

# TDI-F User Manual



water management solutions

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# Chapter 1. Introduction

The Two-wire Decoder Interface (TDI) is designed to integrate conventional systems with proven two-wire technology. The TDI allows clients in the landscape irrigation industry to retrofit their existing controllers systems. Not only does this provide a cost-efficient solution, it also ensures the clients' vendor independence by allowing them to use the main controller of their preferred choice. The TDI will enable any conventional irrigation system for the two-wire technology.

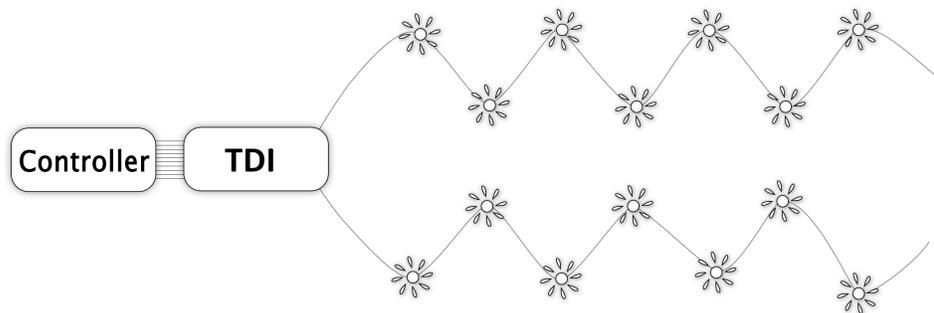
## 1.1. Target group

This manual provides instructions intended for the setup and management of the TDI and therefore is primarily intended for installation and maintenance people.

## 1.2. The Two-wire Technology

Once set up, the communication between the TDI system and the stations happen over a two-wire path. Depending on the signal from the controller, the stations each activate or deactivate a valve. Via the TDI board, the controller signals to the stations based on configurable schedules, eliminating the need for human interaction when the park, garden, or other surroundings need watering.

The TDI uses two-wire transmission technology to tell the stations when to act. This means that instead of laying out a cable to each individual valve, just one or two cables are laid out, and the stations all connect to the same cable(s).



The two-wire technology has several obvious advantages over a conventional system:

- Ease of installation: You are handling one roll of wire.
- Ease of expansion: When you need to add a station in the field, you don't have to dig in a new cable and risk damaging the existing web of cables in the ground. You simply attach the new station to the existing cable.
- Cost reduction: You save money on expensive copper cable. Typically as much as 80 percent compared to traditional cabling.

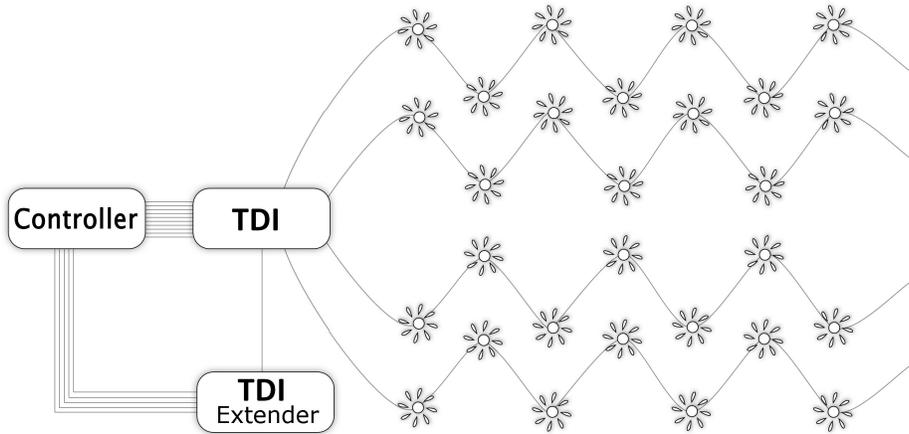
## 1.3. The TDI Extender

The TDI system may be expanded with the TDI Extender - an interface board like the TDI itself but without the display and control panel. By adding the TDI Extender to your TDI system you may increase the capacity

with up to another 48 stations and an additional master valve. The master valve operates in parallel with the existing master valve input. The TDI Extender connects to the TDI system via the expansion terminal on the TDI board.

The TDI Extender is depicted in Chapter 2: Technical Specifications.

For information on connecting the TDI Extender to the TDI Board, turn to Chapter 3: System Installation.



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# Chapter 2. Technical Specifications

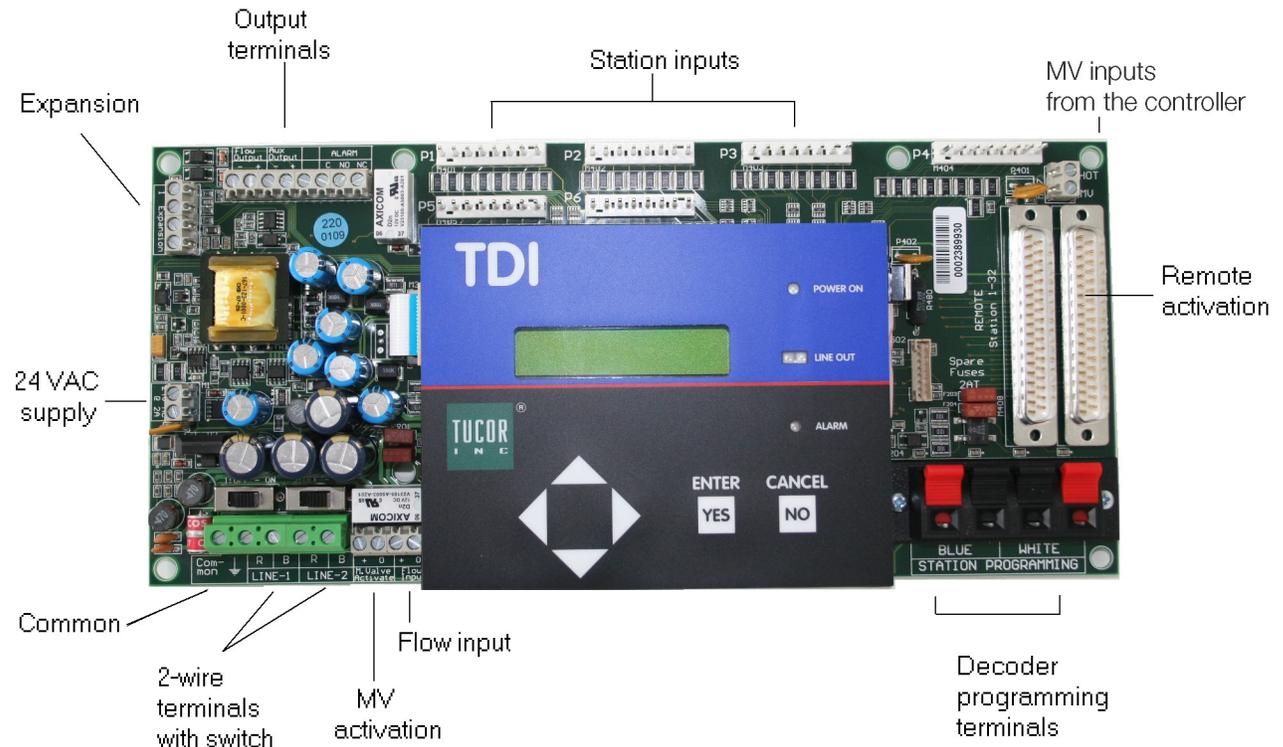
## 2.1. The TDI Package

Your TDI package contains the following units:

- TDI User Manual
- TDI Board
- TDI Extender (if purchased)

## 2.2. The TDI Board

The core of your TDI system is the TDI Board that manages the integration between your main controller and the stations. In the sections below you will find a description of the layout of the TDI Board and its input and output terminals.



### 2.2.1. Expansion terminal

Use the expansion terminal to connect the optional TDI Extender, enabling flow access for up to 48 additional stations and a master valve. For more information on connecting the TDI Extender and the TDI Board, turn to Section 3.1.9, “Connecting the TDI Extender to the TDI Board”[16].

### 2.2.2. Output terminals

Use the output terminals to connect the flow output(s), and load.

**Flow output**

Pulses are output at a frequency similar to the frequency that is read from the first sensor decoder. Maximum is 200 pulses / sec. The pulses are send with a 50/50% duty cycle.

**Aux output**

This is the same as Flow output, but for the second sensor decoder.

**Alarm**

This relay is activated if any decoder is enabled. It can be used to connect a load (resistor or coil) if the controller requires a load.

### 2.2.3. Station inputs

These inputs are used for connecting up to 48 stations in the conventional system to the TDI. All inputs react on a 24VAC input. Use the following connection scheme:

**Table 2.1. Station connection scheme (from left to right)**

P1	Station 1 to Station 8
P2	Station 9 to Station 16
P3	Station 17 to Station 24
P4	Station 25 to Station 32
P5	Station 33 to Station 40
P6	Station 41 to Station 48

1) If the maximum number of simultaneous stations in the system are active, and one of the active stations is deactivated at the same time as a station with a higher number is activated, then the new station will not be activated.

### 2.2.4. Master Valve terminal

Use this input terminal to connect the master valve. The HOT is the 24VAC from the mains transformer. For more information, turn to Section 3.1.3, "Connecting the Master Valve" [10].

### 2.2.5. 24VAC supply

Use this input to connect to the power supply 24VAC 50/60 Hz. Power consumption is up to 2A (in addition to the main controller's electrical current. That is, the transformer must be rated *at least 50 VA!*). For more information, turn to Section 3.1.2, "Connecting the TDI to 24VAC and Ground" [9].

### 2.2.6. Common

Use this input to connect to the main controller's common and GND rod. For more information, turn to Section 3.1.2, "Connecting the TDI to 24VAC and Ground" [9].

