User Guide

DEVItector™ II V2

Tracing and correcting faults
in electric heating cable systems

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User Guide

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1. WARNINGS

General Precautions

When not in operation detach the power cable from the mains supply.
Also, remove the safety key from the front panel.
The precautions also apply before leaving the High Voltage Unit unattended.

Before usage User Guide must be read and e-Learning must be completed!

ELECTRICAL HAZARD

10 kV~ / 400 V⎓

The DEVItector™ II V2 is a high voltage unit outputs up to 10000 V~/ 400 V⎓!

This equipment must only be used by authorised and instructed personal!
Do NOT leave the unit unattended!
Incorrect use can be fatal!

Besides the operator, all other persons must be kept out of the working range. This also includes animals.

Preferably, the working range is marked by visible markers, i.e. yellow tape.

Unplug all other equipment from the wall outlets to disarm the risk of the high voltage cable terminals touching a wire within the thermostat wall box.

When the burning is activated, DO NOT touch the high voltage cables as neither the RCD relay or the high voltage unit will disconnect in case of a faulty current.

The user must be aware that, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Warning against operation when wet or in wet conditions.

IP class of each part of DEVItector™ II V2 is 20.
IP First number – protection against solid objects, 2 – protected against solid objects up to 12 mm, e.g. person fingers. IP Second number – protection against liquids, 0 – no protection.

WARNING

Take special care considering heavy weight.

ELECTROMAGNETIC HAZARD

The High Voltage Unit can cause radio noise or electromagnetic radiation, so pay attention to time and place and inform people nearby!

Take special care when working at or near hospitals to avoid disturbing medical equipment.

DEVItector™ should not be operated by people with pacemaker or weak heart.

FIRE HAZARD

If the heating cables are not completely covered by non-flammable materials such as sand or concrete, and close to flammable material, cable burning procedure should be undertaken with great caution as the heating cable will burst into open flames at the fault location.

Danfoss A/S doesn't take responsibility for burned property.

RESTRICTION OF USE

The equipment must only be used on electrical heating cables while these cables and their accessories are disconnected from the mains supply and from building installation.

The user must be aware that, if the equipment is used in a manner not specified by manufacturer, the protection provided by the equipment may be impaired.

2. About this guide

This DEVItector™ II V2 guide includes information about tracing and correcting faults in electric heating cables.

The equipment and this guide are intended solely for personnel working in the interest of Danfoss A/S. No part of the equipment is to be resold or handed over to other parties.

The equipment has been tested by Intertek according to EN/IEC 61010-1 with amendments, EN/IEC 61010-2-030 with amendments and EN/IEC 61326-1 with amendments to protect you.

You are obligated to read this instruction carefully. You are dealing with a potentially dangerous piece of equipment. You are responsible for keeping yourself and other persons and property safe.

WARNING: Any kind of equipment must be used by instructed personnel. Any user must sign page Declaration on Safety Rules (see Appendix A) to confirm that he/she fully understands this Guide, all instructions and the safety precautions necessary for operating the DEVItector™ II V2.

3. How it works

Troubleshooting with DEVItector™ II V2 is a structured technique for tracing and correcting faults in electric heating cable systems.
The DEVItector™ II V2 comprises troubleshooting equipment and this guide.

The DEVItector™ II V2 ensures an efficient and easy tracing of heating cable faults.

The system features:
- Automatic test and measurement of electric heating cables.
- Provoking faults in order to speed up the troubleshooting process.
- Tracing hidden heating cables.
- Locating a fault within a few centimeters.

An installed and faulty heating cable is shown on Fig. 1. It is most likely that you do not know the layout of the heating cable as it is embedded in concrete or covered by wood. Instead you will use a magnetic sensor to 'see' through the floor.

To locate the fault, you will have to create a magnetic field along the heating cable. You do this by sending current through the cable. The trick is to create this field only between the cold cable and the fault. Then the magnetic field changes abruptly at the fault.

If the fault is a short circuit, you already have a return path for the current. If the fault is a disruption, you will have to make a short circuit without knowing the location of the fault.

This is done by high voltage burning, in which the polymer insulation between any two conductors is converted into carbon, which is electrically conductive.

A high voltage will burn through the weakest point of the insulation which is at a fault. In case of several faults, they are treated one after another.

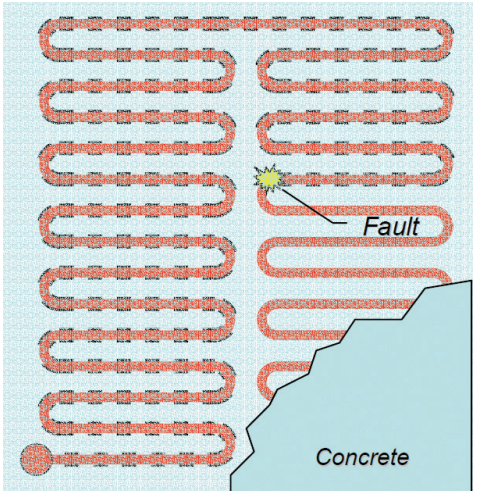


Fig. 1: Heating cable embedded in concrete and invisible to the eye is made visible to the DEVItector™ II V2 tracing equipment. After burning a carbon bridge at the fault, the magnetic field to be traced will appear only between the cold cable and the fault.

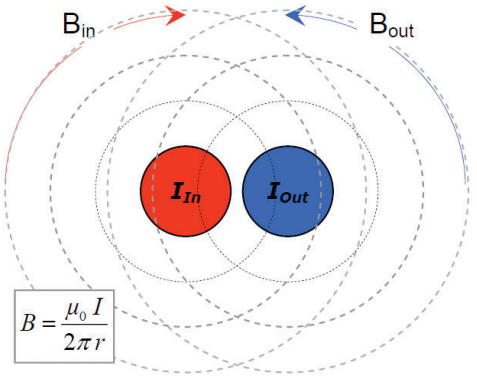


Fig. 2: Sketch of magnetic flux of two conductors carrying current in opposite directions. The magnitude B of the flux is proportional to the current I and decreases with distance r to the conductor. The flux of the two conductors nearly cancels out. Note that the screen may act as one of the conductors.

4. The equipment

The DEVItector™ II V2 equipment comprises:
1. A high voltage unit (HVU) with a built-in 1,8 kHz transmitter.
2. A battery-driven Magnetic tracer on crutch.
3. A battery-driven Magnetic tracer - Hand held.

The devices are shown in Fig. 3.

High Voltage Unit

The high voltage unit is used for creating a short circuit at the fault location by applying a high voltage between two conductors thus burning the polymer insulation into a so called carbon bridge at the fault location.

The HVU also acts as a transmitter exposing the heating cable to a 1,8 kHz square voltage. This signal generates a magnetic field around the conductors from the burner terminals along the cable to the fault location.

Tracer

The tracer is a magnetic sensor which is an open transformer comprising a ferromagnetic yoke and a pickup coil. Thus the 1,8 kHz magnetic flux from the heating cable is converted into an amplitude modulated voltage. This signal is also converted into an acoustical signal and output to a set of earphones.

A maximum tracer signal indicates the closest distance to a cable segment. However, this case may be modified due to the effect of closely neighboring cable segments. The tracer has a gain and volume control which allows you to adjust the meter or volume level to fit the actual depth of the cable.

Fig. 3: Photo of High Voltage Unit (left), the Magnetic tracer on crutch (mid) and the Magnetic tracer - Hand held (right).
Note: The photos are not to scale.

Packing list

The DEVItector™ II V2 set comprises:

1. **One High Voltage Unit (HVU)** in transportation cardboard box with shock absorbing foam.
2. **One Magnetic Tracer**, one Magnetic tracer - Hand held and one earphone headset to be connected to the tracer outlet placed in second transportation cardboard box with shock absorbing foam.

Note: Keep transportation boxes for shipping in case of repair which must be performed by manufacturer (Danfoss A/S).

Enclosed in the top bag attached to the HVU you will find:

3. **Supply cord** for single phase grounded main supply according to EN/IEC 60799: Appliance couplers and cord sets.

Two types are supplied, a type conformant to Danish standards and a type conforming to German standards (Schuco type).

Note: The main supply cord and main plug must comply with national regulations.

4. **Two identical mechanical keys** to lock / unlock the mains supply within the HVU.

5. **Two yellow high voltage outlet cables** attached to the HVU within the top bag. The cables are tied together to minimize radio noise emission.

6. This User Guide.

Unpacking

The equipment should be kept above condensation temperature of the ambient air. If the equipment has been stored at a lower temperature and then brought into a warmer air, it must be acclimatized before use.

Transportation

The transportation cardboard box should be used for transportation to prevent damage from dropping. In particular transportation by air or ship will require a high mechanical shock protection.

Avoid any conducting material like moisture, metal or carbon powder to enter the equipment. Likewise, avoid any spillage of liquids over the equipment.

5. User Interfaces

High Voltage Unit (HVU) user Interface

This chapter explains how to handle the equipment and how to take safety precautions. The actual usage of the equipment is explained in the chapter "Troubleshooting of the heating installation".

