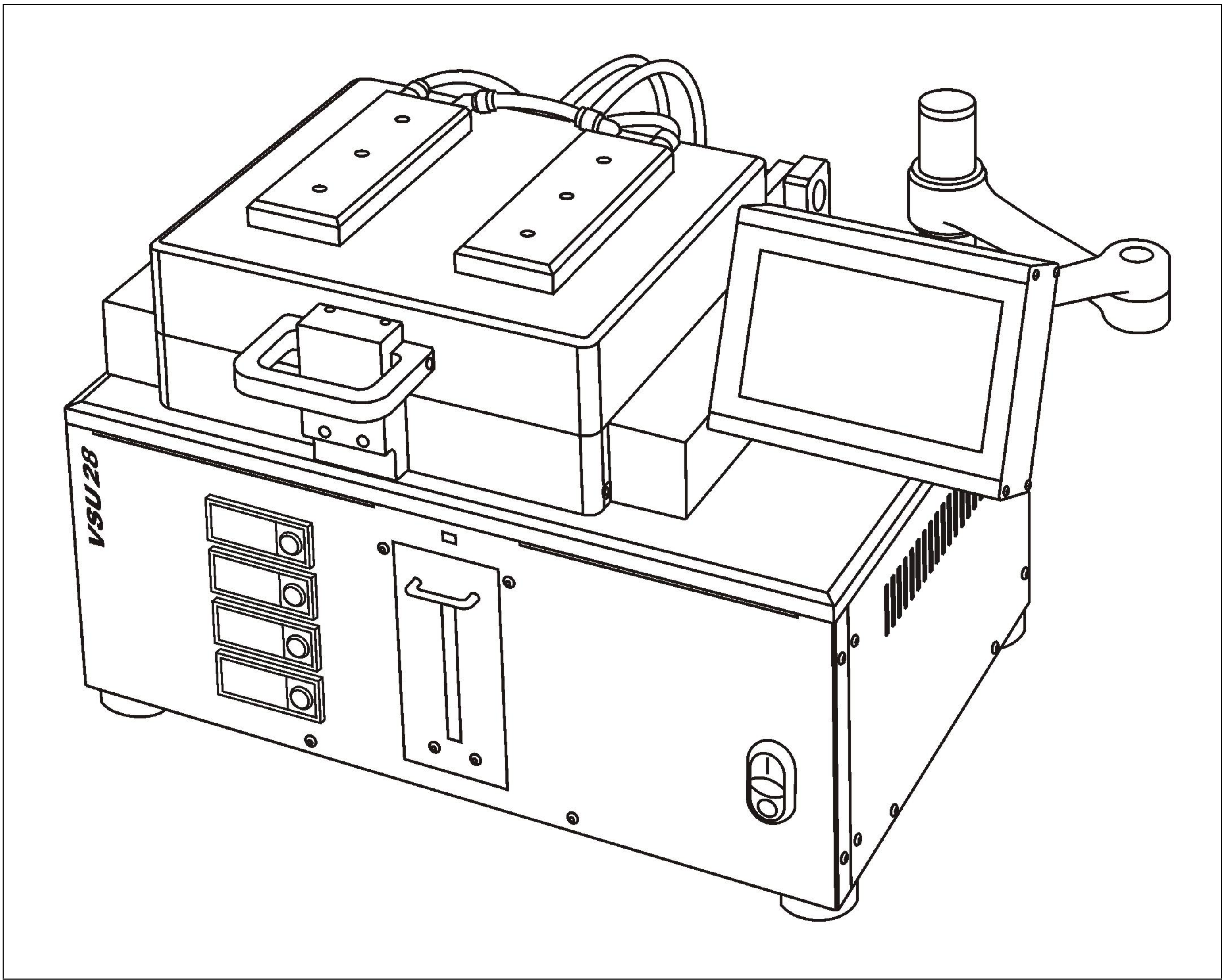
VSU 28

Operating instructions



Printed 1st December 2014

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Warning and safety instructions

This soldering machine conforms to current safety requirements. Inappropriate use can, however, lead to personal injury and damage to property. To avoid the risk of accidents and damage to the machine, please read these instructions carefully before using it for the first time. They contain important information on its installation, safety, use and maintenance. Keep these instructions in a safe place and ensure that new users are familiar with the content. Pass them on to any future owner.

Correct application

Only use the soldering machine to solder items which are specified by the manufacturer. Any other applications may be dangerous. The manufacturer cannot be held liable for damage resulting from incorrect or improper use or operation.

This soldering machine is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they are supervised whilst using it or have been given instruction concerning its use by a person responsible for their safety.

Main menu

VSU28 is controlled using the display. VSU28 allows programmed execution of recipes. The recipes carry the temperature profile which should be followed, as well as the sequence of usage of gases or vacuum. The display also serves the purpose of manual control and setup of VSU28.

Edit recipe

Recipes for programmed control of VSU28 are organized in a list. They are recorded in the controller's memory. Each recipe consists of separate steps. A step contains the information on active lines, target temperature and pressure, time for execution or conditions for moving on to the next step. The recipe ends with the completion of its last step.