## 2.2.7. Two-wire terminals

LINE-1 and LINE-2 terminals are used for the actual two-wire connection. Each terminal is equipped with a switch for disconnecting the line during troubleshooting. For more information, turn to Section 3.1.7, “Connecting the Two-wire” [14].



### Warning

While the TDI is running, a short on the two-wire will not clear the display and thus it might still display active stations even if they are not active.

## 2.2.8. Master valve activation

Use this terminal to connect a push button which may turn on the master valve when activated. This enables you to manually activate the master valve. When activated, the master valve will remain turned on for a specified number of hours. Pressing the push button quickly, when the master valve is on, will restart the timer. A longer push (more than 3 seconds) will stop the master valve. For more information, turn to Section 3.1.3, “Connecting the Master Valve” [10].

## 2.2.9. Flow input

Input is not used. Instead flow is read via one or two sensor decoders on the 2-wire. These sensor decoders must have address 50000 and 50001 respectively.

## 2.2.10. Decoder programming terminals

These terminals are used when programming decoders. All wires on the decoder must be connected. Blue wires to the left, white wires to the right. Section 3.1.8, “Connecting Decoders for Programming” [15].

## 2.2.11. Remote activation

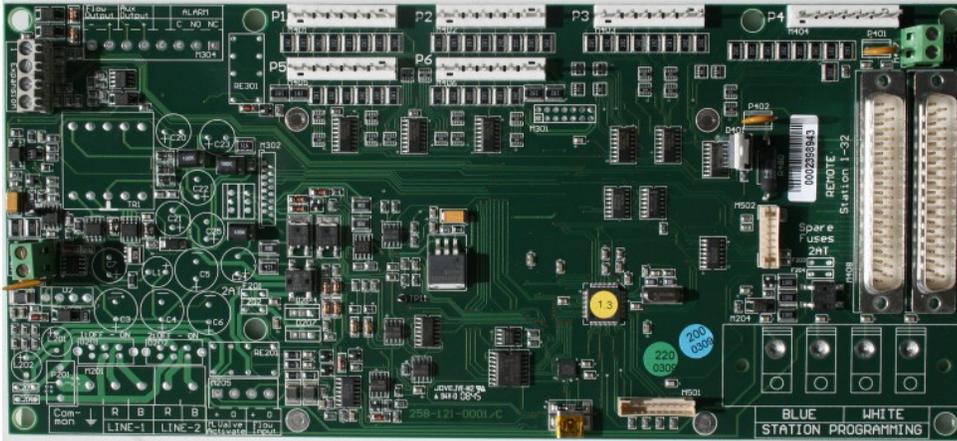
This feature is not implemented. Planned for a future release.

## 2.3. The TDI Extender

The TDI Extender is like the TDI Board itself but without the the display and control panel. By adding the TDI Extender to your TDI system you may increase the capacity with up to another 48 stations and an additional master valve. The master valve operates in parallel with the existing master valve input. The TDI Extender connects to the TDI system via the expansion terminal on the TDI board.

For information on connecting the TDI Extender to the TDI Board, turn to Section 3.1.9, “Connecting the TDI Extender to the TDI Board” [16].

# The TDI Extender



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# Chapter 3. System Installation

This chapter provides information on connecting the various output and input terminals of your TDI system.

## 3.1. Physical Installation

The physical installation of the TDI System involves the following procedures.

- Installing the TDI Board in the Cabinet
- Connecting the TDI to 24VAC and Ground
- Connecting the Master Valve
- Connecting the Main Controller Output to TDI Station Inputs
- Connecting the Flow Input and Flow Output
- Connecting the Alarm Output
- Connecting the Two-wire
- Connecting Decoders for Programming
- Connecting the TDI Extender to the TDI Board

In the following, each of these procedures are depicted in simple illustrations. Turn to the TDI Installation diagram at the end of this chapter for a full overview.

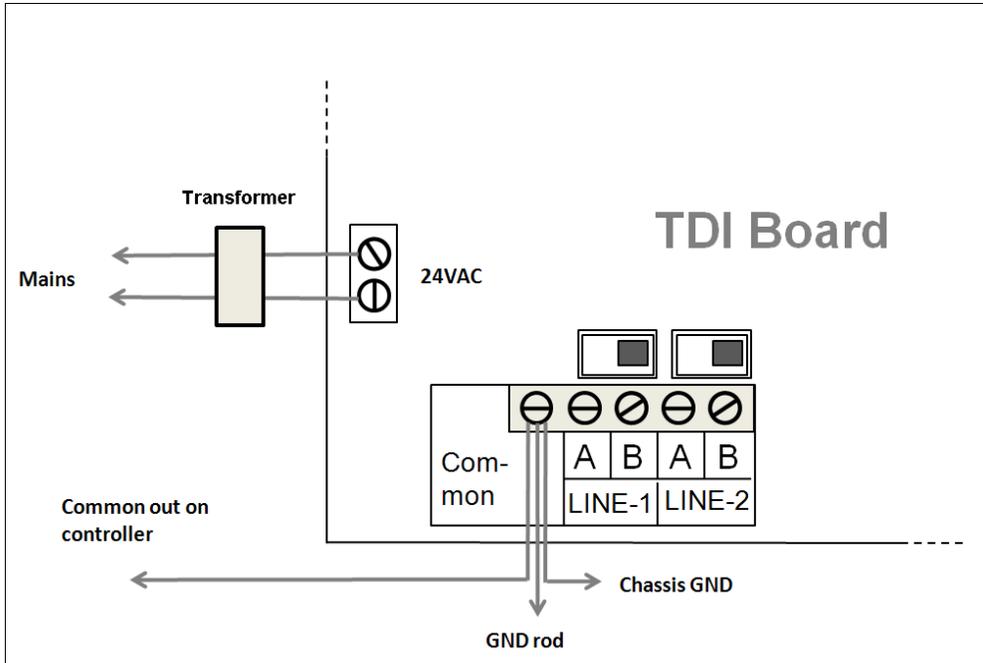
### 3.1.1. Installing the TDI Board in the Cabinet

Depending on which main controller you use, installation may vary. Use four screws and a screwdriver to mount the board. Note that standoffs are typically required, which isolates the underside of the circuit board from the metal chassis. *Ensure that the board is not shorted before applying power, or damage may occur.* The photo below shows an example installation of a TDI with a typical controller. Please refer to the following sections for connecting the various terminals of the TDI Board.



### 3.1.2. Connecting the TDI to 24VAC and Ground

Using a flat head screwdriver connect the 24VAC terminals to the 120 V mains using a suitable transformer (supplied by the customer). Also, to help secure your system against lightning, you must ensure that the TDI is grounded. Refer to the illustration below and to the TDI Installation diagram at the end of this chapter.

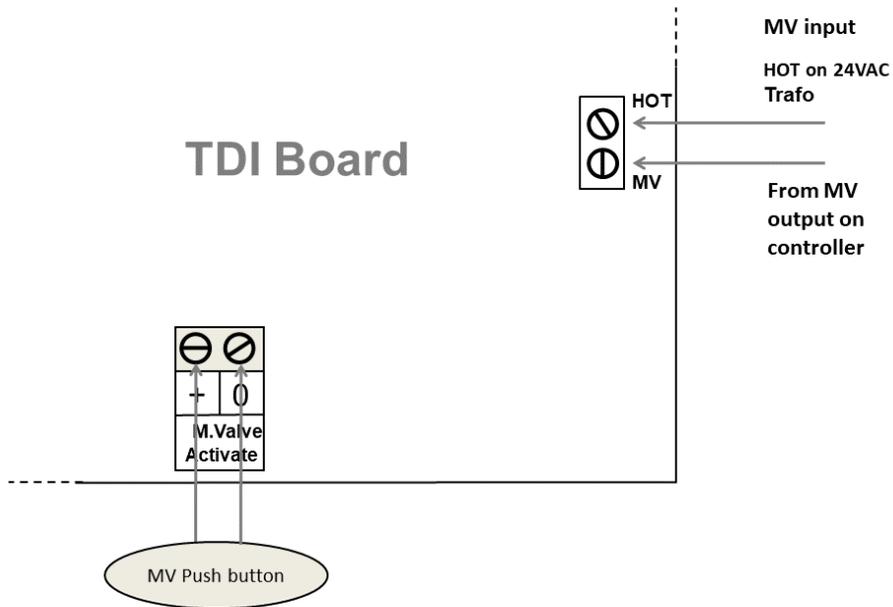


### 3.1.3. Connecting the Master Valve

In terms of master valve connections, the TDI Board allows for the following:

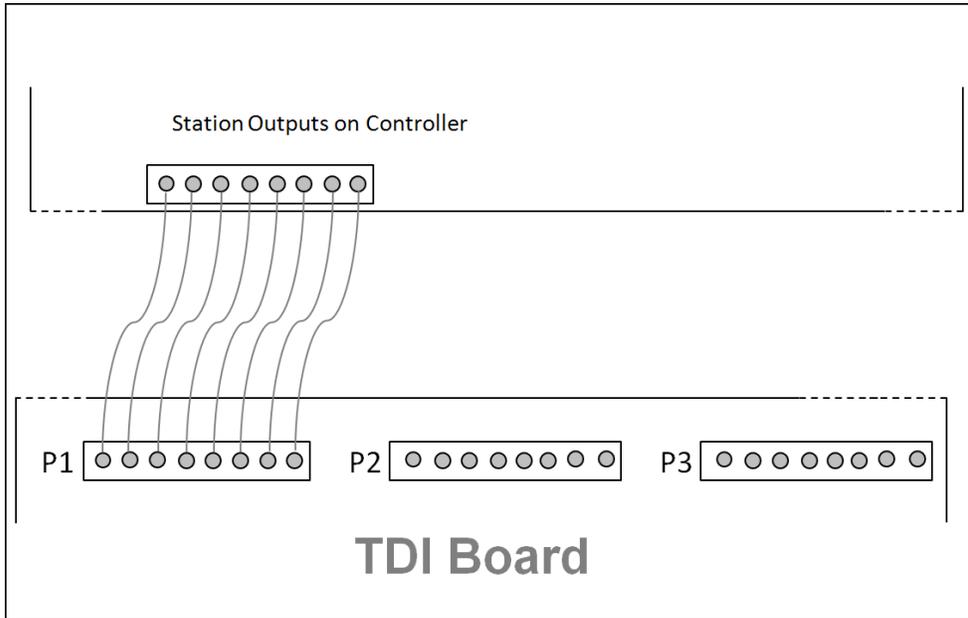
- Connection of the master valve to the primary controller.
- Connection of a push button (supplied by the customer) for the manual activation of the master valve.

