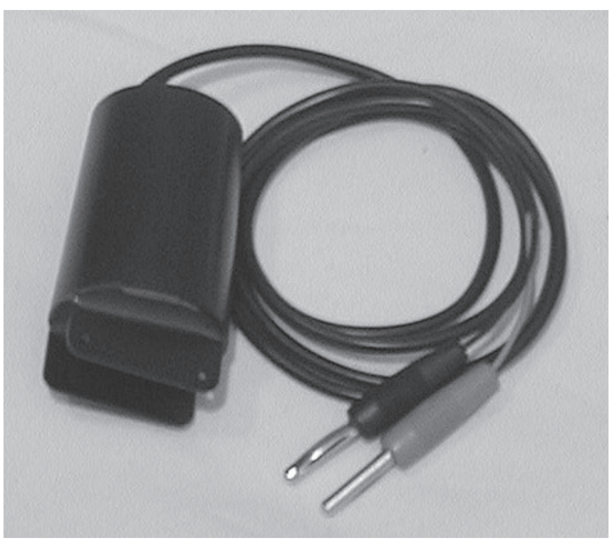
	Strengths	**Weaknesses**
Current Tracker	• Can measure around the entire two-wire path or individual wires in the cable • Very sensitive when measuring individual wires	• Requires an additional voltmeter (a cheap piece of hardware, though) • No direct association between readings on the controller and the readings from the Current Tracker • Little sensitivity when measuring around the entire two-wire path - typically 50-100mA • Reading depends on the angle between the Current Tracker and the two-wire • Other powered up cables can affect the reading

	Strengths	Weaknesses
		• Optimized for 450Hz troubleshooting mode
Clampmeter (current leakage meter)	• Can only measure around individual wires in the two-wire path. • Very accurate • Good association between readings on the controller and the clampmeter • Very sensitive - will detect changes in the range of 1mA • Doesn't depend on being held in the right angle • Not sensitive to other power cables in the surroundings	• Can not measure around the entire two-wire path • Relatively expensive • Optimized for 50-60Hz normal mode

8.4.1. Using a Current Tracker

The current tracker is used to inspect the two-wire in the landscape in order to locate shorts. You need physical access to the two-wire, or at least parts of it, since the current tracker measures directly on the cable.

Figure 8.5. Current tracker



To use the current tracker you need a voltmeter. The voltmeter must be able to measure up to 200 mV DC - usually an inexpensive model from your local electric supply store is sufficient.

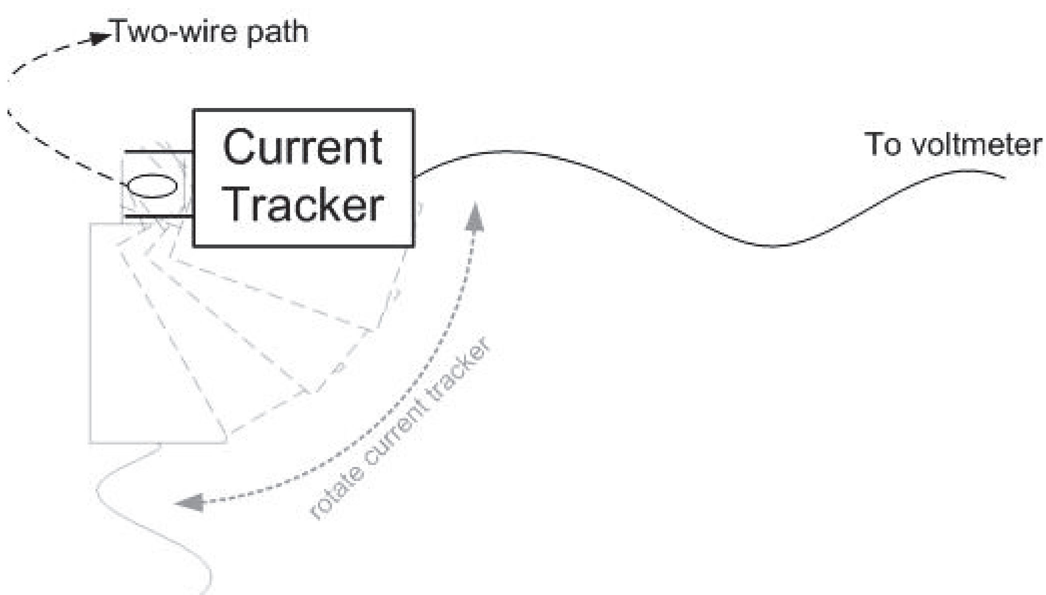
Procedure 8.1. Locating a short on the two-wire

1. Follow the first two steps of Running the short test [62] and select "Current tracker. (450Hz)".
2. Connect the current tracker to your voltmeter. Red line to red termnial, black line to black termnial.
3. Expect to be measuring somewhere in the range 10-200 mV DC and set the voltmeter accordingly - the closest higher setting. Typical settings are 100 or 200 mV.
4. Now start measuring the two-wire from the controller and out. You measure the two-wire by placing the cable between the two blades on the current tracker and checking the voltmeter. If the voltmeter shows nothing, you've passed the point of the short.