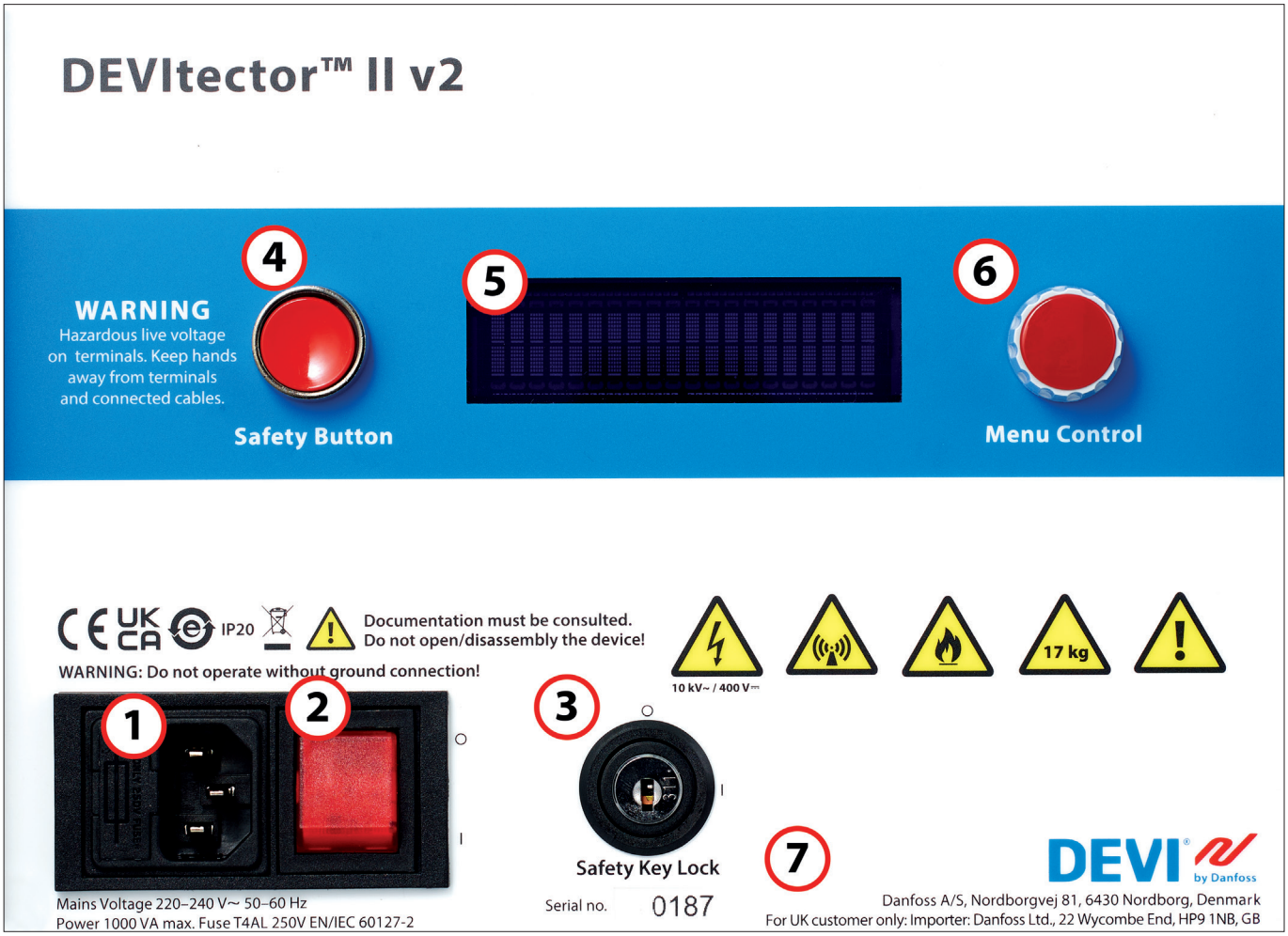


Fig. 4: Front panel of High Voltage Unit. The encircled controls are explained below.

1. Mains connector:
   Male connector with ground for mains supply 220–230 V~ of 50–60 Hz according to EN/IEC 60320-1.

2. Power ON/OFF switch:
   A backlit button to turn ON/OFF the mains supply. Also, the Safety Key must be engaged to operate the HVU.

3. Safety Key Lock:
   Must be engaged to enable the mains supply. Insert key (not shown) and turn right 90° to activate the mains supply.

4. Safety Button:
   Must be engaged (pressed down) continously during burning operation. Releasing the button will switch OFF the high voltage output.

5. Display:
   Used to show the control menu and actual values of voltage, current and pulse cycle.

6. Menu Control knob:
   The knob has two functions:
   - turn it right or left to select menu items on the display, or to change the value of a voltage , etc.;
   - press it down to activate or toggle the selected menu item.

7. Serial no. is located below the Safety Key Lock.

High voltage Outlet Cables

The heating cable is connected to the HVU by two High voltage Cables located in the top bag of the unit. The cables are permanently connected to the unit. The ends are terminated by insulated alligator clips for ease of connection to the heating cable.

Warning. Probe wires should be inspected before use: the outer sheath and clamps sleeves should be checked for possible damage. In case of any damage the device must not be used.

Warning. Probes and wires are not to be repaired or modified. In case of need of repair please contact Danfoss A/S.

HVU safety markings

Front panel of the HVU

The HVU features several safety markings. Below you will for each marking find an image and a description.

Fig. 5: The equipment must only be used on electric heating cables while these cables and their accessories are disconnected from the mains supply or from building installation.

WARNING
Hazardous live voltage on terminals.
Keep hands away from terminals and connected cable.

Fig. 6: Located on front display besides the safety button. The terminals are the alligator clips at the end of the two High voltage Outlet Cables connected through the top side of the HVU.

10 kV~ / 400 V⎓

Fig. 7: High Voltage label located on the front display. The label signifies potentially dangerous levels of electrical energy.

Fig. 8 Electromagnetic hazard label located on the front panel. The label signifies that the High Voltage Unit can cause radio noise or electromagnetic radiation.

Fig. 9 Fire hazard label located on the front panel. The label signifies that cable burning procedure should be undertaken with great caution as the heating cable will burst into open flames at the fault location.

Fig. 10 Heavy product label located on the front panel. The label signifies that the device is heavy and needs special care.

Inside the HVU cabinet

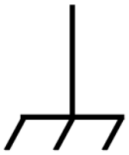


Fig. 11: Protective earth logo located on the inside of the HVU close to the common ground.

High voltage Outlet Cables

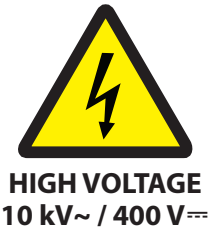


Fig. 12: High voltage Outlet Cables marking.

User Interface of Magnetic tracer on crutch

Fig. 13: Control panel of the large Magnetic tracer on crutch unit.

Control items are explained below.

Gain:
Controls the amplification of the sensor signal as shown on the meter. Turn clockwise to increase, and counterclockwise to decrease amplification.

Offset:
The regulator "zero balance" allows in some cases to compensate for induction of a signal reflected by the pointer indicator.

Volume:
Controls the acoustic amplification of the sensor signal. Turn clockwise to increase, and counterclockwise to decrease amplification.

User interface of Magnetic tracer - Hand held

Gain:
Controls the amplification of the sensor signal as shown on the meter. Turn clockwise to increase, and counterclockwise to decrease amplification.

Fig. 14: Control panel of the small Magnetic tracer - Hand held unit.

Tracers safety

Both Tracer units are battery powered and contains only safe voltage. Can only be used together with DEVItector™ burner unit while in trace mode.

6. Menus of DEVItector™ II V2

Below is shown the display readout for the entire menu structure of the HVU. How to navigate is explained on the pages below.

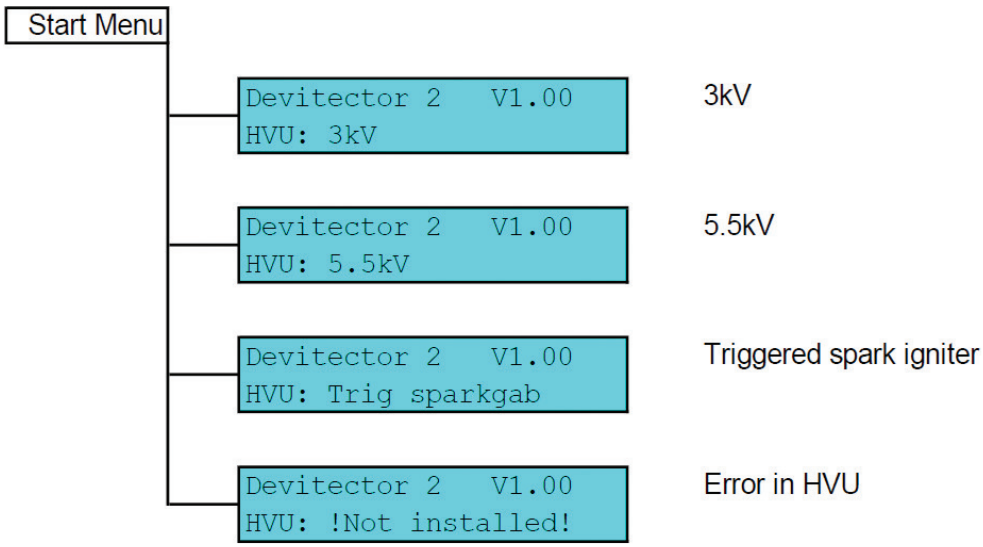


Fig. 15: Start Menu displayed during initialization after power on. After initialization, the Main Menu is displayed. The menu has no user interaction. The item "V1.00" indicates the software version of the HVU.