Using a flat screwdriver refer to the illustration below for master valve connections.



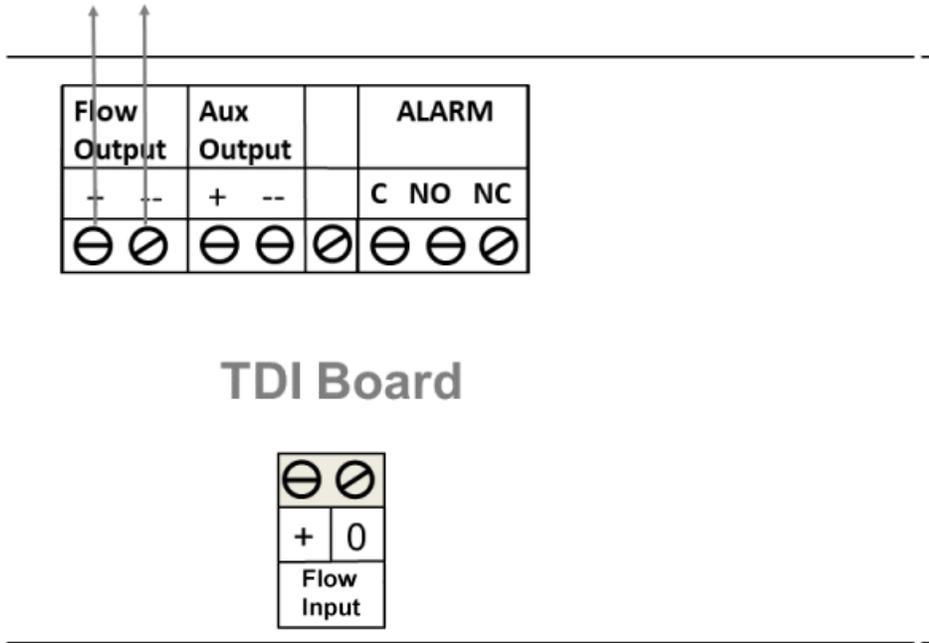
### 3.1.4. Connecting the Main Controller Outputs to TDI Station Inputs

Using a flat head screwdriver, connect the main controller's outputs to the TDI station inputs. Refer to the illustration below and to the TDI Installation diagram at the end of this chapter.



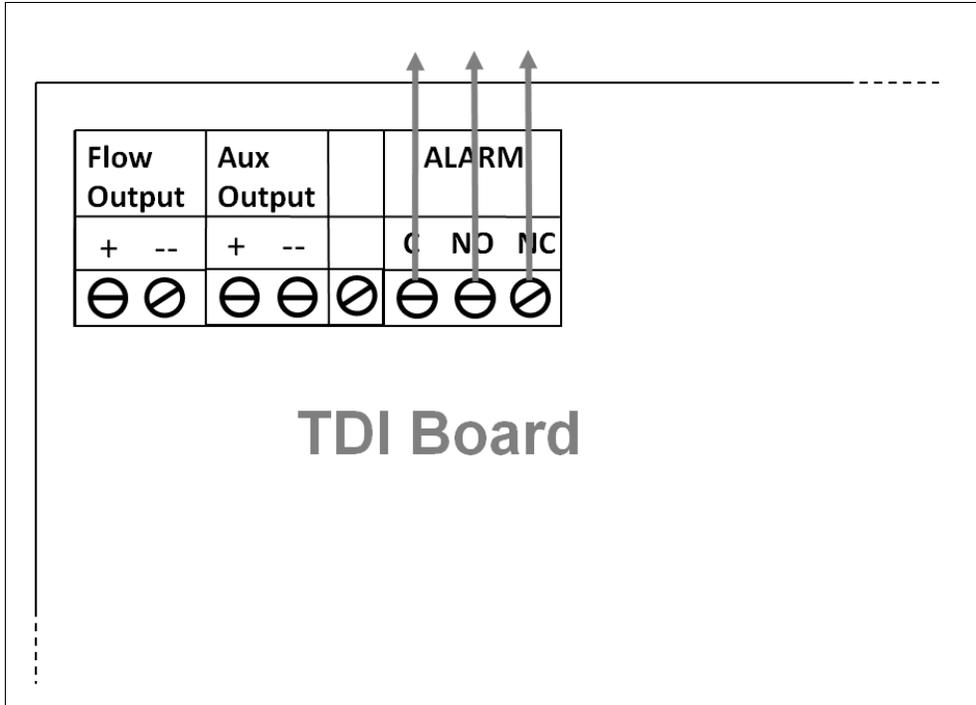
### 3.1.5. Connecting the Flow Input and Flow Output

Using a flat head screwdriver, connect the flow output. Input is not used. Instead flow is read via one or two sensor decoders on the 2-wire. These sensor decoders must have address 50000 and 50001 respectively. Refer to the illustration below and to the TDI Installation diagram at the end of this chapter.



### 3.1.6. Connecting the Load Output

Using a flat head screwdriver, refer to the illustration below and to the TDI Installation diagram at the end of this chapter for information on connecting the load output.



**Flow Output:** outputs the same frequency as sensor decoder 1.

**Aux Output:** outputs the same frequency as sensor decoder 2.

**ALARM:** controls dynamic load.

### 3.1.7. Connecting the Two-wire

Using a flat head screwdriver, connect the two-wire by fastening it to the two-wire terminals (Line 1 and/or Line 2). A and B are required on each 2-wire. Refer to the illustration below and to the TDI Installation diagram at the end of this chapter.

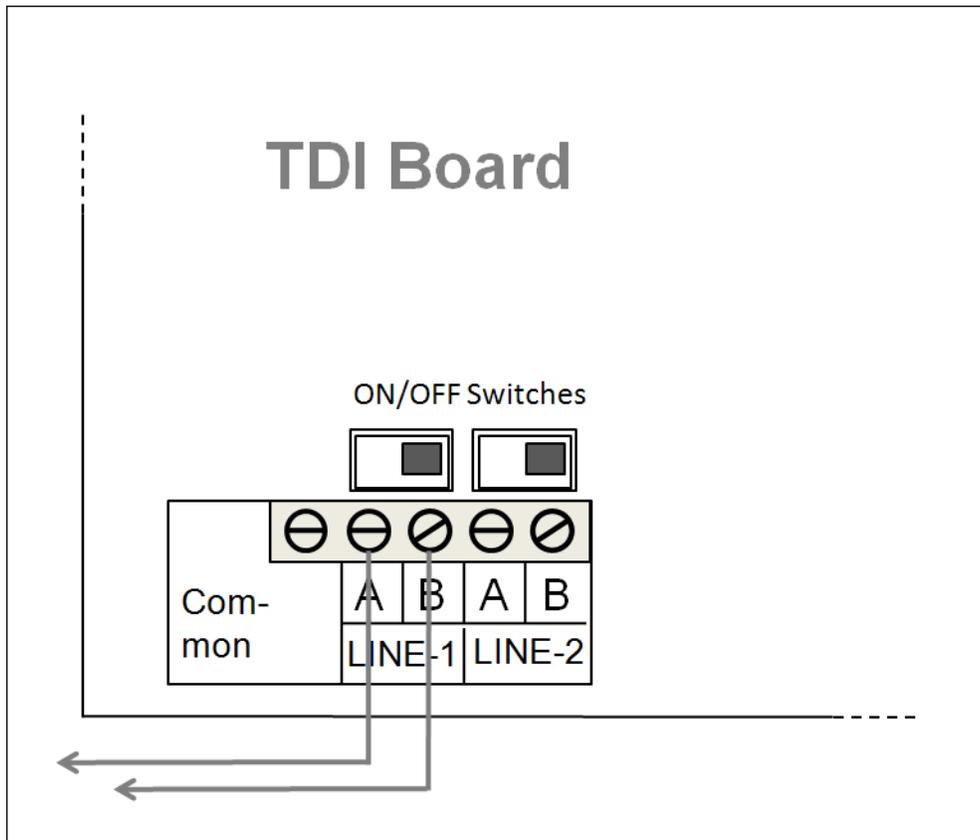


#### Important

It is necessary to protect the two-wire against lightning by adding an LSP-100 for every 500 feet. The LSP should be grounded via a ground rod with less than 50 ohms.

Note that Line 1 and Line 2 are parallel terminals. This enables you to split the two-wire in two parts, using Line 1 for one part of the installation and Line 2 for the other.