Once created, recipes can be started immediately. Recipes can be edited at any time, provided that VSU28 is not in operation.

The controller's memory can hold up to 64 recipes, organized in a total of 1024 steps. Information on the available recipe memory can be found at **Main menu** / **Information**

Creating recipe

To create a new recipe, go to **Main menu** / **Edit recipe** / **More** and press **New**. The keyboard will appear. Type a name for the recipe and press **Enter**. The newly created recipe will appear in the list of recipes. Newly created recipes contain one empty step. Select the recipe from the list and press **Edit** to edit the recipe.

Edit recipes steps

To edit a recipe, select it from the list at **Main menu** / **Edit recipe** and press **Edit**. The Edit Recipe Form will appear. Each screen of the recipe holds one of its steps. Navigating between steps is done using the buttons **Previous step** and **Next step**. Press and hold these buttons to quickly move through individual steps.

To create a new step press **Edit** / **Append**. The step will be inserted after the old one; all data fields of the old step will be copied into the new one. The steps remaining to the right will be moved by one.

The step forms contain the following: Step properties:**Recipe name**, **Step name**, **Step index** Press onto the name of the step to change it.

Step end condition. The **end condition** field holds the condition which has to be met, in order for the step to end and to move on to the next one. **Temperature**, **Pressure** and **Time** can be

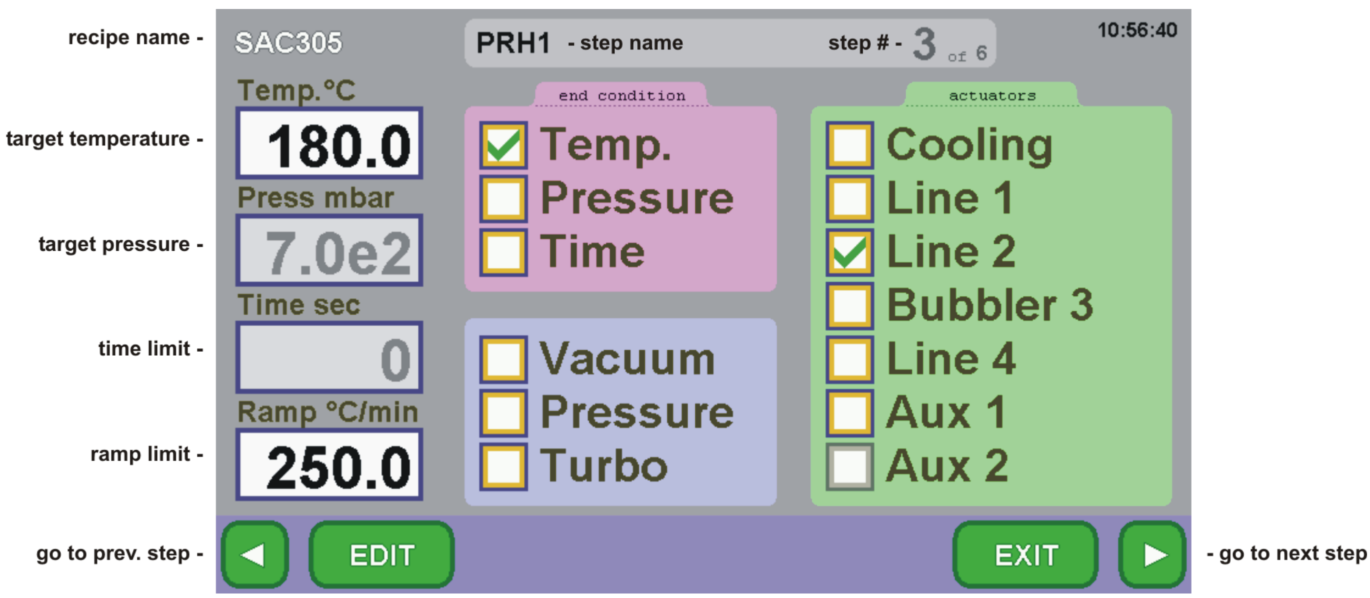


Figure 1: Edit step

selected independently from each other. Avoid selecting of both temperature and pressure as **end condition**. In such a case the temperature regulator may miscalculate the ramp, because the time, needed to reach the target pressure is unknown. Fulfilling of any one of these conditions will lead to moving on to the next step.

*E*xample:

The **actuators** field allows you to choose which gas channels to be active or whether you would like to open the vacuum port. Caution: if you, for example, have set **end condition: pressure<20mbar**, make sure that you have opened the vacuum port and you are evacuating the chamber. Otherwise, the end condition will never be fulfilled. Likewise, if you have set an end condition of higher pressure, make sure that you have opened one of the lines - 1 or 2 - which shall fill the chamber.

Set timeout parallel to one of the other end conditions in order to avoid waiting for an unfulfillable task.

Cooling turns on nitrogen flow cooling under the tooling plate. The cooling nitrogen flow rate is monitored by a flow meter, installed on the cooling line, see gas plan on page 7. In case you require controlled cooling as per a prespecified temperature ramp which is slower than the cooling rate, the temperature regulator will ensure following the ramp by adding additional power.