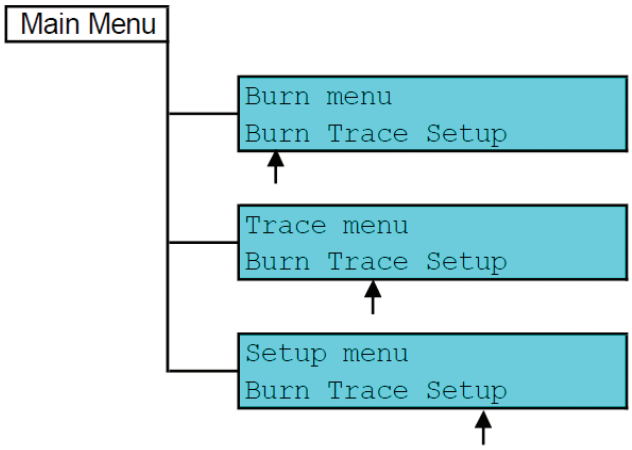


Fig. 16: Main Menu: You can select among three modes: Burn, Trace and Setup. Each of those has their own submenu as shown below.

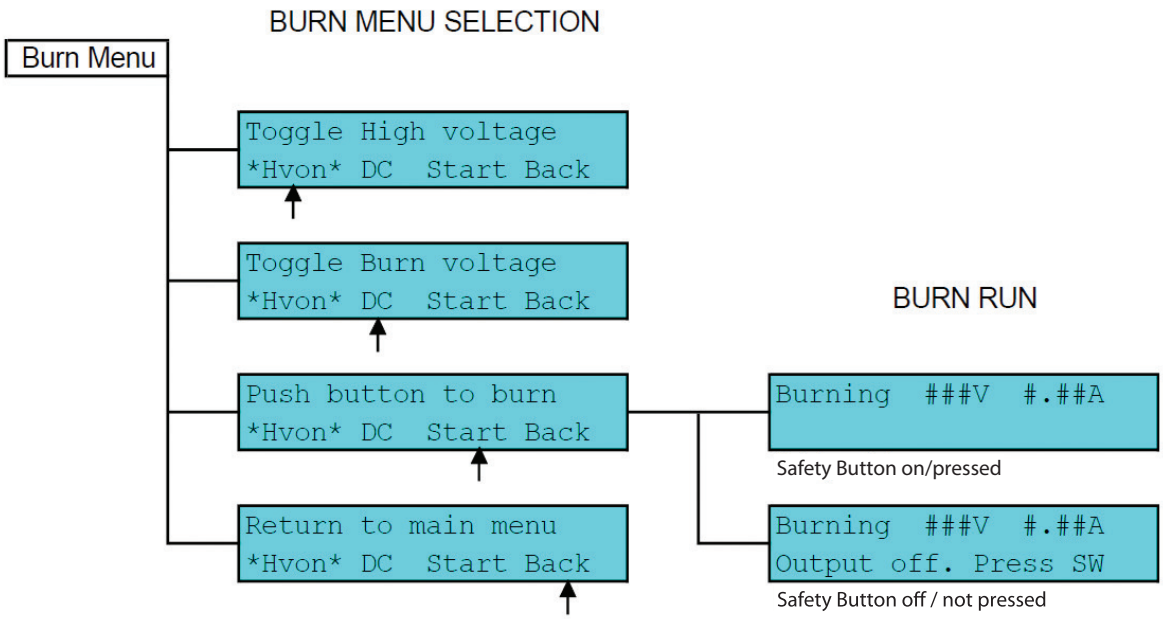


Fig. 17: Burn Menu: The arrow indicates the active menu item as you turn the knob. On the display, the active menu item is highlighted (the arrow is not shown on the display). The character "#" indicates a digit, e.g. "#.##A" representing "1.23A". Please note that the Burn Run display depends on whether you press the Safety Button or not.

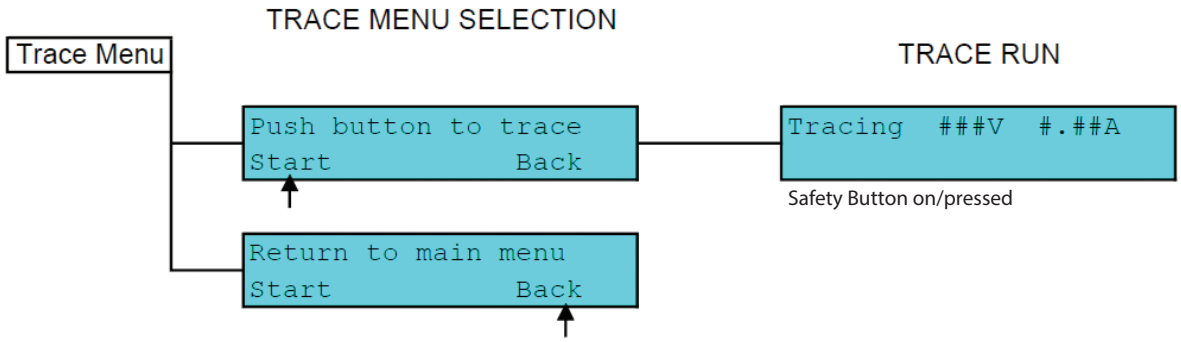


Fig. 18: Trace Menu: The "TRACE RUN" displays the Voltage and current of the signal.

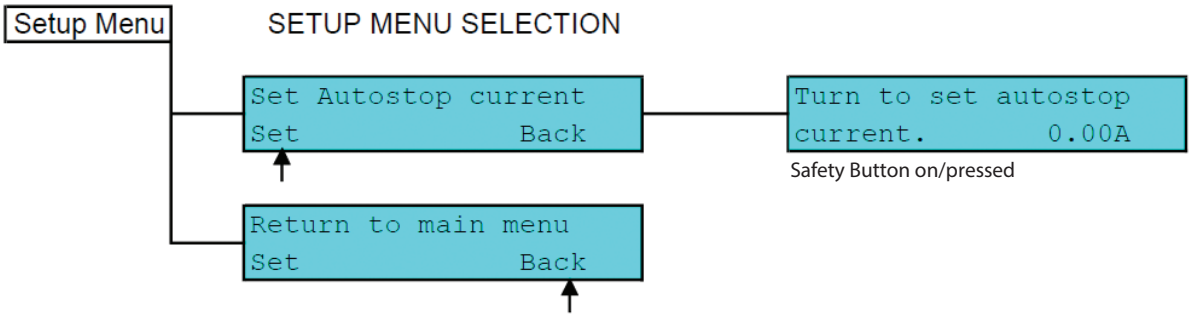


Fig. 19: Setup Menu: Here you select the Autostop current at which the burning operation is halted.

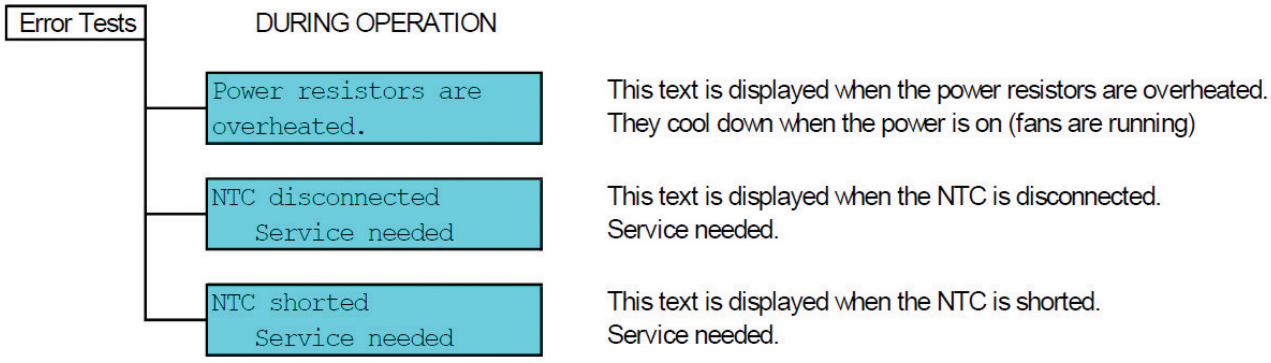


Fig. 20: Error Tests: During operation the HVU continuously tests itself. If one of the tests fails, one of the above error messages will be displayed.

Navigating the menus

The DEVItector™ II V2 has four menu displays as shown above. Each menu display features a number of menu items.

- Selecting a menu item: Turn the knob until the menu item flashes.
- Activating or deactivating a menu item: Press the knob once.
- Changing the value of a menu item:
  - Numbers: A number is composed of one or more digits. Each digits is set in turn until all digits have been entered.
    The background of the active digit will flash. Turn the knob clockwise to increase the value of the digit, turn the knob counterclockwise to decrease its value. Press the knob to enter its value and continue to the next digit.
  - ON/OFF values: Press the knob once.