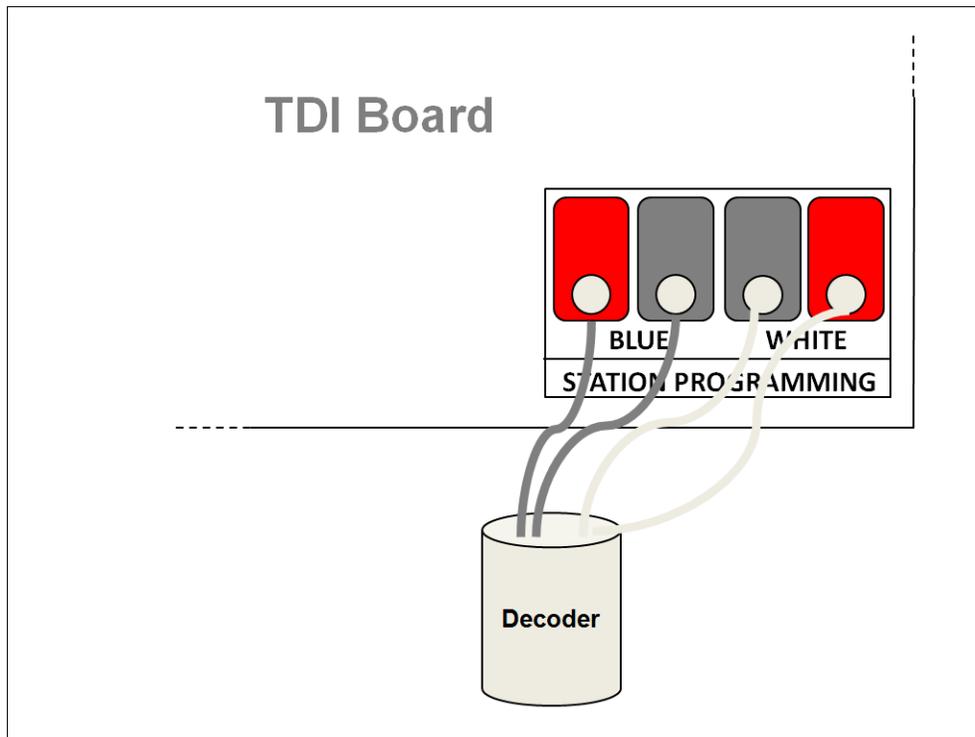
The switches located above Line 1 and Line 2 may be set to either *On* or *Off* thereby activating or deactivating the two-wire. Each switch should be set to *On* when the installation is up and running. Set the switch to *Off*, for instance, during troubleshooting a short in the installation. This is a quick way to exclude either one of the two-wires. *On* is to the right, *Off* is to the left.



### 3.1.8. Connecting Decoders for Programming

Use the Station Programming terminals to the right on the TDI Board when connecting the decoder for programming. Connect the two-wire by fastening it to the terminals labeled Blue and White, respectively. Refer to the illustration below and to the TDI Installation diagram at the end of this chapter.

Once connected, you can assign an address to the decoder from the TDI panel. You can also test that the decoder is fully functional. For information on programming and testing decoders turn to Chapter 6: Configuring the TDI.



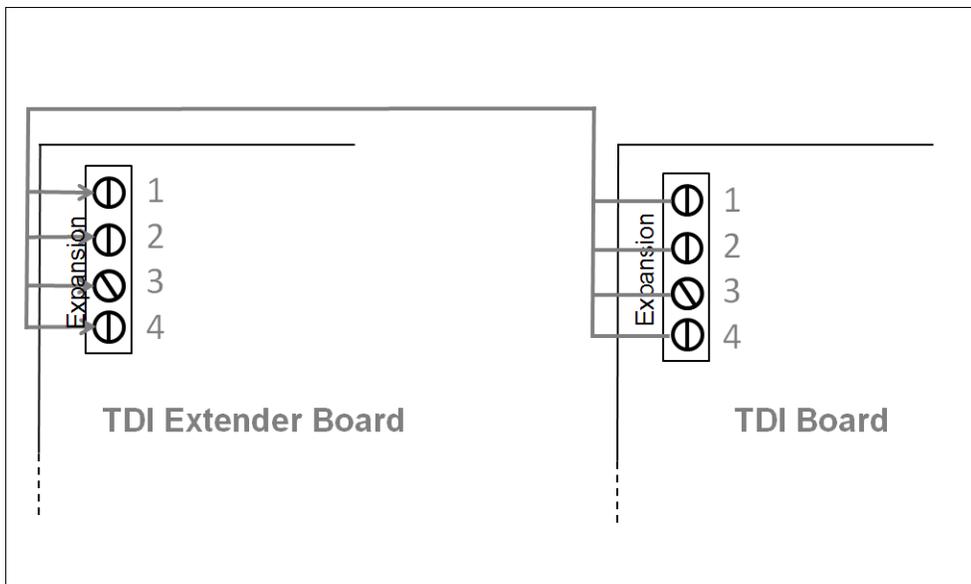
### 3.1.9. Connecting the TDI Extender to the TDI Board

Use the expansion terminal to connect the optional TDI Extender to the TDI Board enabling the expansion of up to 48 additional stations and a master valve.

Using a flat head screwdriver connect the wires as follows:

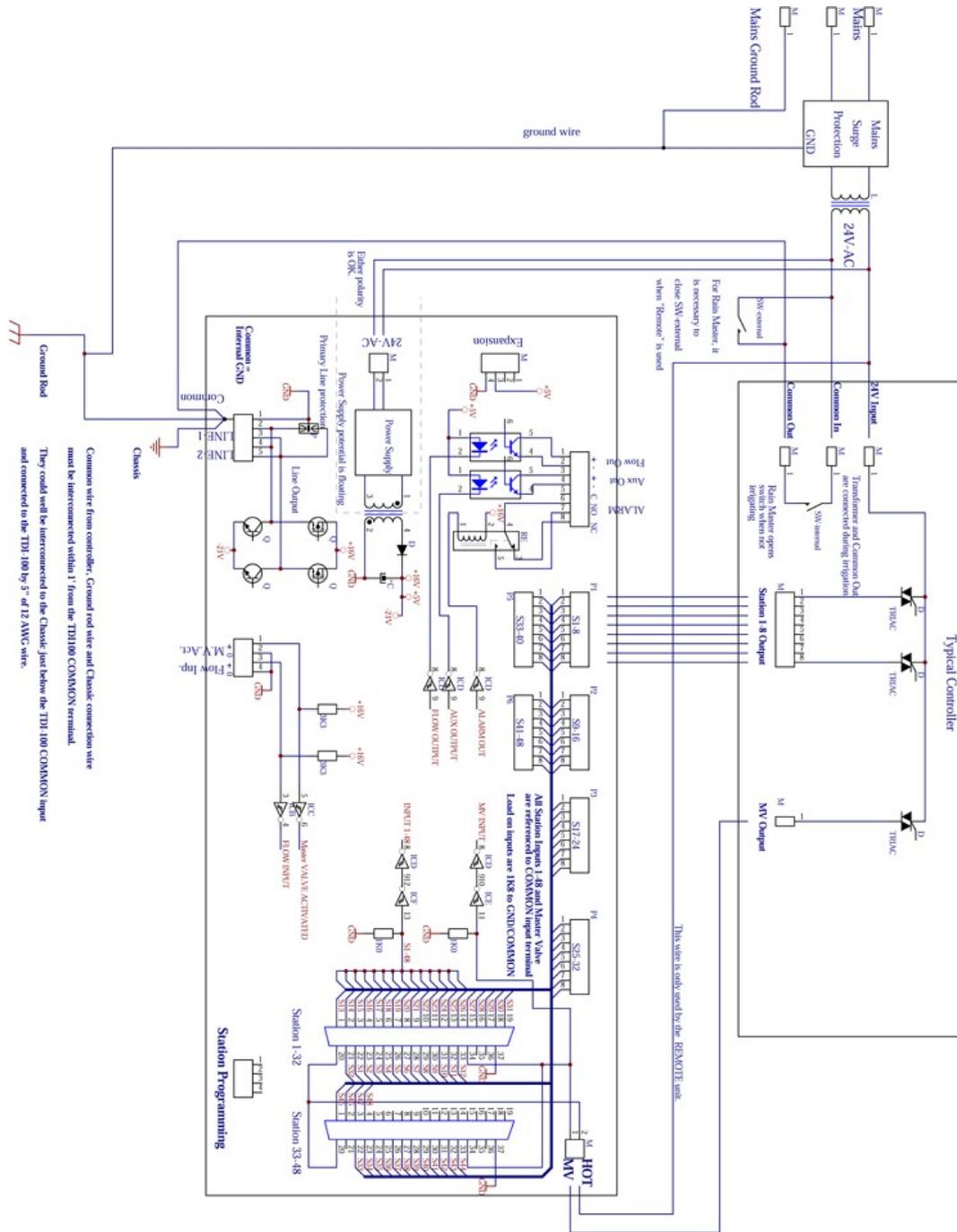
- Terminal 1 on the TDI Board connects to terminal 2 on the TDI Extender Board.
- Terminal 2 on the TDI Board connects to terminal 1 on the TDI Extender Board.
- Terminal 3 on the TDI Board connects to terminal 3 on the TDI Extender Board.
- Terminal 4 on the TDI Board connects to terminal 4 on the TDI Extender Board.

Note that terminal 1 is towards the top of the board. Also refer to the illustration below when connecting the TDI Extender.



### 3.2. TDI Installation Diagram

Refer to the TDI Installation diagram below for a full overview of the TDI Board and its terminal connections.





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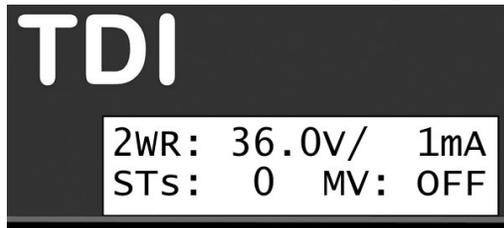
# Chapter 4. Operating the TDI

This section presents the display and the controls on the TDI.

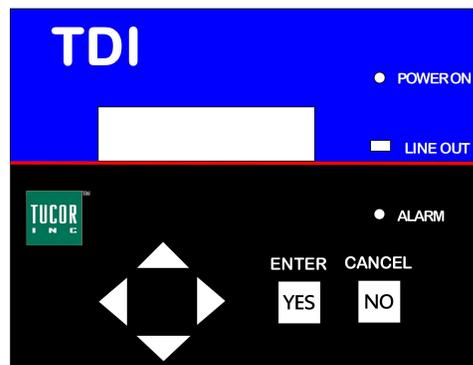
## 4.1. The Display

The TDI has a back lit LCD display with two rows of 16 characters. Since the limit is 16 characters per row, sometimes words are abbreviated, but all messages should still be easy to understand. If in doubt about a message, consult this manual.