Deleting a step can be done using the **Edit / Delete** button.

In order to copy one or more steps of the recipe into the same or different recipe, press **Edit / Copy**. The step will be copied in the clipboard and the recipe will automatically move on to the next step. This feature aims to facilitate copying of sequential steps. If you would like to copy steps which are not in a sequence, you can point to another step and copy it to the clipboard. Copying steps into the clipboard arranges them one after the other. An indicator in the upper right corner of the screen shows the number of steps in the clipboard. In order to paste the steps from the clipboard, press **Edit / Paste**. The steps will be pasted in front of the one you have currently selected; the step which is currently selected, as well as the rest of the steps after it, will be shifted to the right. In order to delete the contents of the clipboard, press **Edit / Clear**

After you are done with the recipe you can exit by pressing the **Exit** button. All changes you have made are stored in the controller's memory.

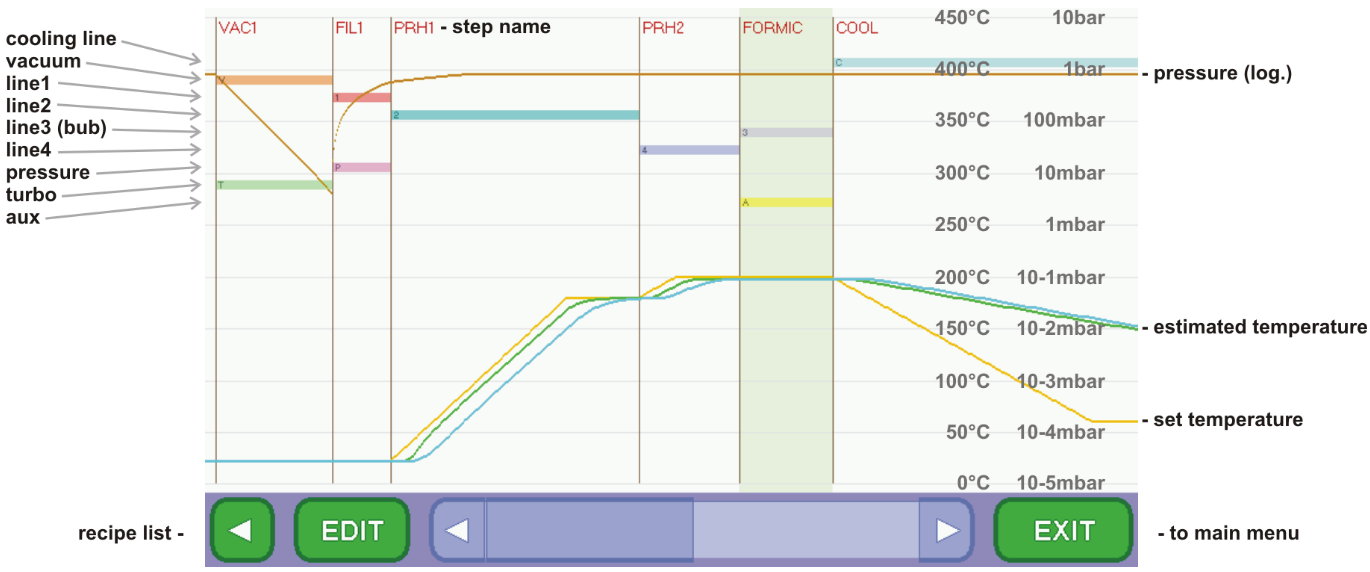


Figure 2: Preview recipe

Managing recipe

To change a recipe's name, select the recipe from the list and press **More / Rename**. To delete a recipe, select it from the list and press **More / Delete**. To change a recipe's position in the list, press and hold onto the recipe. On the right, in the recipe bar, will appear the symbol for moving.

Use the arrows on the slider to move the recipe up or down. Again press and hold onto the recipe bar to exit the "moving" mode. To go to the **Main menu** use **Exit**.

In order to select which of the thermocouples shall be used for regulation purposes within this specific recipe, press **More** / **Options**. Here you can select one or more thermocouples to provide input for the temperature regulator. In case you select two or more thermocouples, their mean value will be taken into account. If you don't select any of thermocouples, the default values of the system will be taken into account; see **Device Settings**

Preview recipe

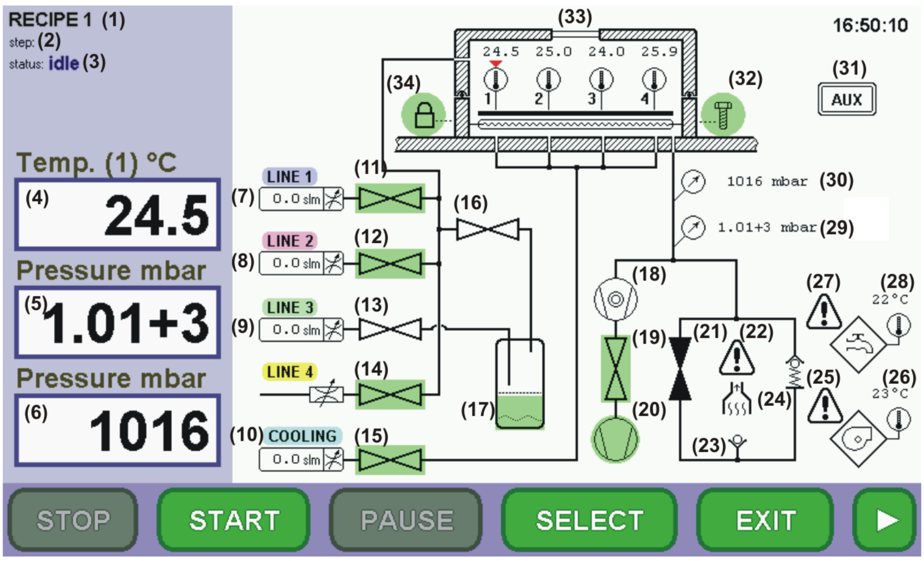
To preview a given recipe press the right arrow in the list of recipes **(Main menu** / **Edit recipe)**