Power on:

1. Turn the power on safety key in clockwise direction to enable the power supply.
2. Press the backlit red button to activate the power supply.
3. The power on menu will appear in the display.
4. From the power on menu, press the knob/dial once.
5. The main menu will appear in the display.

Start Menu

After power on, the controller software initializes itself and reports the progress in the display.

After initialization the Main Menu is displayed.

Main Menu

Here you select the operating mode among Burn, Trace and Setup.

Burn menu

1. From the main menu, select menu "Burn".
2. Press the knob once to enter the burning menu.
3. The Burn menu will appear in the display. High Voltage and DC voltage will be activated by default.
4. Burning:
   a. HV and DC must be activated. Select menu item "Burn" and press the knob once. To activate the burning, you need to press the Safety Button for the desired duration of the burning process.
   b. To stop the burning process, release the Safety Button, press the knob once again or switch OFF the power using the red button or the safety key.
   c. Adjust the DC voltage by turning the knob.
   A low DC voltage may cause a slow burning process.
   A high DC voltage may cause a poor carbon bridge to appear due to violent burning. This will make it difficult or impossible to trace the fault.
   The conductivity of the carbon bridge must be several times larger than the heating conductors in order to short circuit the remainder of the heating cable.

Trace menu

1. From the main menu, turn the knob to select menu item “Trace”
2. Press the knob once to enter the tracing menu.
3. Select a proper value of the tracing voltage.

Setup menu

1. From the main menu, turn the knob to select menu item “Setup”.
2. Press the knob once to enter the setup menu.
3. Turn knob to set the Autostop Current to the desired value, e.g. 1,00 Ampere.

7. Troubleshooting a heating system installation

Troubleshooting a heating system involves a diagnosis of
1. Power supply
2. Controller (thermostat) and sensors
3. Heating element(s)/heating cable(s) followed by a correction of the fault.

Diagnosing the installation

Note: You must follow this guide to ensure a safe and optimal troubleshooting.

Warning. Conductive building materials, e.g. metal mesh in concrete, metal water pipe, drain pipe, etc., might be in contact with cable under test. These building materials or other metal parts might be not grounded and, in this way, be dangerous during the testing process.

1. Make sure that the circuit breakers, the optional Residual Current Device (RCD) and the mains voltage all are working properly and have correct size/ value.
   Do not proceed until this is the case.
2. Test the controller/thermostat:
   Does it activate/deactivate, when the temperature setting is changed?
   If Yes go to step 5.
3. Check the external temperature sensor.
   The resistance value [kOhm] for sensors may be found in the installation instructions or in the product catalogue.
   If the sensor is faulty, replace it and continue with step 5.
4. Repair or replace the controller/thermostat.
5. Check the output of the controller/thermostat.
   If it is missing, continue with step 4.
6. If no faults appeared in the above tests, the heating element/heating cable is probably faulty.
   If a mistake occurs, check the heating element/ cable before proceeding.
7. Disconnect the thermostat from the heating element/cable before starting the measurement of the resistances.
   Note: De-energize all power circuits before the disconnecting.
8. Measure the resistance of the heating element/ cable using an ohm-meter. Resistance values of heating element/cable may be found in the Data Sheet, Product Catalogue, etc.
   Compare the measured resistance of the heating element/cable to the resistance of a representative heating element.
   If the two values differ significantly, you probably have a faulty heating element/cable.
9. Measure the insulation resistance of the heating element/cable using an megohmmeter. The insulation resistance should read >20 MOhm after one minute at min. 500 V, preferably 2,5 kV.
   If the insulation resistance value is lower than 20 MOhm, you probably have a faulty heating element/cable.
   Note: Real insulation resistance of heating cables is usually more than 100 MOhm or even 1000 MOhm, and depends from cable length, cable age, moisture conditions, etc.
10. A heating cable fault has now been verified and you may start the troubleshooting process.

Common types of electric heating cables

Before you start measuring the cable, it is important to know the different types of faults, and how they affect the diagnosis. The 4 most common cable types are shown below. They feature from one to three conductors, including the optional screen. Heating cables having more than three conductors are treated similar to twin conductor cables.

Note: Only heating cables with two or more conductors can be handled by the DEVItector™. The tracing principle is based on an electrical return path within the heating cable. So, keep in mind that "Single conductor without screen" cable is not possible to be handled by the DEVItector™.

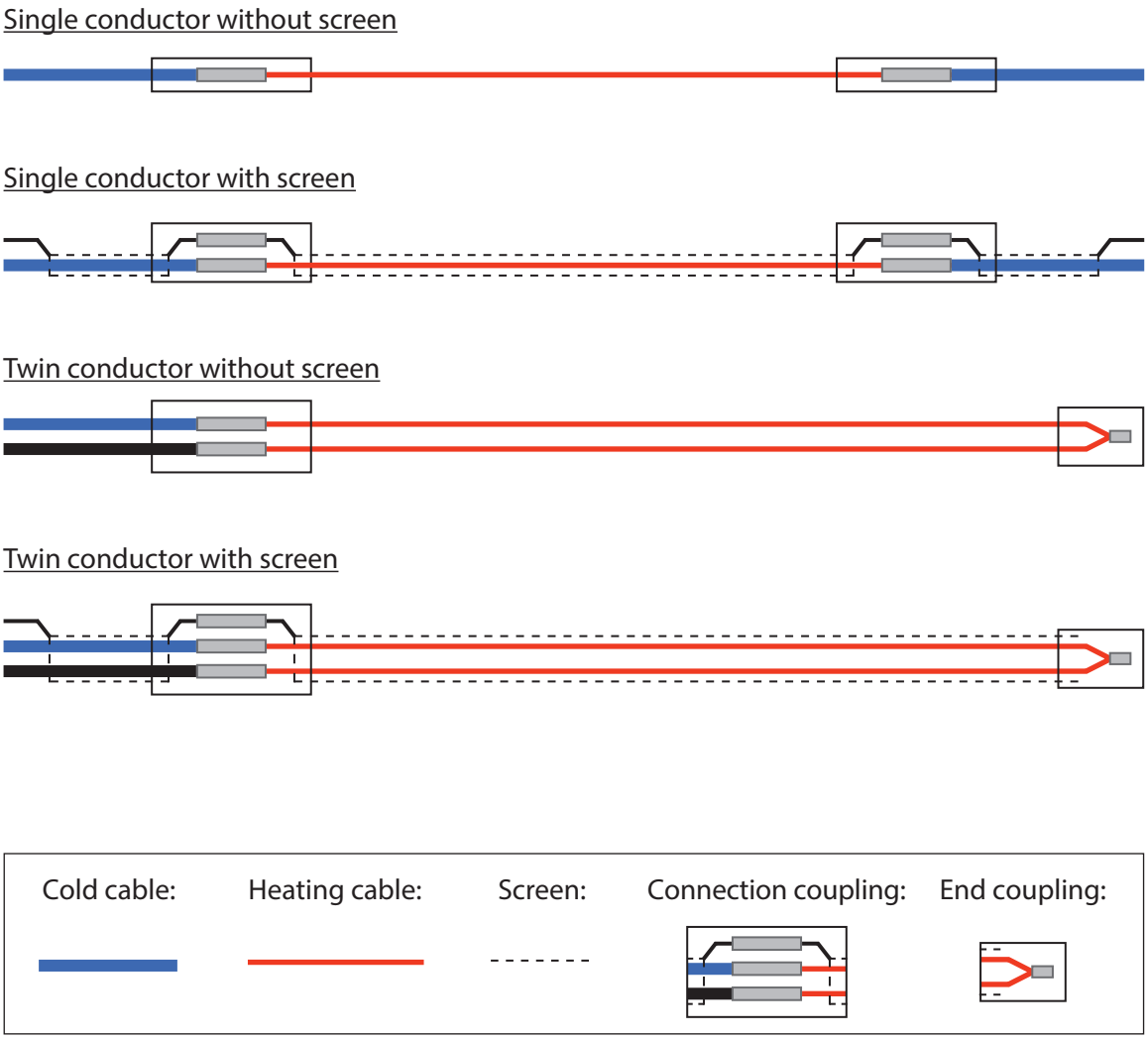


Fig. 21: Four types of heating cable. The first two cables are single conductor cables, and the last two are twin conductor cables. Drawings indicates heating conductors as "heating cable".

Fault symptoms

The types of faults comprise:

- One or more of the conductors disrupted (open circuit).
- Short circuit between two or more conductors.
- Combination of disruptions and short circuit.

The table below show the symptoms for a given combination of heating cable and type of fault.