A typical message is the following that is displayed when the TDI is idle and displaying the present status.



## 4.2. Buttons and LEDs

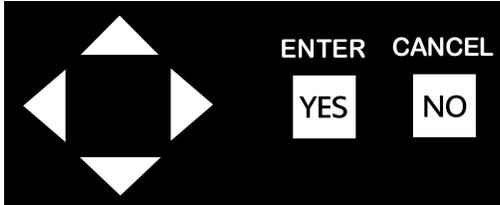


The front plate of the TDI contains the following controls and LEDs:

- Item selectors: These buttons let you scroll up, down and sideways in the various menus and commands of the TDI.
- CANCEL / NO: Press this button to cancel the current operation or exit the current menu.
- ENTER / YES: Press this button to activate the selected menu or accept the current setting.
- POWER ON: When the TDI is turned on, the POWER ON LED will light green.
- LINE OUT: When the TDI is turned on and the 2-wire is functioning properly, the LINE OUT LED flashes green and red every half second. See Section 7.2, “Testing the Two-wire Path” [41] for troubleshooting.
- ALARM: Flashes when the TDI has registered one or several alarms. The display will show you more information about the alarm type. See Section 5.2.5, “Displaying the Alarm Status” [23] for alarm causes.

## 4.3. Navigating the Menus of the TDI

1. Use the item selectors to toggle (move right and left) and scroll (move up and down) through the menus of TDI.



2. In case more than one option is available in a particular menu or view, you will see Up and Down arrows. Use the item selectors to scroll through the options. The \* sign next to a command indicates that the command is selectable. To select the option, press **ENTER**.

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# Chapter 5. Running the TDI

This chapter contains information how to run the TDI once it has been set up.

Read more about:

- The main view
- Displaying controller status

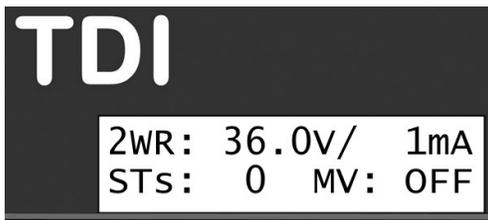
## 5.1. The Main View

The main view is the active view when the system is up and running. Use the main view to get an overview of the overall status of the two-wire. In case of alarm(s), the display will alternate between the normal display and the display of each alarm.

1. Power up the TDI. For a few seconds the current firmware information and the TDI number shows on the screen. While the TDI is turned on, the POWER ON LED will light green, and the LINE OUT LED will flash red/green every ½ second.



2. The main view displays.



### Note

Except when you work in the submenus, the TDI will revert to the main view after 10 seconds with no panel activity.

The top line of the main view shows the voltage and mA measured on the two-wire. The voltage should show 32V to 36V on a 2-wire with no decoders installed, and the mA should be close to 0 mA. On a 2-wire with decoders installed (but not running), the mA should show approximately 0.5 mA per decoder.

The bottom line shows the total number of active stations (i.e. decoders) and the status of the master valve (MV), i.e., if it is turned on or off.

For active decoders, the mA depends on the power level. The more power you assign, the less number of simultaneous active stations is possible. For more information turn to Adjusting the Power Levels.

Each decoder uses about 0.5 mA in idle mode. For instance, if your system includes 50 decoders, the mA value should total 25 mA with no activity. If the mA value is suddenly significantly higher, for instance 200 mA, then something is wrong: This could indicate a ground leak. For more information, turn to Chapter 8: Troubleshooting in the Field.

## 5.2. Displaying Controller Status

Five different types of statuses are available:

- Flow input
- Status of active stations
- Alarm status

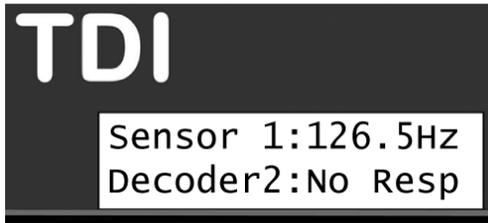
### 5.2.1. Displaying the Flow Input

The current flow input on the system can be seen from the **Flow Input** view. This view expresses the current flow in pulses per seconds (in Hz), and tells how many gallons per minute (GPM) this corresponds to.

When setting up the TDI, you define what type of flow sensor should be used, i.e., how it should convert from pulses to gallons. For more information, turn to Defining the Flow Input.

To display the flow input:

1. In the **Main** view, use the item selectors to scroll sideways to the **Flow Input** view.



### 5.2.2. Displaying the Number of Active Stations

The **Active Stations** view shows the number of active stations, master valves and pumps. The view also displays the names of the active stations.

1. In the **Main** view, use the item selectors to scroll sideways to the **Active Stations** view.



2. If more stations are active, use the item selectors to scroll to the other active stations.

If no stations are running, this view will not display anything.

### 5.2.3. Displaying the Alarm Status

When the ALARM LED on the TDI panel indicates that one or more alarms have been detected, proceed to the **Alarm Status** view to get an overview and determine what action to take.





## Note

For each alarm type you may set the reaction type. For more information, turn to Section 6.5, “Setting Up FloGuard” [31].

To display the alarm status:

1. In the **Main** view, use the item selectors to scroll sideways to the **Alarm Status** view.



2. Use the item selectors to scroll through the alarms, and check whether the status is **Passive**, **Active** or **Pas Clr?**. The **Pas Clr?** option indicates that at some point an alarm was detected, but that it is no longer active.

The **Alarm Status** view may display the following alarm types:

### Sht

2-wire short alarm. The alarm stays on as long as there is a short in your system. You can clear the notification by viewing the alarm list.

### MST

Max active stations reached. This means that a program tried to start a station when the maximum number of stations was already running. The alarm will be cleared once you have viewed the alarm list and acknowledged the alarm.

### P2Q

Indicates whether the quality of the 2-wire has dropped to a level where the TDI-F cannot read the sensor decoder, for example due to leak to ground, bad connections etc.

# Chapter 6. Configuring the TDI

## 6.1. Setting Up the TDI System

All set-up is done by using the menus and commands accessible from the `Main` menu.

When setting up the TDI system, we recommend you use the following sequence:

1. Programming Decoders
2. Setting the Master Valve Override
3. Adjusting the Power Levels
4. Resetting your Configuration Data

## 6.2. Programming Decoders

When programming decoders you perform two actions for each decoder:

1. Assign a unique ID to the decoder.
2. Test the decoder.

To program a decoder:

1. Connect the decoder's white and blue wires to the sockets labelled White and Blue on the TDI.
2. Scroll sideways to the **Main** menu, then scroll to the **Dec Program** menu, and press **ENTER**.



3. If you did not already connect the decoder, you will be prompted to do so at this point. Once it is connected, press **ENTER**.



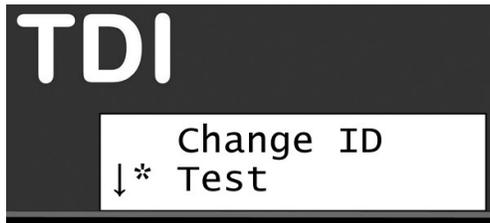
4. Scroll to the **Change ID** menu to open the **Choose ID** window.
5. Scroll through the IDs (ST1, ST2, ST3, etc). Press **ENTER** two times to confirm your selection.



6. The TDI will use a few seconds to verify the ID, then prompt you to label the decoder for future identification. Press **ENTER**.



7. Scroll down to the **Test** command and press **ENTER** to test the output of the decoder. If the decoder has a defect you will encounter an error at this point.



8. If you want to program another decoder, use the item selectors to select the **Another** command, and press **ENTER**. Repeat steps 2 through 6.



### Warning

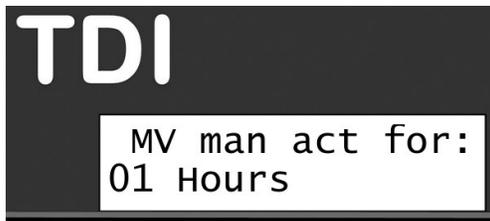
The TDI contains no in-built control mechanism that prevents you from assigning the same ID to several stations. Consequently, we advise you to assume caution when assigning IDs to the stations and the master valve to minimize the risk of assigning identical station IDs. Creating identical stations will likely overload the system and cause failures.

## 6.3. Setting the Master Valve Override

With this setting you control the activation time (in hours) for the manual activation of the master valve.

To set the master valve override:

1. Scroll sideways to the **Main** menu, then scroll down to the **MV Override** menu, and press **ENTER**.



2. Use the item selectors to set the time period (in hours). The range is 1 to 12 hours press **ENTER** to confirm your selection.

## 6.4. Adjusting the Power Levels

TDI allows you to adjust the power levels for each station and the master valve independently.

Choose between:

- Normal power
- High power
- Higher power
- Highest power

For most systems, **Normal power** is sufficient. Within agricultural systems, however, you may find stations and valves that need more power.



### Important

Increasing the power levels for your stations mean that fewer stations may be active at a time. TDI lets you supervise the impact. For more information turn to the section "Checking the Number of Active Stations" later in this chapter.

### 6.4.1. Adjusting the Station Power

To adjust the power levels for your stations:

1. Scroll sideways to the **Main** menu, then scroll down to the **Power Levels** menu, and press **ENTER**.



2. Scroll down to the **ST Power** command, and press **ENTER**.
3. Choose between **Normal power**, **High power**, **Higher power** and **Highest power**.