From the preview pane, you can select a step in the recipe and by pressing **Edit** you will open the window for editing of the respective step.

The Preview screen contains the recipe, stretched in time. The temperature, pressure, individual channels and end conditions are shown. Use the slide bar to navigate to the left and to the right within the recipe. The time axis is hypothetical. The diagram shown in Preview is based on a theoretical model, with the only purpose of visualization of the recipe, in order to facilitate detection of eventual shortcomings in it. The actual pressure values in reality depend on the flow rate of the vacuum pump and the individual channels. The temperature values depend on the thermal load of the system. Arbitrary values have been used for the purpose of visualization of the recipe preview.

Before starting a recipe for the first time you should manually adjust the values of the flow meters!

1. Recipe name
2. Step name
3. Device status
4. Gauge 1
5. Gauge 2
6. Gauge 3
7. Flowmeter line1
8. Flowmeter line2
9. Flowmeter line3
10. Flowmeter cool.
11. Valve Y1
12. Valve Y2
13. Valve Y3
14. Valve Y6
15. Valve Y5
16. Valve Y4
17. Bubbler



18. Turbo pump
19. Vacuum valve
20. Backing pump
21. Pressure valve
22. Aspiration sense
23. Check valve
24. Relief valve
25. Blower sense
26. Blower temp.
27. Water flow sense
28. Housing temp.
29. Vacuum gauge
30. Pressure gauge
31. Auxiliary output
32. Wind/unwind screws
33. Termocouples 1-4
34. Lock/unlock lid

Figure 3: Device status

Run process and view status

Device status

Recipes can be started from one of the two screens of Machine Status. On the first screen, a symbology of the gas plan of VSU28 is shown, together with the sensors and actuators. Here are visualized the temperature and pressure in the chamber, the thermometers of water cooling loop and blower, the position of the chamber lid, the flow rate of the cooling line, the valves of the four lines, etc.

In order to bring this screen up, press **Main menu** / **View status**

Here, in the purple field are shown (from top to bottom):

- Name of the recipe **(Fig.3.1)**

- Name of the step **(Fig.3.2)**, or *step nr.*, if no name has been set

- Device status **(Fig.3.3)**: *running* during the process, *busy* during wind or unwind or *idle* if no process has been started.

Further down, there are three indicator fields **(Fig.3.4-6)**, which can be set to indicate: TC1 to TC4 (Fig.3.33), Pressure (Fig.3.30), Vacuum (Fig.3.29), Housing temperature (Fig.3.28), Blower temperature(Fig.3.26) or any of the Flow meters (Fig.3.7-10).

To select a value, press and hold the desired indicator field. You will hear a short "beep" sound and the field will turn green. Select your desired parameter from the right part of the screen by pressing onto it.

Supervisor password is required to force open or close the valves. Press onto the green fields of each actuator to force it. Forcing the actuators is disabled during process execution. **Forcing valves and other actuators** **Supervisor mode** can be activated from **Main menu** / **Settings** / **Privileges**. During execution of a process **Supervisor mode** cannot be activated. In order to allow activation of **Supervisor mode** you need to stop or pause the process.

- Line 1, 2 - press on valve Y1, Y2 (Fig.3.11, 12) to force open/close

- Line 3 - press on valve Y3 (Fig.3.13) to force open/close. You can only open Y3 if Y4 is already open.

- Line 4 - press on valve Y6 (Fig.3.14) to force open/close

- Cooling line - press on valve Y5 (Fig.3.15) to force open/close

- Line 3 after bubbler - press on valve Y4 (Fig.3.16) to force open/close. Opening of this valve is disabled if chamber is pressurized or aspiration is missing.

- Bubbler refill. This field (Fig.3.17) highlighted means that the bubbler is not filled up completely. Press on it to start manual filling. No supervisor rights are required to do this.

- Turbo pump field (Fig.3.18) goes green if the pressure is under 20mbar. You can start manually the turbo pump by pressing on it.

- Vacuum valve - press on field (Fig.3.19) to force open/close. Opening vacuum valve is disabled if the chamber is pressurized.

- Backing pump - press on field (Fig.3.20) to force open/close.

- Overpressure valve - press on field (Fig.3.21) to force open/close. This valve is normally open. Closing it requires absence of formic acid in chamber. Purge before closing this valve.