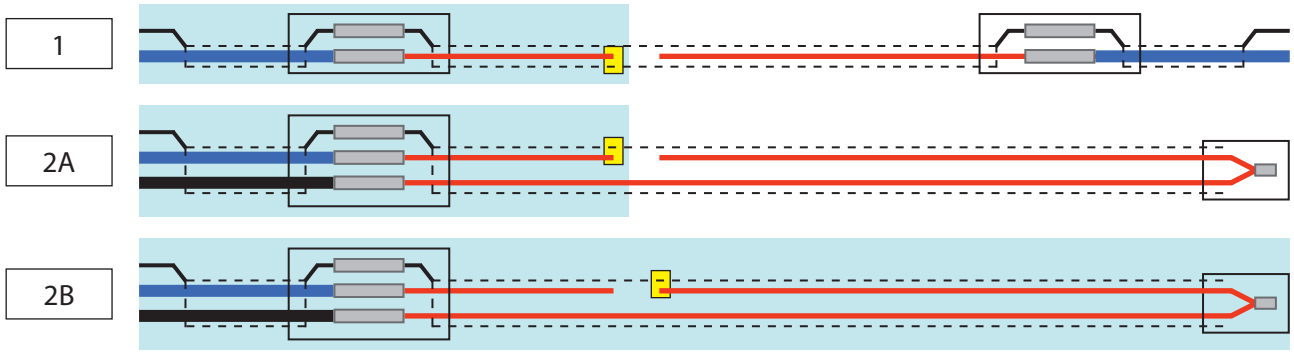
Cable / Fault	Disruption of		Short circuit between	
	Screen	**Conductor (L or N)**	**Screen and Conductor**	**Conductors (L and N)**
Single conductor with screen	Will not show	No heat **Fault no. 1**	RCD-relay cut off or fuse is burnt out **Fault no. 3**	
Twin conductor without screen		No heat **Fault no. 2**		Fuse is burnt out **Fault no. 5**
Twin conductor with screen	Will not show	No heat **Fault no. 1**	RCD-relay cut off or fuse is burnt out **Fault no. 4**	Burnt fuse **Fault no. 5**

= No action!

= Not possible!

Gallery of Heating Cable Faults

Fault no. 1 : Conductor is (L or N) disrupted and screen is present



No connection can be measured in the heating conductor (infinite resistance or very high resistance as compared to the heating wire).

The insulation resistance of the heating cable is assumed OK.

In this case the idea is to burn a connection or carbon bridge (shown as a small yellow box) between the disrupted conductor and the screen. The carbon bridge is then used for tracing. In case of a single conductor [1] the burning is straight forward.

In case of a twin conductor [2], one of two situations may occur:

2A: The carbon bridge connects to the shortest part of the disrupted conductor. This case may be traced directly.

2B: The carbon bridge connects to the longest part of the disrupted conductor. This case is not traceable, as the tracing signal will radiate from the entire length of the cable.

Note: In cases [1] and [2A] a further situation may occur. The screen typically is formed by a bundle of wires which may or may not touch each other along the length of the cable. Imagine that some of the screen wires are disrupted and the carbon bridge connects to the right side of one of these. Then the tracing signal will extend from the cold cable until the point at which the connected screen wire touches one of the undisrupted screen wires, much like the situation in case [2B].

If a twin cable cannot be traced like in [2B], try to burn a carbon bridge between the two conductors.

The blue bars on the pictures above are shown the area of tracing signal availability.

Fault no. 2: Conductor (L or N) disrupted and no screen is present

A connection cannot be measured in the heating conductor (infinite resistance or a decreased conductivity).

In this case the idea is to burn a connection between the disrupted conductor and the other conductor.

This is done by burning between the two conductors, to create a carbon compound at the point of disruption. The carbon bridge is then used for tracing.

Fault no. 3 : Screen/conductor short circuit, i.e. a high leakage current may be measured

The resistance of the heating cable is OK. It is possible to measure a finite resistance between conductor and screen. The value will depend on the distance between cold cable and fault.

In this case the idea is to use the short circuit between conductor and screen for tracing.

No burning is required unless the short circuit turns out to be unstable.

Fault no. 4 : Screen/conductor short circuit

The resistance of the heating cable is OK.

It is possible to measure a finite resistance between conductor and screen. The value will depend on the distance between cold cable and fault.

In this case the idea is to use the short circuit between conductor and screen for tracing.
No burning is required.

As the end-terminated heating conductor is not disrupted, the shortest path from cold cable to fault is the one with the least resistance assuming identical resistances of the two conductors. The longest path (the lower conductor on the above sketch) will emit a magnetic field along the entire heating cable.

Thus only the conductor having the shortest path will make the tracing possible.

If it is impossible to determine the conductor having the shortest path, it is necessary to trace the cable twice, first with one and then with the other conductor, respectively.

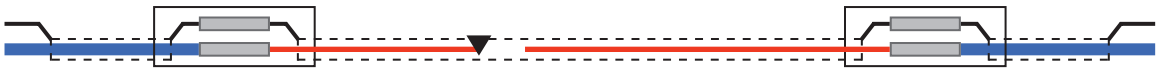
Fault no. 5 : Conductor (L/N) short circuit

The resistance of the heating cable is reduced, depending on the distance between cold cable and fault.

The insulation resistance of the heating cable is OK.

In this case the connection between the two conductors is used for tracing. No burning is required unless the short circuit is unstable.

Fault no. 1 and no. 3: Conductor is (L or N) disconnected and screen/conductor short circuit

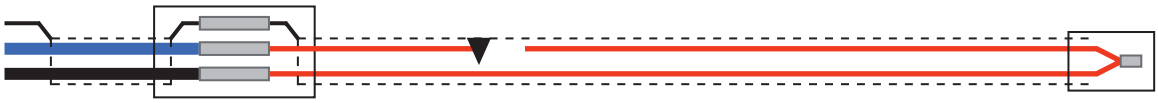


A poor connection can be measured through the heating conductor (infinite or too high resistance). A finite resistance between screen and conductor may be measured.

In this case the short circuit between conductor and screen is used for tracing. No burning is required.

By measuring the resistance between the screen and the two conductors (L and N), you may be able to locate the heating conductor having the shortest distance to the fault.

Fault no. 1 and no. 4: Conductor is (L or N) disconnected and screen/conductor short circuit



No connection is measured in the heating conductor (infinite or too high resistance). The insulation resistance also shows a fault, and it is possible to measure a finite resistance between conductor and screen.

In this case the connection between conductor and screen is used for tracing.

Fault no. 4 and no. 5 : All three conductors (L, N, screen) short circuit

The resistance of the heating cable is reduced depending on the distance between cold cable and fault.

The resistance between screen and anyone conductor is finite, signifying a short circuit. In this case, the tracing may be carried out using any two conductors of the heating cable.

As shown in the examples it is recommended to use the authorised cable testing equipment to facilitate the choice of the troubleshooting process.

In some cases you may go directly to tracing, and in some cases you will need to burn the necessary connection for use in the tracing process.

For appropriate use of the equipment, please proceed to the next section.

8. Burning and Tracing

When the cable fault is a disruption or a weak connection (high resistance), the burning procedure should be followed.

WARNING

Hazardous voltage on terminals. Keep hands away from terminals and connected cable.

WARNING

If the heating cables are not completely covered by non-flammable materials such as sand or concrete, and close to flammable material, cable burning procedure should be undertaken with great caution as the heating cable will burst into open flames at the fault location.

WARNING

Burning can produce smoke – secure ventilation of the room.

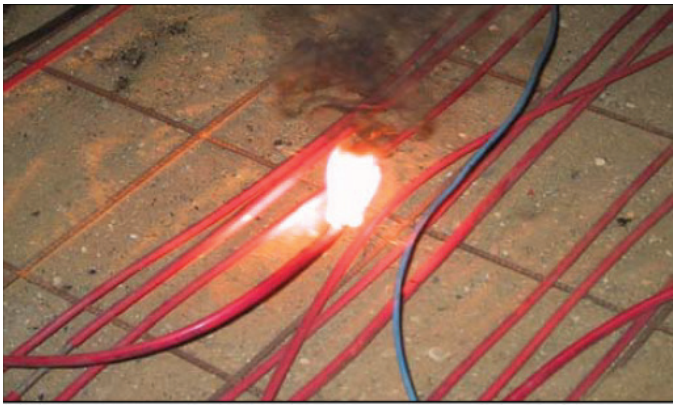


Fig. 22: Photo of HVU-treated heating cable installed in open air on sand

Overload protection

The DEVItector™ II V2 unit has several built-in overload protection modes.

Burning mode
A software-controlled reversible thermofuse monitors two power resistors. If their temperature exceeds 75 °C the display will show the message "Power Resistors Overheated" and you will have to let the HVU cool down for several minutes before proceeding.

Note: Do not switch power OFF when HVU is cooling down because of possible work of fans.

The temperature sensor itself is monitored. If it should disconnect, the display will show the message "NTC disconnected". If it is shorted, the display will show "NTC shorted". In both cases, authorized repair will be needed.

The DC voltage is limited by software to yield a maximum of 3A current. The limiting is automatic and requires no user intervention.

Resetable thermo fuses
If DEVItector™ is in Burning mode and does not produce sparks the resettable thermo fuse could be OFF. The thermo fuse will automatically restore On condition after approx. 10–20 min.

Note: Do not switch power OFF when HVU is cooling down.

Burning procedure

Preparations

1. Choose a mains outlet to supply the HVU.
2. Disconnect all other equipment which are connected to the supply line of that outlet.
3. Connect the HVU to the mains outlet.
4. Switch OFF the HVU.
5. Disconnect the heating cable from the controller / thermostat.
6. Connect heating cable to the sockets of the HVU outlet cables. Make sure that other cable terminals (e.g. the floor sensor cable) will not touch the HVU outlet terminals. Generally, the optimal pair of conductors of a screened twin heating cable is the pair exhibiting the lowest resistance.
7. Insert safety key.