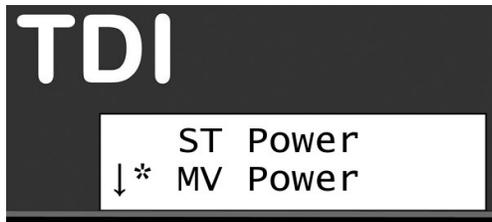


4. Press **ENTER** to confirm your selection.

### 6.4.2. Adjusting the Master Valve Power

To adjust the power levels for the master valve:

1. Scroll sideways to the **Main** menu then scroll down to the **Power Levels** menu, and press **ENTER**.
2. Scroll down to the **MV Power** command, and press **ENTER**.



3. Choose between **Normal power**, **High power**, **Higher power** and **Highest power**.



4. Press **ENTER** to confirm your selection.

### 6.4.3. Resetting Station Power

In case you want to reset the station power to the factory settings, please use the reset command.

1. Scroll sideways to the **Main** menu, then scroll down to the **Power Levels** menu, and press **ENTER**.
2. Scroll down to the **Default reset** command, and press **ENTER**.



3. Press `ENTER` to confirm.



#### 6.4.4. Checking the Number of Active Stations

Increasing the power levels for your stations mean that fewer stations in your system may be simultaneously active. The TDI lets you supervise the impact of changing these settings.

To check the number of active stations:

1. Scroll sideways to the **Main** menu, then scroll down to the **Power Levels** menu, and press **ENTER**.
2. Scroll down to the **Show max act** command, and press **ENTER**.



The screen will show you the maximum number of stations that can be active at the same time, in this case 10.



#### 6.5. Resetting Data

In rare cases, it may be necessary to reset the data.

To reset you data:

1. Scroll sideways to the **Main** menu, then scroll down to the **Data Reset** menu, and press **ENTER**.



2. Press **ENTER** again to confirm you want to reset your configuration data.

---

# Chapter 7. Troubleshooting from the TDI

## 7.1. Testing Stations

This section describes the various ways you can troubleshoot your stations from the TDI.

### 7.1.1. Testing Individual Stations

There are two ways to test if a single station is working correctly:

1. If you don't have access to the station - maybe it's buried in the landscape - you can run the test program (see Section 7.1.2, "Running the Electrical Test" [39]).
2. If you have physical access to the station, you can detach it from the two-wire, take it to the TDI, and perform a station test by connecting the decoder to the `STATION PROGRAMMING` terminals. The display will then inform you of the status. Refer to Section 3.1.8, "Connecting Decoders for Programming" [15].

If this test fails, the station must be replaced.

### 7.1.2. Running the Electrical Test

The TDI has a built-in test that will activate each station in turn for just one second in order to check if they are responding correctly. The stations must be connected to the solenoids that activate valves in the landscape, and the test can tell whether the stations and solenoids are working correctly in conjunction.

#### Procedure 7.1. Running the station test

1. Scroll sideways to the `Main` menu, then scroll down to the `Tests` menu, and press `ENTER`.



2. Scroll down to the `ST Electrical` command, and press `ENTER`.



Now you'll be prompted to select the station you wish to start from:



- 3 Use the *item selectors* to select a station and push the `ENTER` button to start the test.

The screen will either confirm that the test went OK or it failed.



In addition to this basic information, three values are displayed: The *Before current mA*, the *Inrush current mA* and the *Holding current mA*:

- Before current: Shows the current just before the station is activated.
- Inrush current: Shows the current in the "inrush" period, which is the short period when the station activates the decoder. In this case, the station pulled a current of 400mA.
- Holding current: Shows the current level after the decoder was open, in this case 33mA

Numbers in this range are normal. The Before current corresponds to the number of stations multiplied by 0,5 mA. In this case, there are 16 decoders in the system which amounts to 8mA. As for the Inrush current it takes a larger charge in the "inrush" period to pull the solenoid open, and then a smaller current (the Holding current) to keep it open afterwards. Typically, the Holding current is approximately 25mA higher than the Before current, in this case 33mA.

If the station fails, the display will look something like this:



In this case, there was no response from the station.

Regardless of whether the station fails or turns out OK, you move on to testing the next station in line by pushing the `ENTER` button.

### 7.1.3. The Built-in Short Finding Test

If you suspect your system has a short somewhere in the field, use the built-in short test in the TDI. This test won't tell you anything you can't already 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 7.2. Running the short finding test

1. Scroll sideways to the `Main` menu, then scroll down to the `Tests` menu, and press `ENTER`.
2. Scroll down to the `Short Finding` command, and press `ENTER`.



3. Inspect the measurements in the display:



- If the two-wire is OK, the voltage will be relatively high (34-36V), and the current (mA) relatively low. In a test setup this is what it looked like:

The voltage is 36V and the current is 0mA.

In addition, both Red and Green Line Out LEDs will be lit.

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

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 Out LEDs will both be out.

- If the voltage is just slightly lower than normal (31-35V), consult the table in Section 8.1, "Checking Power and Current Readings" [43].

If you find that there's a short in your system, you should try to locate it, using a clampmeter. (See Section 8.4.1, "Using a Clampmeter" [51]).

## 7.2. Testing the Two-wire Path

The first indication that you might have a short or a fault somewhere on the two-wire path is that the Line Out indicators (the green and red LEDs on the TDI) will flicker very quickly, or be not lit at all.

If the TDI senses an electrical leak somewhere, the two-wire path will change to 50Hz mode, meaning that the LEDs may both be lit. After a while you'll see an indication in the lower part of the display that a short occurred.

If the leak is severe (current more than 600-650mA), the LEDs will turn off due to the loss of power. However, current will still be running on the two-wire.

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

## 7.3. Increasing Station Power

In case the stations are not giving out enough power for the valves or pumps to pull open, it is possible to increase the power.



### Note

Do not simply increase station power because the valves are not opening. First verify the integrity of the 2-wire. If the current is too high, then you must fix that problem.



### Important

Increasing the station power means that fewer stations can run simultaneously (less than 10). When changing the power setting you can see how many stations can be run at the same time. For example, when changing the power setting for regular valves to "Highest Power" you can run a maximum of five simultaneous valves.

For more information on adjusting power, turn to ???.

---

# 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	33-36V	31-34V
Current	0-3mA (no stations attached)	300-600mA



### Tip

See Section 7.2, "Testing the Two-wire Path" [41] for instructions on how to do power and current readings in the display of the TDI.



### Tip

When the TDI shows high current readings, always first disconnect two-wire at the TDI. Use the switches to do so (refer to Section 3.1.7, "Connecting the Two-wire" [14]). If the high current disappears, the two-wire is the problem. If the high current remains, the TDI has the fault.

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 no valves are running, all connected stations 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. Note that this will be true even if there is nothing connected to the white (output) wires of the decoder. Each decoder all by itself draws 0,5 mA.

#### Active Stations

When active, any station, controlling a valve or master valve, will consume around 15 - 35mA.

This means that when running just one station or a master valve on a system with 96 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 ???) 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 TDI has lowered the power on the two-wire, and you should go locate the problem in the field (See Section 8.4, "When there is a Short Circuit in the Field" [50]).



### Note

The current reading can be "normal" in this situation (350-600mA or lower) - this is one of the TDI's safety features.

If the power reading is between 25V and 31V

This is abnormal. The TDI will keep running normally, but there's a probability you have a short somewhere - you should go locate the problem in the field (See (See Section 8.4, "When there is a Short Circuit in the Field" [50])).

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.

The following table tries to give you an idea of whether or not your system is behaving as expected. You calculate the expected current as  $0.5\text{mA} \times \langle \text{number of stations} \rangle$ . Though no station consumes exactly 0.5mA, the figures average 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	96	
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 7.1.2, "Running the Electrical Test" [39]).
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.  The TDI can handle this, but you could be looking at problems that dramatically increase under wetter conditions. See Section 8.1.1, "Problems on the Two-wire" [45].
Excessive current (More than +50%)	> 15mA	> 30mA	> 45mA	> 60mA	> 75mA	This is a risky situation that can interfere with the functionality of the TDI, 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 (see (See Section 8.4, "When there is a Short Circuit in the Field" [50])), 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 wet the soil is.

## 8.2. Dealing with Unstable Stations

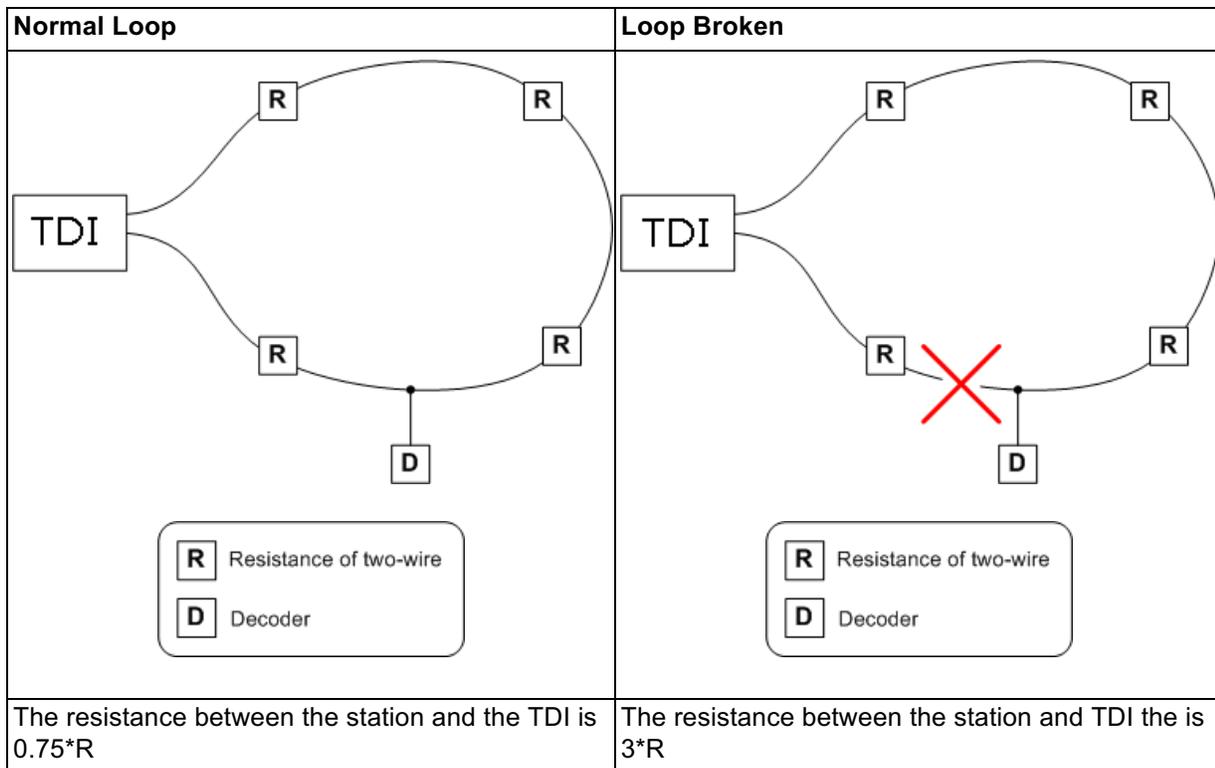
If a station seems to fail randomly, typical reasons include:

- You have increased the power used to activate stations (See ???). This means that you need to lower the number of simultaneously running stations, 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 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 TDI can increase, pushing up the power consumption:



### Note

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



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

2. Perform an "electrical test" as described in "Running the Electrical Test" in Chapter 7: Troubleshooting from the TDI. 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 "Dealing with Failing Stations".

## 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 TDI, 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

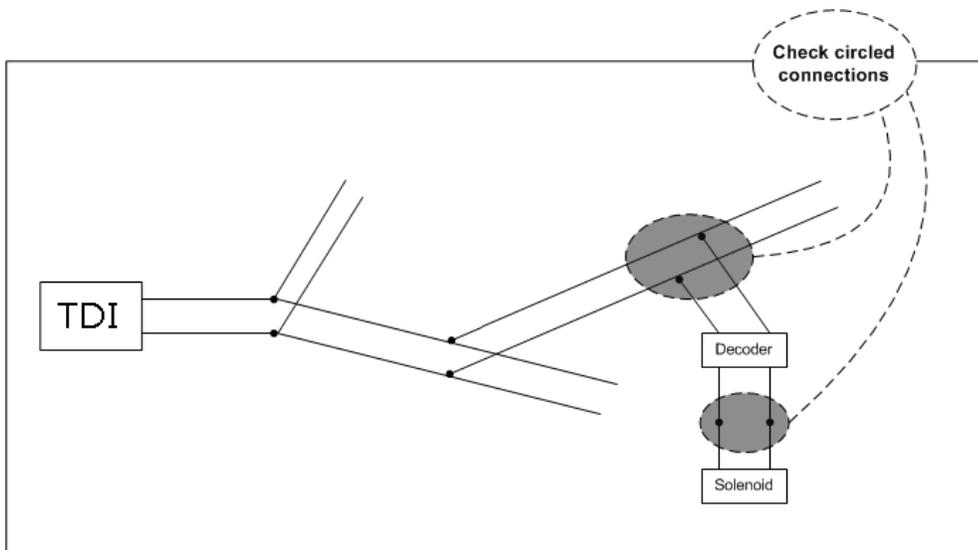
If the failing station has just been installed, did you remember to assign an ID to the decoder?

If the failing station has been known to work, perform the electrical test (See Section 7.1.2, "Running the Electrical Test" [39]) on the station in question and follow these guidelines:

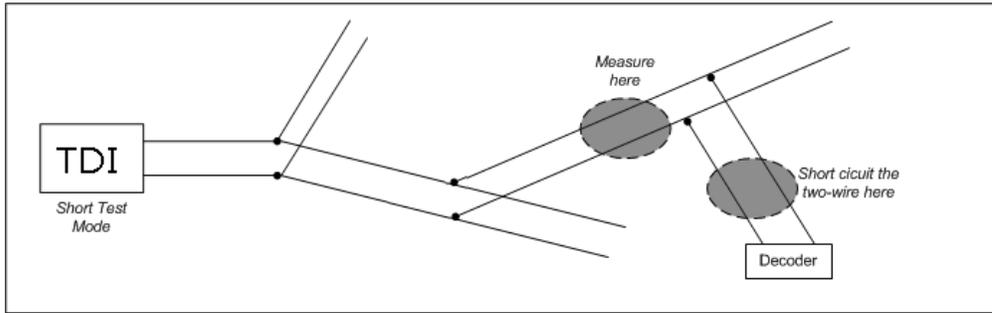
<p><b>If there's little or no reaction from the stations</b></p>	<ol style="list-style-type: none"> <li>1. Go to the station in the field and perform these tests: <ul style="list-style-type: none"> <li>• Check wires and connections between the two-wire, the station and the solenoid (see figure on next page).</li> <li>• Short circuit the two-wire at the station and use a clampmeter (see Section 8.4.1, "Using a Clampmeter" [51]) to check if power is still OK. In this case, the current should be &gt; 200 mA. If this is the case, the problem is in the station or solenoid, and not on the two-wire between the station and the TDI (see figure on nextpage).</li> <li>• 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.</li> </ul> </li> </ol> <div style="margin-top: 10px;">  <p><b>Note</b></p> <p>Some solenoids come with a diode on one of the wires. This means that the solenoid is polarized and the connection of the white wires from the decoder to the solenoid is</p> </div>
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	<p>significant. Thus you can try to swap the two wires around and see if it makes a difference.</p> <p>The wires to polarized solenoids will be different from each other. They may be red and black, or might have a white stripe. If the two solenoid's wires are different, always try swapping their connections to the decoder..</p> <ul style="list-style-type: none"> <li>• Take the station to the TDI and perform a direct test before replacing it.</li> </ul>
<p><b>If the station fails with too high current reading</b></p>	<ul style="list-style-type: none"> <li>• Check the two-wire between the solenoid and the station for cracks in the insulation or bad connections.</li> <li>• Detach the solenoid from the station and measure the resistance of the solenoid itself. If the resistance is less than expected, it might be damaged by lightning or it might have a short circuit. Try replacing the solenoid.</li> <li>• Take the station to the controller and perform a direct test before replacing it.</li> </ul>

**Figure 8.1. Checking Connections**



**Figure 8.2. Testing the path to a station**



### 8.3.2. Several Stations Fail

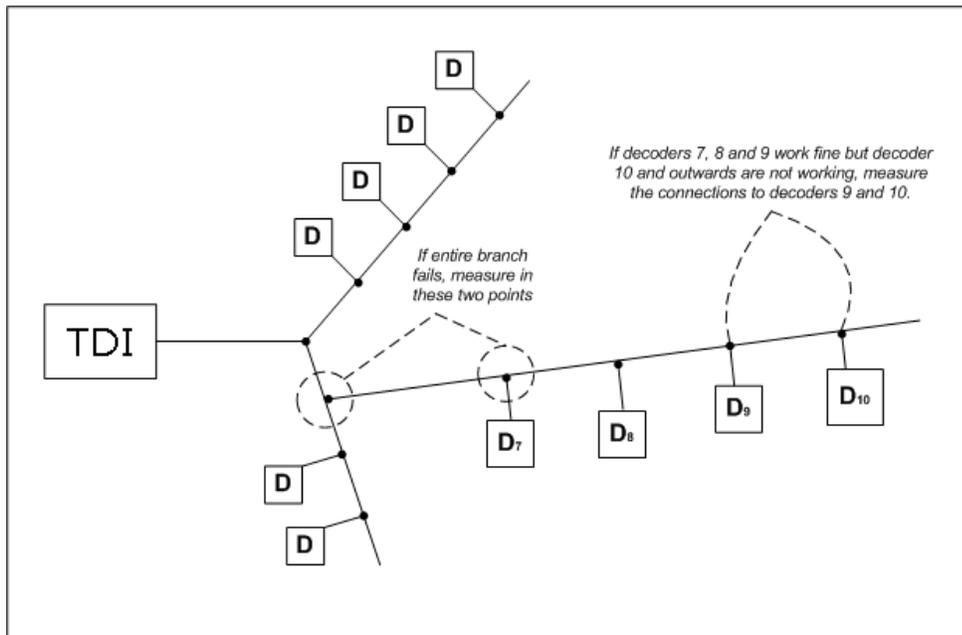
Here is a checklist if multiple stations fail:

- If two stations are configured with identical IDs 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"	<b>M</b> and/or <b>N</b> 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 the resistance in the solenoids, one or both can fail to open.
Try to activate "ST21"	Both <b>M</b> and <b>N</b> 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 previous section "A Single Station Fails" 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 - using a clampmeter - until you reach the point of failure. For more information turn to see Section 8.4.1, "Using a Clampmeter" [51].

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 (disconnect all connections), 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 TDI to display a warning. In addition to the warning, you'll see that the Line Out LED is constantly lit instead of blinking as it normally does. If the short is very severe the Line Out LED may stop working all together.

But you can't always be sure that the TDI 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.

### 8.4.1. Using a Clampmeter

In order to locate a short you can use a clampmeter. You need physical access to the two-wire, or at least parts of it, since the clampmeter directly measures on the individual wires in the cable.

#### Procedure 8.1. Using a clampmeter for short finding

1. Run a short test on the TDI.
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. Now measure the other one. Always measure both wires separately. Sometimes one wire will have a problem and the other will be OK.

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.