- Auxiliary output - press on field (Fig.3.31) to force activate/deactivate.

- Lid screws - press on field (Fig.3.32) to force wind/unwind. Unwinding the screws is disabled if the device is pressurized.

- Lid lock - press on field (Fig.3.32) to force lock/unlock the lid handle.

Before manually open the chamber make sure it is properly purged from formic acid and all internal parts are cooled down to a safe temperature.

Device sensors

- Gas flow meters - Line 1, 2, 3 and cooling line (Fig.3.7-10)

- Blower temperature (Fig.3.26) - thermistor measures the temperature of the blower case.

- Housing temperature (Fig.3.28) - thermistor measures the temperature of the chamber bottom plate.

- Vacuum gauge (Fig.3.29) - this sensor returns a logarithmic value in the range of 20mbar down to 5x10-4mbar.

- Pressure gauge (Fig.3.30) - this sensor returns a linear value in the range of 20mbar to 5bar (abs).

- Thermocouples (Fig.3.33) - 4x type-k thermocouples

Warnings

- Aspiration sense (Fig.3.22) - Warning appears if aspiration is poor or missing. Recipe that uses formic acid cannot be started.

- Blower sense (Fig.3.26) - Warning appears if blower does not generate underpressure into blower inlet duct. This warning appears when the blower is stopped. After process start the blower turns on and the warning must disappear in a couple of seconds.

- Water flow sense (Fig.3.27) - Warning appears if cooling water circulation is missing. No recipe can be started.

Process graph

To move on to **Process graph** press the right arrow in the **Device status** screen or select **Main menu** / **Run process**.

Here, similarly to **Device status** you will find, in the left part, a field with the status of VSU28. The End Conditions and the active channels are highlighted. Below are shown *Time*, *Pressure*, *Setpoint* of temperature (if a process is being executed), *Feedback(PV) for regulator*, *TC1 to TC4*

In the right window, there are shown the graphs of actual temperature, probe temperature, temperature setpoint, pressure. On the left is the temperature scale in °C. If a process is being executed, separate steps are marked with vertical lines, similar to **Preview recipe**. Open actuators leave color marks during their execution as well. See figure 4, on page 10

In order to display or turn off individual curves from the graph, press on their representation in the left pane.

From **Process graph** press the left arrow to go back to **Device status** screen.

Start Process

Use **Select** in **Device status** or **Process graph** to bring up the table for selection of recipe. From the table, you can select the recipe to be executed.

By using the buttons **Start, Stop and Pause** you can control the execution of the recipe.

Settings

Date and time

This menu allows you to set the date and time shown by the clock on the display.

Touch panel

Here you can calibrate the display. For calibration use a stylus.

After each pointing to a given target the display is calibrated. You can calibrate the targets in whatever sequence you prefer and as many times as you desire.

Warnings

In this menu you can select which elements shall participate in the machine's initialization sequence upon start up. If, for example, there is a malfunctioning heating element, and you are aware of that but would like to use the machine, in order to prevent it from annoying you at each start up, you can take the malfunctioning heating element out of the initialization list.

The same applies for the cases when you only use one of all thermocouples - you can switch off the remaining slots. Please note that you need to have at least one available thermocouple in order to operate the machine.

User privileges

This menu allows you to switch between **Supervisor mode** and **Locked mode**. The protection can cover the following levels: - editing recipes - entering the settings menu - manual operation of valves in the gas plan

In order to set protection, **Locked mode** for the machine, check **Lock device** and then press **Apply**. Next time you enter any of the above mentioned levels, an access code will be

Figure 4: Process graph

required. Once entered, the access code is valid till next restart.

In order to deactivate protection, **Supervisor mode** for the machine, un-check **Lock device** and then press **Apply**.

In order to set new password for the machine, press onto the password field, type in the new password and confirm it.

Lid lock

When the bubbler line is activated the chamber goes in "dirty" state. Lid open is forbidden until the chamber is being purged back into "clean" state.

- In the box **Initial Purge Volume** you can set the minimum purge volume that must flow through the chamber before it is safe to open. This volume needs to be set according to the chamber volume and content.

Warning: Setting very small value for this parameter can cause formic acid release in the atmosphere. Set purge volume at least 3x the chamber volume!

- **Flow meter reading** shows the sum flow from all the purge lines (Line1, Line 2 and Cooling Line).

- **Volume to purge** is the remaining volume before the chamber get "clean"

- **Lock status** indicates the current state, **locked** or **unlocked**.

If the interlock has been actuated at startup of the machine, then this menu will also contain information about how many liters still have to flow before the chamber is purged and the lid is unlocked.

Device

Temperature control. In this menu you can select the default thermocouple which shall be used for temperature regulation. Choose one or more TCs. In case you select more than one, their mean value shall be transmitted to the regulator. The TCs selected in this menu can be overridden in the option menus of each recipe.

Recipe finalize. After recipe ends the device can perform an **Auto purge** or **Auto cooling** until the chamber goes to a safe-to-open state.

From the vacuum pump power options select whenever you want it to run or stand by.