Burning

8. Switch ON the HVU. The HVU initializes through the Start menu and enters the Main menu.
9. Select the Setup menu if you want to use the Autostop current feature.
   - Select Set menu and enter the desired Autostop current allowed through the carbon bridge, e.g. 1.20 A.This setting will stop the burning process when the chosen current has been obtained. The Autostop current will protect the insulation material against a too violent burning which ultimately may destroy the carbon bridge. An Autostop value of 0,00 Ampere indicates no Autostop current and you will have to stop the burning process manually.
   - Exit to the main menu by choosing the Back menu.
10. Select the Burn menu.
11. Select "HVon" and activate (the circular indicator in the display is highlighted). The role of the HV-pulse is to "shoot" through the insulation thus paving the way for the DC current.
12. Select menu "DC" and activate (highlight the circular indicator in the display). The role of the DC current is to form the carbon bridge.
13. Select "Start" and activate by pressing and releasing the knob and then press and hold the safety button during the burning process. Clicks of the relay will be heard. Pulses of high voltage, 10 kV, will be sent to the heating cable and lead to a breakdown/short circuit" of the cable's faulty section.
14. To build-up the carbon bridge, increase the DC voltage by turning the knob stepwise. You may at any time pause the burning operation by releasing the safety button.The burning will stop once the Autostop current has been reached. If you have not activated the Autostop current, you will have to observe the current shown in the display until a desired value has been reached. If the current does not settle but varies between zero and a higher value, do increase the voltage one step further. When it does settle, stop the burning by pressing the knob. You are now back in the Main menu.
15. Check the stability of the carbon bridge by the following procedure: Leave the HVon disabled, do enable the DC voltage and start burning. Turn the knob to achieve 100 V and observe if the current is of the magnitude 0,5 A or higher, that is the carbon bridge has a resistance of 200 Ohms or less.

    Note: If water has entered the heating cable, the burning of a carbon bridge may last considerably longer, say 10–20 minutes.
16. If the carbon bridge turns out to be unstable it is necessary to repeat all operations from step 9, 10.
17. After reaching a stable burning current, stop pressing the Safety Button to stop the burning.
18. Select menu "Back" of the burn menu to reach the main menu.
19. Switch OFF the device.

Tracing procedure

WARNING

Hazardous voltage on terminals. Keep hands away from terminals and connected cable.

The tracer is battery-driven and it is recommended to switch OFF the tracer when not in use to increase battery life.

1. Connect the HVU outlet cable to the heating cable if not already connected.
2. Select menu "Burn/Trace".
3. Select menu "Trace".
4. Square pulses of 1,8 kHz frequency now flows into the heating cable.
   Depending on the depth of a cable installation, you may change the tracing current by the knob. Normal values of the tracing current are within the 300–500 mA range.
5. Connect the earphone headset to the tracer console and mount the headset.
6. Use the magnetic tracer on crutch to follow the heating cable starting from the cold cable. Sweep sidewards to find the highest acoustic signal, that is the location of the heating cable.
7. Adjust Gain, Offset or Volume if needed.

Moving the tracer

When tracing a heating cable it is important to keep the tracer steady and in a vertical angle with a constant distance to the floor.

Do not rotate tracer in a vertical axis.

Tracing the heating cable

When trying to locate the heating cable you must move the tracer until the readout on the meter is at maximum. Then move the tracer along the cable keeping track by means of the readout of the meter. It is important always to keep the tracer „lengthwise" to the cable. If the tracer is turned 90° in relation to the cable, the read out will be reduced to some extent. In this manner, it should be possible to trace the cable along its length across the floor. The signal should vanish where the fault is, that is when you pass the fault, the tracer readout drops to the low level adjusted on the meter.

Beware of the special situations of screened cables described in section "Gallery of Heating Cable Faults".

You can now break up the floor and repair the heating cable!

Twist effect (Transposition)

When tracing heating cables, it may seem as the cable is wriggling along the floor (like a loop). However, the cable is probably laid down in a straight line, but the transposition of the relationship between the two conductors used in the cable, gives a „twist effect" of the signal which is seen on the tracer.
Therefore, the tracer will at some locations show a maximum signal when the tracer is right on top of the cable, but at other locations will show a maximum readout when the tracer is somewhat to the left or right along the cable.
It makes the tracing of the cable slightly more difficult, but when looking at the average line along the floor, it should not cause any problems.

Single conductor without screen

With regards to single conductor cable faults without screen, it is not possible to use the described equipment, as two conductors are not provided.

Guidelines for tracing an area

We propose a guideline for tracing which is independent of the layout of the heating element. Often you will have no documentation (drawings or photos) of the layout of the heating element(s). Even if you have a drawing, there is a possibility that the installer has chosen his own layout. So you cannot use your eyes and you have to rely on the magnetic tracer and / or your ears.

In the following, we assume that the fault will bridge at least two conductors within the cable thus making a current path for the tracing signal. The bridge is either a shortcircuit or a carbon bridge created by the devitector II burner device. We also assume that the fault is not located near the end termination of a twin cable.

We suggest the procedure below to minimize the duration of the tracing.

Preparations

a. Connect the cold tail of the faulty cable to the output cables of the burner.
b. Activate the tracing signal using the Trace menu.

Step 1

First, trace the faulty cable from its supply terminal within a radius equal to the length of the cold tail as shown on Fig. 21. The search circle is shown shaded at the lower left corner of the sketch. If the fault resides in the cold-warm connection, you will thus have found it quickly. If it does not, then proceed to Step 2.

Step 2

Trace the floor along parallel lanes as shown on Fig. 24, starting at the cold tail. It doesn't matter which direction you choose as seen on Fig. 24. The lanes should be no wider than 50 cm apart. For this coarse tracing, you may prefer the tracer mounted on the crutch. At every point, where the tracing signal disappears or reappear, place a mark on the floor, shown as X on the sketches. Also place a mark along a new lane if its neighboring lane was opposite in the signal sense, that is if the new lane gives a signal and its neighboring lane did not, and vice versa. Be careful to follow parallel lanes of equal separation. You should trace enough of the floor area to be sure to cover the faulty cable.

Step 3

Trace the area surrounding the marks made in step 2, shown as yellow areas on Fig. 25. In doing this you may prefer to trace along narrow lanes of say 15 cm, thus narrowing in on the fault. In this way you will find a more precise boundary between active and nonactive heating cable. For this fine tracing, you may prefer to use the handheld tracer.

Depending on the floor construction (concrete and tiles, wood on joists, etc.) you may be able to hear the more precise location of the fault. This requires switching OFF the tracing signal and switching ON the High Voltage Pulse and making sure the DC Voltage is zero. Using the high voltage signal may destroy the carbon bridge temporarily.

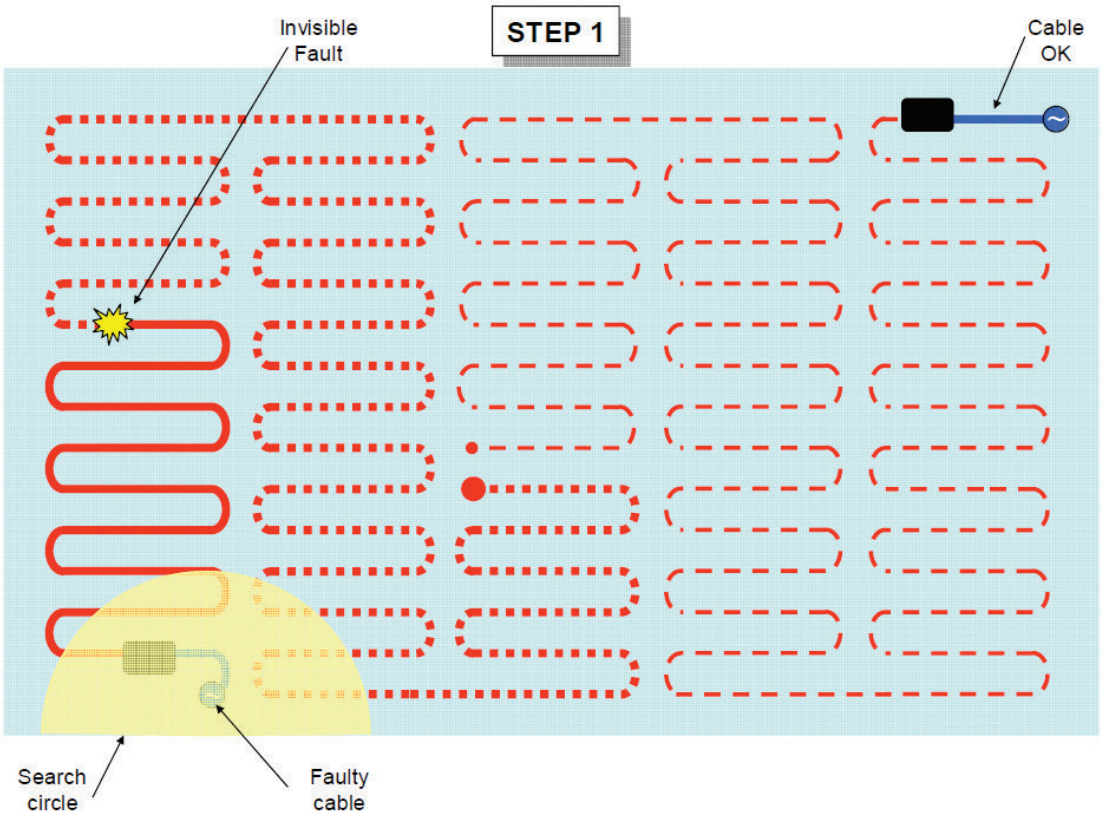


Fig. 23 Step 1: Sketch showing a room having two heating elements of which only one is faulty.