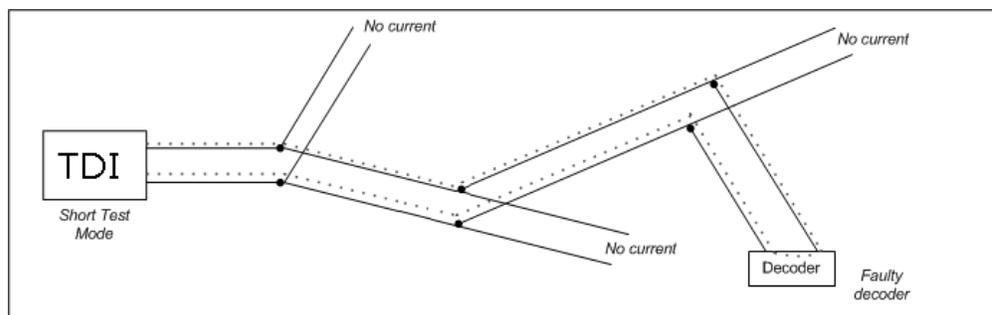
### 8.4.2. Locating the Short

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

- 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 8.4. Faulty station**



#### Note

If your installation loops back to the TDI 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

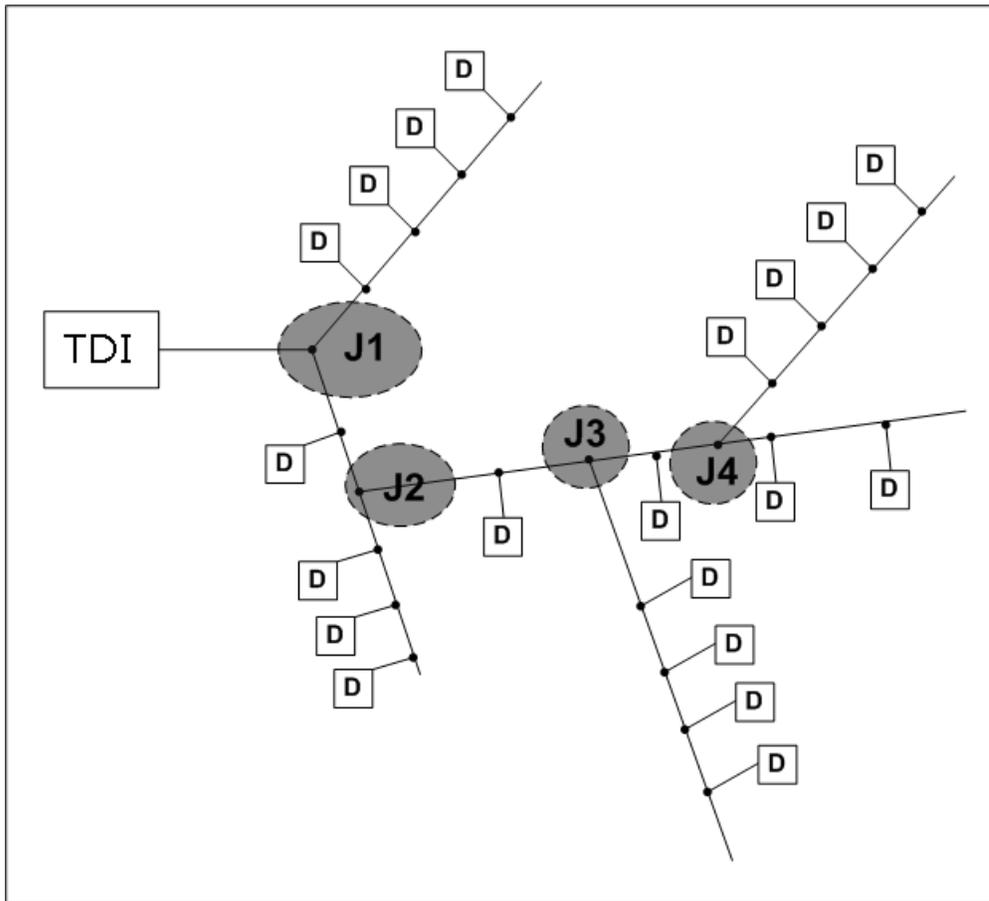
We do not recommend using loops since troubleshooting these can be a complex process.

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.

### **Procedure 8.2. 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 both wires in the two-wire path separately, one at a time. Make a note of your readings as you'll use these for comparison if you need to locate a faulty branch in the field.
  - If one of the cables connected to the TDI loops back to the controller, you must open the loop before measuring.
  - If more than one non-looped cable is connected to the TDI, you can readily determine which cable holds the short - it will be the one with the highest current reading. You can easily disconnect the paths by using the line switch (see Section 3.1.7, "Connecting the Two-wire" [14]).
  - 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 TDI.
  
2. If all readings in the previous step seem OK, or maybe even a bit lower than expected, you could be looking at an 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 defective.

### Procedure 8.3. 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 TDI - perform a binary search (see procedure below) on this part of the cable.
- 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 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.

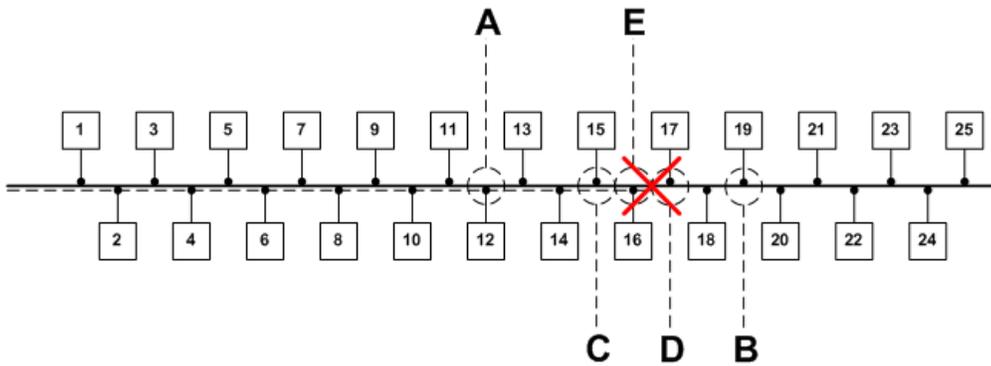
- If you have a station attached to the junction itself, make sure you measure that as well, as the station and not the two-wire could be the problem.
- If you get excessive readings on both branches after the junction but they are significantly lower than at the controller, you have problems on the two-wire on both the section from the controller to the junction, and further out as well. Detach the junction and start by finding the problem on the section from the controller - then attach the junction again and work on each branch.

- When you locate the faulty branch, move on and perform a binary search. See next section.

### Procedure 8.4. 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 high 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 1 but no current is running at station 25. To start the binary search we measure in the middle, at point A:



After measuring in each point, you will know that the problem is between the dots:



- 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.
- 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.
- You measure in point C and find that the current is running. The problem must be between station 15 and 19.
- 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.
- Since you find the current in E to be OK, the problem must be between station 16 and 17.
- If you don't want to replace the entire cable between stations 16 and 17 (it might be a longer section,) you can perform a new binary search on the cable itself.

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# Appendix A. Flashing new Firmware to the TDI System

This appendix contains procedures for flashing new firmware to both the TDI Board and the TDI Extender.



## Note

The most recent firmware version is available from Tucor. Please check [www.tucor.com](http://www.tucor.com) for contact information.

## A.1. Requirements

- A service PC
- USB Cable (USB Type A - Mini USB Type B)
- USB Drivers
- The new firmware

### A.1.1. Installing the USB driver

In case the USB driver is not already installed, you must install it:

1. Connect the TDI Board and the Service PC using the USB cable.
2. Follow the on-screen prompts to install the drivers.

## A.2. Flashing new Firmware to the TDI Board



### Important

In the sequence below, it is essential that you complete steps 5 through 10 while the POWER and ALARM LEDs are still both active. These LEDs are turned as a result of steps 2. If you fail to complete steps 5 to 10, you may have to start the entire process all over.

If you already have a newer firmware, you can find an upgrade menu under the main menu. Here you can upgrade the main board or an extender if fitted. If you select to upgrade the main board, please proceed to step 5.

If there is no upgrade menu, please proceed with all the listed steps.

To flash new firmware:

1. Remove the power from the TDI Board.
2. Press and hold down the **ENTER** button on the TDI panel.
3. Turn on the TDI Board.
4. When the POWER and ALARM LEDs are both lit and flickers, release the **ENTER** button.
5. Connect the TDI Board and the Service PC using the USB cable.
6. Start a terminal application, for instance HyperTerminal.

7. Select the COM port assigned for the USB device.

### Flashing New Firmware to the TDI Extender

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8. Set the following parameters for the serial port:

- 115200 Baud
- 8 bit
- No parity
- 1 stop
- No flow control

9. Press **Enter** on the Service PC keyboard 4 times or until the password prompt is displayed.

At this point, only the POWER LED should be blinking.

10. Enter the password. The flash menu will open:

**TDI boot Vx.xx**

**\*\* Flash Menu \*\***

**1. Flash**

**2. Get Status**

**3. Get Flash Info**

**4. Start**

**5. Exit**

**Choose ->**

11. Press **1** on the keyboard and confirm to flash by pressing **Y**.

12. The following message appears: **Load TDI.chx**.

13. On the menu of the terminal application, select **Transfer/Send text file**. Then select the firmware file: **twi\_x.xx.chx**.

14. After the transfer you will see the message: **Flash completed**.

15. Press **4** to re-start.

16. Remove the USB cable.

17. Proceed to the TDI **Vers Info** screen to verify that the firmware has been updated successfully.

## A.3. Flashing New Firmware to the TDI Extender

Connect the USB cable to the extender board and select upgrade mode for the extender board. Continue from step 6.

To flash new firmware:

1. Power on both the TDI Board and the TDI Extender.

2. Make sure the TDI Board and the TDI Extender are connected to each other.

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Flashing New Firmware to the TDI  
Extender

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3. On the TDI Board, use the item selectors to scroll to main menu, then select **Ext upgrade**.
4. Repeat steps 6 through 17 from procedure **A.2 Flashing New Firmware to the TDI Board**.
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