Select **vacuum pump power management** mode. Vacuum pump will operate at full power according to **Vacuum pump ON** setting. Vacuum pump will be driven to standby mode according to **Vacuum pump STANDBY** setting. For vacuum pumps that do not support standby mode this setting is not used.

Example:

If "Process is running" is selected in "Vacuum pump ON" menu, and "Device is powered" is selected in "Vacuum pump STANDBY" then:

- the pump will operate at full power during a process i.e. the "PUMP-ON Relay" will be opened, "PUMP-STANDBY Relay" will be closed.

- the pump will operate at reduced power when process is not running i.e. both the relays "PUMP-ON Relay" and "PUMP-STANDBY Relay" will be opened.

Screw driver

This menu is for service only. Here are 13 parameters that configure the screw and unscrew operation of the lid locking motors. Do not change the parameters without consulting with the service manual. This might damage the screw motors.

Working with Formic Acid (HCOOH) bubbler

Using formic acid

Corrosive

Formic Acid is dangerous by inhalation, skin contact or ingestion. It is corrosive to all body tissues. Personal protective clothing and other protective equipment must be used and maintained to be effective in preventing skin contact with formic acid.

Flammable materials

Flash point: 69°C
Auto ignition temperature: 539°C
Firefighting: Use dry chemical, carbon dioxide, water spray (fog) or foam. Do NOT use water jet.

Formic acid is dangerously irritating to the skin, eyes, and mucous membranes and may also be toxic to the kidneys. Atmospheric concentrations as low as 32 mg/l may be corrosive. Permissible exposure limit (PEL) for formic acid has the value of 5ppm in air average over an eight-hour work shift. This may also be expressed as 9 milligrams of formic acid per cubic meter of air (mg/m3). Acute, overexposure to formic acid causes corrosion of the skin, eyes, and mucous membrane of the mouth, throat, and esophagus and may be associated with complications such as cardiovascular collapse and ischemic damage to the heart, liver and kidneys, swelling of the airway, and respiratory distress. Ingesting causes ulceration of the gastrointestinal tract, which results in perforation and peritonitis and late scarring of structures of the gastrointestinal tract which, in turn, produces obstructions that require surgical repair

Symptoms of acute exposure include redness, swelling, blistering of the skin and mucous membranes of the mouth and throat, eye irritation, nausea, vomiting, diarrhea, difficulty in swallowing, difficulty in breathing, headache, dizziness, blood in the urine, decreased or absence of urine production, and unconsciousness. Signs of shock and impending cardiovascular collapse including clammy skin, a weak and rapid pulse, shallow breathing. Symptoms of chronic exposure may include kidney damage, dermatitis, and skin sensitisation.

Emergency first aid procedures

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

- **Eye exposure:** If formic acid or solutions containing formic acid get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- **Skin exposure:** If formic acid gets on the skin, immediately flush the contaminated skin with water. If formic acid soaks through the clothing, remove the clothing immediately and flush the skin with water. If irritation persists after washing, get medical attention.
- **Breathing:** If a person breathes in large amounts of formic acid, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- **Swallowing:** If formic acid has been swallowed and the person is conscious, give him large quantities of water immediately to dilute the formic acid. Do not attempt to make the exposed person vomit. Get medical attention immediately.
- **Rescue:** Move the affected person from the

hazardous exposure. If the exposed person has been overcome, call fro First Aid and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the location of rescue equipment before the need arises

Spill, leak and disposal procedures

Persons not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed. If formic acid is spilled or leaked, following steps should be taken:

1. Remove all ignition sources

2. Ventilate area of spill or leak

3. For small quantities, absorb on paper towels. Evaporate in a safe place (such as fume hood). Allow sufficient time for evaporation vapors to completely clear the hood ductwork. Burn the paper in a suitable location away from combustible materials. Large quantities can be collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Formic acid should not be allowed to enter a confined space, such as a sewer, because of the possibility of an explosion.

Waste disposal method

Formic acid may be disposed of by atomizing in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device.

Do not eat, drink, use tobacco products, apply cosmetics, or take medication in areas where formic acid or a solution containing formic acid is handled, processed, or stored.

Formic acid should be stored in a cool, dry, well ventilated area; in tightly sealed containers that are labeled in accordance local hazard requirements. Containers of formic acid should be protected from physical damage and ignition sources, and should be stored separately from strong oxidizers, alkaline materials, strong caustic agents, concentrated sulphuric acid, hydrogen peroxide, and furfuryl alcohol.

Filling the container

Before filling the container, put safety gloves on. Filling the container must always be performed in the presence of another person.

Turn the machine off. Lift up the latch over the bubbler pane to unlock it. Slowly pull the bubbler using its handle until it reaches the open position.

Filling with acid 1. Unscrew the cap of the container using an allen key 5. 2. Use a syringe to pour acid in the container. 3. Close the cap of the container securely Caution: do not exceed the indicated maximum liquid level.

Put back and secure the container inside in the reverse order.