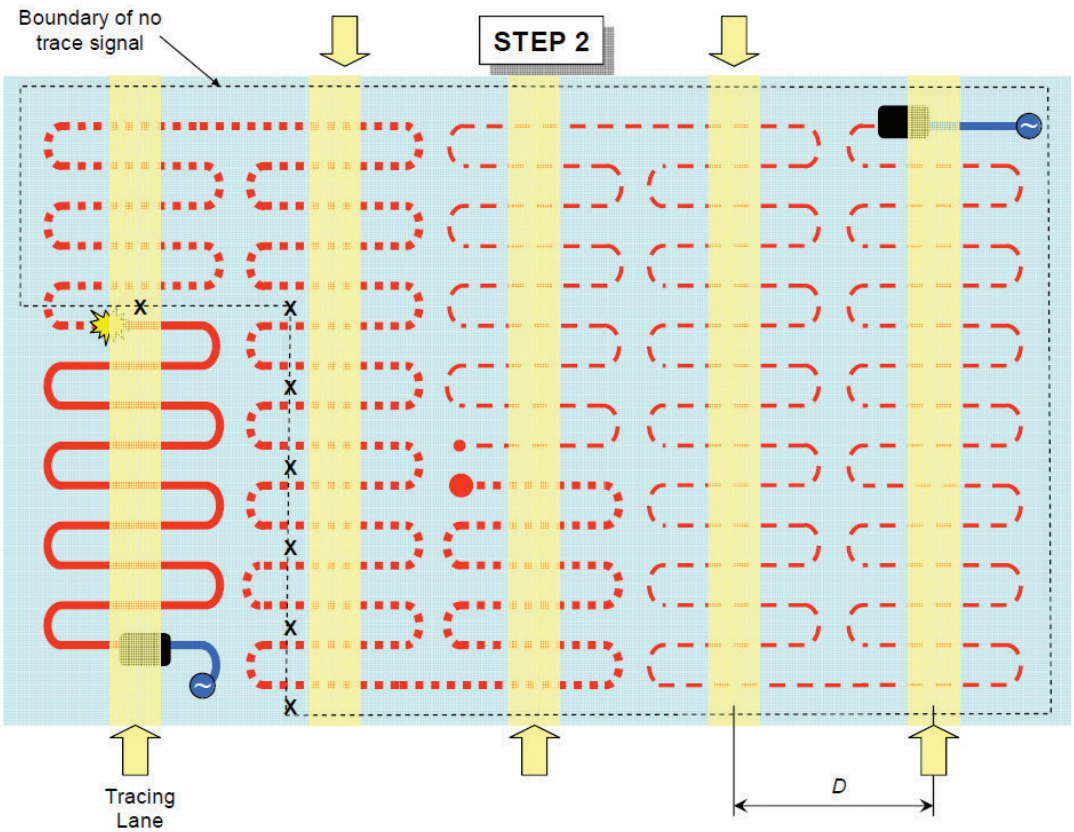


Fig. 24 Step 2: Trace the floor along parallel lanes a distance D=50 cm apart, shown as transparent yellow.

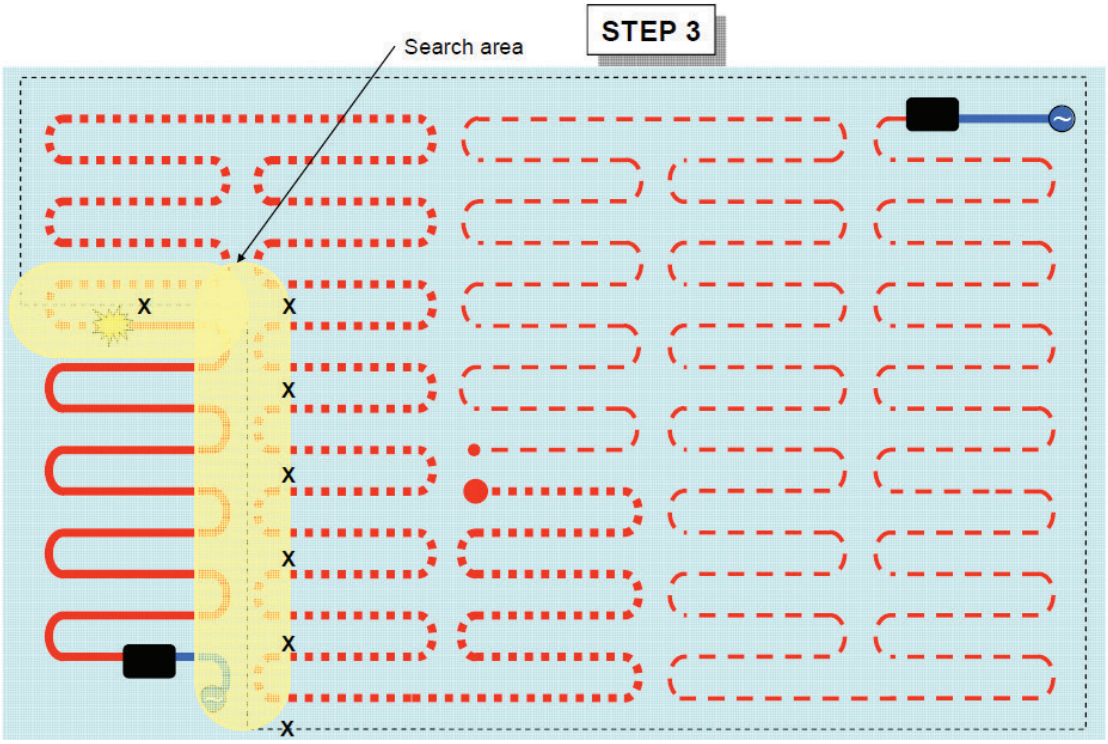


Fig. 25: Step 3: Trace the area around the marks of step 2. (shown as yellow areas around marks X).

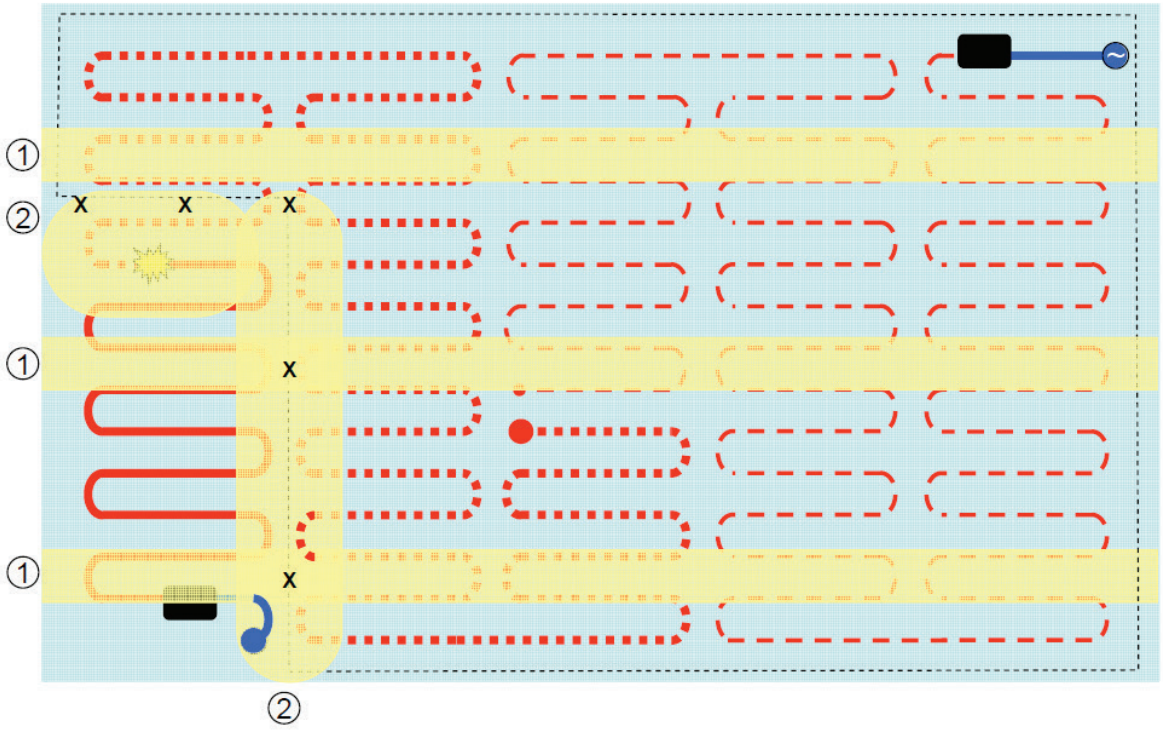


Fig. 26: An alternative tracing direction along lanes marked ① will result in the same search area marked ②.