Important

If the voltmeter shows nothing, make sure to try placing the blades of the current tracker in different angles around the cable - the current tracker is direction aware and you need to try at least a span of 90 degrees around the cable in order to be sure that there's no signal available:

Figure 8.6. Rotating the current tracker around the two-wire



Ideally, you should rotate the current tracker around the individual wires inside the two-wire - do this if enough plastic is stripped off the two-wire.

Now you can work your way through the entire two-wire installation to locate the point where you can no longer pick up the signal. Hereby you should be able to locate precisely where the short is at.

8.4.2. Using a Clampmeter

Instead of the current tracker that ships with the RKD you can use a clampmeter to locate a short. You need physical access to the two-wire, or at least parts of it, since the clampmeter measures directly on the individual wires in the cable.

Procedure 8.2. Using a clampmeter for short finding

1. Follow the first two steps of Running the short test [62] 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.

8.4.3. Locating the Short

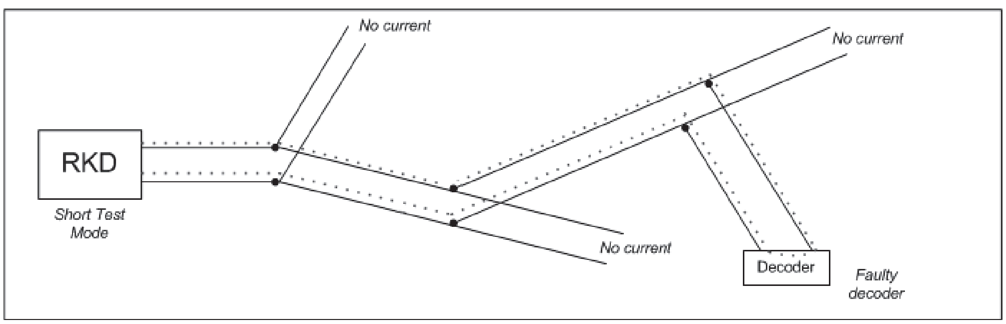
Before trying to locate the short in your system, make sure you have the following:

- Current Tracker, clampmeter or both.

- 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 8.7. Faulty station



Note

If your installation loops back to the RKD 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 [79], Phase II: Locating a Faulty Branch in the Field [80], and Phase III: Performing a "Binary Search" on a Faulty Branch [81].

Procedure 8.3. Phase I: Checking for Problems at the Controller

1. Select which which type of probe (Current Tracker or clampmeter) you wish to use for troubleshooting. See Section 7.4.1, "The Built-in Short Test" [62] for instructions.

2. 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 (and the entire two-wire if you're using the Current Tracker.) 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 [80].)

   - If one of the cables connected to the RKD loops back to the controller, you must open the loop before measuring.

   - If more than one non-looped cable is connected to the RKD, you can already now determine which cable holds the short - it will be the one with the highest current reading.