Before starting a process with Formic Acid, make sure that the process exhaust is correctly connected to the aspiration system. Make sure the aspiration system is on and working. See connecting the aspiration on page 17

Formic acid auto-refill (optional)

The formic acid container is placed in a stainless steel box on the front side of the mounting rack. Open the box door. Unhook the spring clamp and take off the empty container. Unwind the cap from the empty container and mount it on the full one. Make sure the 6mm tube is reaching the container bottom. Place the full container in the box and hook back the spring clamp. Close the box door tightly.

> If you mount formic acid container for first time we recommend using a cap with a build-in ventilation. Perforate the cup and put the 6mm tube inside it until it reaches the bottom. The tube must fit tightly in the cap hole.

Hardware operation and safety

Lid locking operation

The use of formic acid impels provisions for locking the chamber, in order to protect the operator against accidental exposure to harmful gas. At start of recipe execution the lid handle is locked. After the recipe is complete and the chamber is purged of formic acid, the lid is unlocked.

If formic acid has been used in the recipe execution, the chamber is considered toxic. In order to purge the chamber, nitrogen has to be fed along line1, line2 or cooling line, in volume of 20 standard liters. Thus, the formic acid concentration will be reduced to a safe level. The quantity of nitrogen, fed along the lines above is monitored by mass-flow-meters.

Example: If you feed purge nitrogen along cooling line, at flow rate of 20 slm, you will need 1 minute to raise the "chamber clean" flag, which will allow the unlocking of the lid after completion of the recipe.

Lid screw locking (optional)

(overpressure device only)

According to chamber lid resistance to the applied force during overpressure step it must be properly winded to the chamber base. There are four motorized screws that wind up against the lid and fix it strongly to the base. Screws get winded at the time of recipe start and unwinded after finish. If the recipe does not contain overpressure steps (pressure actuator has not been selected anywhere in the recipe) the screws will not be activated at the recipe start.

Temperature regulation

The temperature can be regulated on the basis of the input of any of the four thermocouples or a combination of any of them.

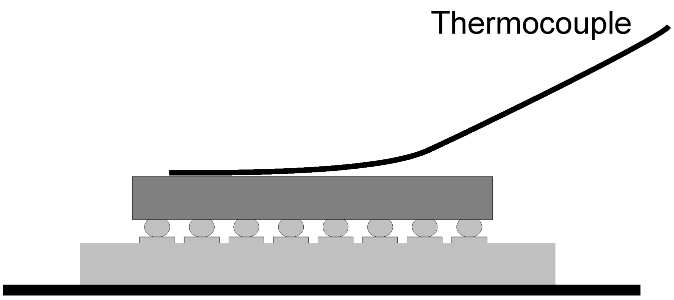
Regulation over plate temperature.

In order to implement this regulation method, place the thermocouple on the plate and secure it so that a good thermal contact is ensured. Select the respective thermocouple in **Settings** / **Regulator** or in **Recipe** / **More** / **Options** in order to regulate the temperature on the basis of this thermocouple's readings.

Regulation over probe temperature.

In a similar fashion as above, this time secure the thermocouple on the sample. An important condition for correct regulation is that the thermocouple shall be placed well onto the probe, ensuring good contact between them. If the thermocouple is not in good contact, the measured temperature will be lower than the actual temperature of the probe. As a result of this, the probe will be overheated and damaged.

The figure shows an example of how the thermocouple can be placed, so that it ensures the best possible contact. The last section of the thermocouple shall be as close as possible, almost parallel with the probe. The tip of the thermocouple must touch the probe.



After you have placed the thermocouple, make sure that there are no unnecessary forces acting on it, and it will stay in place till the end of the process.

It is recommended that the used substrates shall have smooth surface for good thermal contact with the hotplate.

If a cartridge is used for more than one substrate, it would be good for the thermocouple to be placed onto the cartridge or inside a dedicated opening in it, so that a very good contact is guaranteed.

Oscillations in temperature, overshooting or slow achieving of the set temperature are signs of bad contact between the hotplate and the probe or the probe and the thermocouple.

Cleaning and care

Periodical cleaning of the machine is recommended. Dust or accumulations of evaporated material can lead to deterioration in soldering quality.

Caution! Do not clean the machine while still hot! Do not clean the hotplate while still hot!

Cleaning the machine shall be done using a soft towel. In order to avoid leaving traces of the towel, it is best to use cleanroom wipes. For better results in removing fat when cleaning all metal surfaces, as well as the window on the lid, you can use alcohol. The display should only be cleaned by a wet towel.

Chamber and tooling plate

The panels of the machine can be cleaned with a towel with alcohol. Raise the lid and clean the hotplate, under chamber ring and the board. Carefully clean the o-ring seal. Take special care not to scratch the o-ring seal! Vacuum can be impaired. Protect the thermocouples! They can easily be broken. Protect the chamber exhaust opening, so that no particles fall in it during cleaning!

Cleaning of lid reflector

The reflector under the lid can be cleaned with a towel with alcohol. Do not apply too much force onto the reflector. It is made of thin sheet metal and can bend.

If the glass of the reflector (if available) is too dirty and you cannot clean under it, dismantle the reflector. It is fixed to the lid by five nuts M4. Unscrew the nuts using a spanner in order to dismantle it. Clean the reflector from the outside using a towel and alcohol. Clean the inside of the lid and the window using a towel and alcohol. Fit the reflector back without tightening the nuts too much.