Hard cases of tracing

a. In case of a disrupted conductor of airembedded cabled under a wooden floor: Do only use the high voltage pulse to generate an acoustic signal at the fault, **do not** overlay the DC voltage as you may very likely start a fire underneath the wooden floor covering.

   In this way you will have to rely on acoustic localization, that is your ears.

b. Twin cables / mats having a fault at or close to the end terminal: The tracing signal will be live along the entire cable length. You will have to rely on acoustic localization.

c. Fault located underneath a permanent installation, e.g. a room divider, a bath tub, etc. You will have to rely on acoustic localization.

d. Unable to burn a carbon bridge; this may be the case for a cable having silicone as primary insulation. You will have to rely on acoustic localization.

Correction of fault

WARNING

Hazardous voltage on terminals. Keep hands away from terminals and connected cable.

Once the fault has been located you will have to remove the floor covering to make the fault accessible. Take care to minimize the damage to the floor covering.

Remove the burnt section of the cable so only undamaged cable remains. Find a proper length of heating cable which is of similar type and linear resistance [Ω/m] as the installed cable.

Splice the substitute cable to the installed cable and seal with shrink fitting tube on all conductors including the screen and seal the entire assembly with shrinkfitting tube.

Applicable repair kits can be found in Product Catalogue, Data Sheets, etc.

9. Glossary

RCD	Residual Current Device. An electronic device normally located in the electric supply branch of a building. It monitors the difference between in-going and outgoing current and if this difference exceeds a threshold, say 30mA, it will cut off the mains supply.
HVU	High Voltage Unit, also known as the burner.
Burner	The HVU of the DEVItector™ II V2 equipment.
Tracer	An electromagnetical sensor which transform a magnetic flux into an acoustic signal. The amplitude indicates the proximity to the heating cable.
Connection coupling	The electric connection between the conductive (cold) and resistive (warm) parts of a complete heating cable.
Screen	Electrical shielding surrounding the live parts of the heating cable. The screen may be realized as twisted wires or a wrapped foil.
Conductor	Common term for either a heating wire or the screen

10. Ordering information

For safety reasons do only use replacements delivered from Danfoss A/S according to the table below.

Item no.	Description	EAN no.
12609001	Magnetic tracer on crutch for DEVItector™ II V2	5703465026602
12609002	DEVItector™ II V2 High Voltage Unit (Burner) with Magnetic tracer - Hand held	5703466111352

11. Data sheet

High Voltage Unit (HVU)	
Equipment specification	Class I Installation category II Pollution degree 2
Power Supply	
Mains Supply	220–240 V~, 50–60 Hz, 1000 VA Voltage fluctuations may not exceed ±10% of nominal value
Fuse at mains connector	4TAL 250V EN/IEC 60127-2
At transformer secondary coils	5A, 2×2A, 0.5A
Burning Mode	
Burning DC Voltages (No load)	41, 82, 123, 164, 205, 246, 287, 328, 369 V⎓
Short Circuit Currents	Limited by Software to 3 A⎓
Measuring	Readout on 2x20 character Vacuum Fluorescent Display: Probe Voltage: 0–400 V⎓ Probe Current: 0–3.00 A⎓ Probe High Voltage Pulse: 0–10 kV
High Voltage Pulse	10 kV
High Voltage Pulse Energy	0,38 J
Max. Pulse Energy	70 J
Number of High Voltage Pulses	1–3 pulses/sec.
Tracing Mode	
Trace Frequency	1,8 kHz
Tracing Voltages (No load)	5, 10, 15, 20, 25, 30, 35, 40 V RMS
Short Circuit Currents	80, 160, 240, 320, 400, 480, 560, 640 mA RMS
Measuring	Readout on 2x20 character Vacuum Fluorescent Display: 0–1.00 A RMS
Volume control	Adjustment of sound in headphones
Other	
Overheat protection	Software controlled cut-off at 3 A or at 75 °C.
Safety in Burning Mode	Only operable with Safety Key
High Voltage Unit should be ON and Safety Button should be pressed to proceed the burning process.	
Mechanical	
Cabinet dimensions	250 x 260 x 380 mm
Weight	17 kg
IP Class	IP20
Approvals	The equipment has been tested by Intertek according to EN/IEC 61010-1 with amendments, EN/IEC 61010-2-030 with amendments and EN/IEC 61326-1 with amendments.
Environment	For burner and tracer: indoor and outdoor use. Temperature range: 5 °C to 40 °C. Altitude: up to 2000 m above sea level. Humidity at 31 °C: max. 80% linear falling to 50% at 40 °C.

Magnetic tracer on crutch unit	
Power Supply	
Mains Supply	4 x 1,5 V⎓, battery type AA
Tracing Mode	
Trace Frequency	1,8 kHz
Gain control knob	Adjust to control amplification of tracer signal
Offset control knob	Used to compensate for induction of a signal reflected by the pointer indicator.
Volume control knob	Adjustment of sound in headphones and ON/OFF unit
Mechanical	
Dimensions	160 × 300 × 970 mm
Weight	1,5 kg
IP class	IP20
Approvals	The equipment has been tested by Intertek according to EN/IEC 61010-1 with amendments, EN/IEC 61010-2-030 with amendments and EN/IEC 61326-1 with amendments.
Environment	For HVU tracer mode: indoor and outdoor use. Temperature range: 5 °C to 40 °C.
Magnetic tracer - Hand held unit	
Power Supply	
Mains Supply	1 x 9 V⎓, battery type PP3 / 6F22 / 6LF22
Tracing Mode	
Trace Frequency	1,8 kHz
Volume control knob	Adjustment of sound in headphones and ON/OFF unit
Other	
Mechanical	
Dimensions	65 x 105 x 40 mm
Weight	0,2 kg
IP class	IP20
Approvals	The equipment has been tested by Intertek according to EN/IEC 61010-1 with amendments, EN/IEC 61010-2-030 with amendments and EN/IEC 61326-1 with amendments.
Environment	For HVU tracer mode: indoor and outdoor use. Temperature range: 5 °C to 40 °C.

12. Warranty

A 2-year product warranty is valid for:

- other products: DEVItector™.

Should you, against all expectations, experience a problem with your DEVI product, you will find that Danfoss offers DEVIwarranty valid from the **date of purchase** on the following conditions: During the warranty period Danfoss shall offer a new comparable product or repair the product if the product is found to be faulty by reason of defective design, materials or workmanship. The repair or replacement.

The decision to either repair or replace will be solely at the discretion of Danfoss. Danfoss shall not be liable for any consequential or incidental damages including, but not limited to, damages to property or extra utility expenses. No extension of the warranty period following repairs undertaken is granted.

The warranty shall be valid only if the WARRANTY CERTIFICATE is completed correctly and in accordance with the instructions, the fault is submitted to the installer or the seller without undue delay and proof of purchase is provided. Please note that the WARRANTY CERTIFICATE must be filled in, stamped and signed by the authorized installer performing the installation (Installation date must be indicated). After the installation is performed, store and keep the WARRANTY CERTIFICATE and purchase documents (invoice, receipt or similar) during the whole warranty period.

DEVIwarranty shall not cover any damage caused by incorrect conditions of use, incorrect installation or if installation has been carried out by non-authorized electricians. All work will be invoiced in full if Danfoss is required to inspect or repair faults that have arisen as a result of any of the above. The DEVIwarranty shall not extend to products which have not been paid in full. Danfoss will, at all times, provide a rapid and effective response to all complaints and inquiries from our customers.

The warranty explicitly excludes all claims exceeding the above conditions.

For full warranty text visit **www.devi.com. devi.danfoss.com/en/warranty/**

WARRANTY CERTIFICATE

The DEVIwarranty is granted to:

Address _____ **Stamp**

Purchase date _____

Serial number of the product _____

Product _____ **Art. No.** _____

***Connected output [W]** _____

Installation Date & Signature _____ **Connection Date & Signature** _____

**Not mandatory*

Appendix A.

Declaration on Safety Rules for Operation and Maintenance of DEVItector™ II V2

Manufacturer of DEVItector™ II V2: Danfoss A/S,
6430 Nordborg, Denmark
Phone: +45 7488 8500

Holder of DEVItector™ II V2, serial no. _____ (see front cover of HVU unit below safety key lock)

Company: _____

Address: _____

Phone: _____

The underwriter is a holder and/or user of a DEVItector™ II V2 unit, developed and designed to be used for provoking and tracing defects of electric heating cables. In the following, the underwriter confirms by his signature that he is in possession of requested professional knowledge about the DEVItector™ II V2 and that he fully understands the safety precautions necessary for operating the DEVItector™ II V2:

- As a holder and/or user of a DEVItector™ II V2, I accept the responsibility for the devitector units and I am aware of possible consequences which may result from its use.
- As a holder and/or user of DEVItector™ II V2, I have carefully read the enclosed 'Instructions for DEVItector™, I have the knowledge on how and where to operate the DEVItector™ II V2, and I am fully conscious about the risks involved.
- As a holder and/or user responsible for DEVItector™ II V2, I acknowledge that it may not be handed over or operated by other persons than the underwriter as well as it may not be left unattended.

If the above mentioned safety regulations will not be respected and maintained, the manufacturer, Danfoss A/S, will be entitled to withdraw the DEVItector™ units from the holder.

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Name: _____ Signature: _____ Date: _____

Danfoss A/S

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Denmark

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