   Note

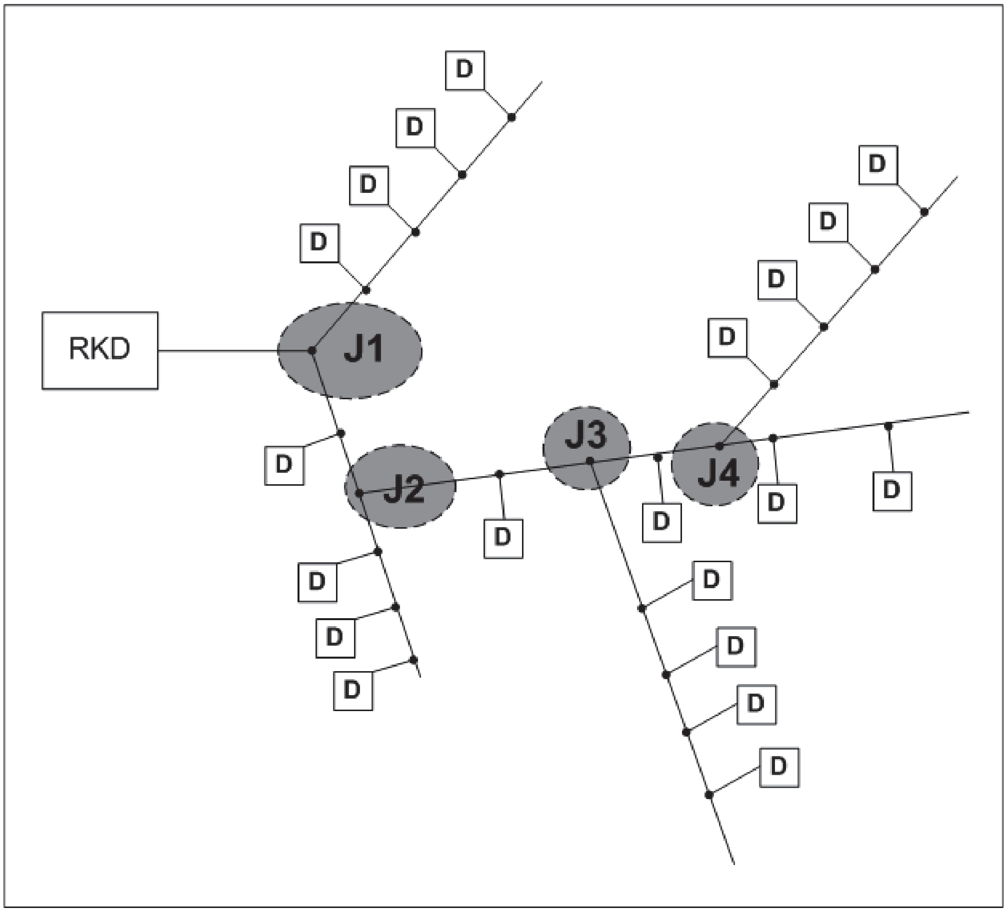
   When measuring with the Current Tracker, readings on the entire two-wire are way lower than when measuring on just one of the wires. Thus remember not to compare the two different types of measurings.

   - 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 RKD.

3. 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 8.4. 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 RKD - perform a binary search on this part of the cable (See Phase III: Performing a "Binary Search" on a Faulty Branch [81] 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 [79]) 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 station attached to the junction itself, make sure you measure on that as well, as the station and not the two-wire could be the problem.

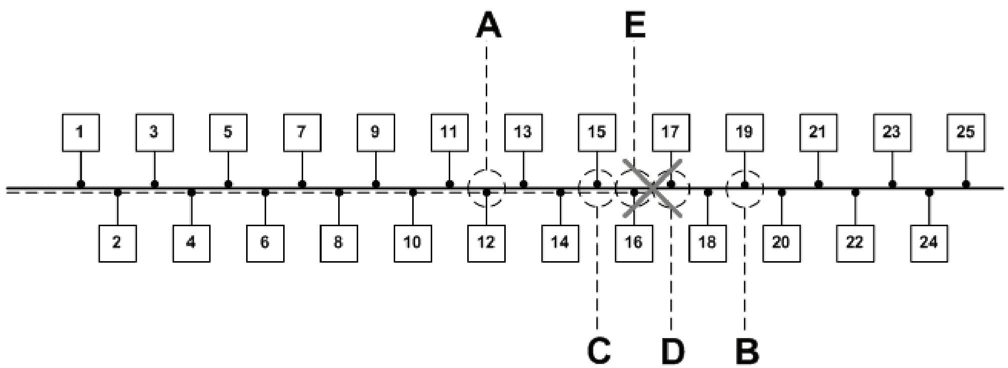
    - If you get readings on both branches after the junction but they are significantly lower than at the controller, you have problems on the two-wire on both the stretch from the controller to the junction, and further out as well. Detach the junction and start by finding the problem on the stretch from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

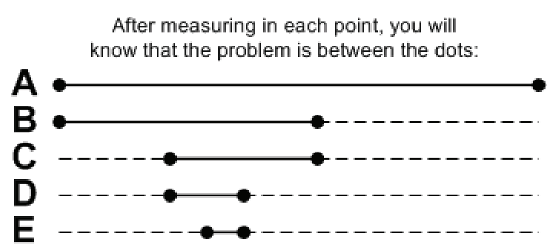
2. When you locate the faulty branch, move on and perform a binary search on the branch as explained in Phase III: Performing a "Binary Search" on a Faulty Branch [81].

Procedure 8.5. 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 station 1but no current is running at station 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 station 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 station 12 and 19.

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

4. You find no current in point D - the problem is narrowed down to between station 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 station 16 and 17.

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