For better results you can clean the reflector in a tub with cleaning products and a soft brush. Rinse the reflector well with water and leave it to dry before fitting it back on.

Caution: Do not remove the glass of the reflector!

Cleaning of lid o-ring

Usually, it is enough to wipe the o-ring along its whole length using a cleanroom wipe. If you think the vacuum is impaired, you can take the o-ring off using a thin screw driver and clean it with a towel. Also, clean well the o-ring groove. It is recommended that you spread a thin layer of vacuum grease on the o-ring before you put it back in.

Caution! When taking the o-ring out of the groove, be careful not to scratch the groove. Vacuum can be impaired. When cleaning the o-ring with a towel, be careful not to stretch it!

Cleaning of heaters

To clean the heaters and the space beneath them, follow this procedure: Turn off the machine's power supply from the grid. Fully open the lid. Unscrew the eight/sixteen M5 bolts and lift the heating pane to 45°. Place a wooden shim to support the pane open. Clean the board and the quartz tubes from underneath. You can use a wipe with alcohol to dissolve the flux residue, if any. Clean the board o-ring as you have done with the upper one, and place it back in its place. Close the heating pane and screw the eight/sixteen M5 bolts without using excessive force.

Caution! Be careful not to drop any foreign objects or dirt through the air ducts. This might damage the blower.

Cleaning of the exhaust

Cleaning of the exhaust check valve is not recommended. In order to avoid it, always use aspiration. This way, there will be no chance for foreign particles to plug the valve and impair its functionality.

Dismantle the exhaust aspiration. Take the metal brace off using a screw driver. Take the check valve ball out and clean it. Reach inside with a cleanroom wipe and clean the o-ring of the check valve. If you think the o-ring is too dirty, you can take it out with your finger. Clean it well and spread a thin layer of vacuum grease on it. Clean the seat of the o-ring using a cleanroom wipe. Assemble everything back in the reverse order and fit the aspiration on.

Tip: In order to take the check valve ball easily out, use compressed air to blow between the ball and the check valve body.
Caution: Be careful not to break the ceramic ball. Be careful not to damage the seat of the o-ring in the check valve. This could significantly impair the vacuum.

Cleaning of heat exchanger

If you use liquid flux processes it is possible for flux residue to condense inside the heat exchanger and plug it. To clean the heat exchanger, follow this procedure

Stop the water circulation through the cooling water loop. Dismantle the heat exchanger from the cooling water tubes. Dismantle the check valve and vacuum valve from the heat exchanger. Loosen the KF-16 clamps connecting it to the outlet port, unscrew both M4 bolts holding it to the spacers and take it out. Soak the heat exchanger into flux cleaning solution in order to dissolve any flux residue. Flush it with clean water. Dry it and install it following the reverse of the above sequence.

After flushing the heat exchanger, it is possible that droplets of water remain inside it. The best way to fully remove any moisture from the heat exchanger is to evacuate the chamber of the machine (and the heat exchanger respectively).

Greasing of screw nuts

(overpressure device only)

Use cotton bud to apply grease on the nut threads inside.

Problem solving guide

The program does not start

If the program does not start, check whether the lid is properly closed. Make sure the lid is tightly closed and the handle is in the lower position.

Error messages on the display

When starting the VSU up, an initialization sequence is carried out. If any faults are found, they will be displayed on the screen after the initialization is complete, as well as a sound signal will be given. If a critical fault has been found during initialization, the machine will turn itself off automatically. In order to see the type of fault, after the start-up of the machine press and hold the green button. This way the display will remain on (while you are holding the button) and you will be able to see the fault type.

Problem with vacuum level

If the vacuum in the chamber is not good enough, check the following, in this order:

- does the lid o-ring lie well in, and are there any particles or dirt on it

- check the connections of the vacuum lines between the machine and the pump

- check the functionality of the exhaust check valve.

Formic acid smell

If you sense a formic acid smell:

- check if the aspiration is functioning properly.

- take the formic acid container out and check if it is properly closed. Check its PTFE connecting tubing. If their integrity is damaged, call for service.

The lid will not open

If, after the completion of the recipe, the lid handle remains locked, it means that formic acid has not been purged. Purge the chamber manually to free the lid interlock.

If the lid handle in unlocked, the recipe is complete, but still the lid will not open, check the pressure in the chamber. If the system is under vacuum, fill the chamber manually with nitrogen.

If, despite the above procedures, the lid does not open, call for service.

The VSU will not turn on

If the machine does not start, check if the power supply cable is properly fitted into the socket.

The VSU goes automatically off

If the machine goes automatically off, this means that the housing temperature exceeds 50°C or the blower temperature exceeds 80°C.

The recipe will not start

Check in **Settings** / **Warnings** and in **Settings** / **Regulator** if you have selected the thermocouples correctly.

Installation and connection

See installation procedure document.

Front view

On the front panel of the machine, in the left part, there are installed 4 flow meters with adjustable valves. In the middle, the formic acid container can be seen. Lift up the lever over the bubbler to open it. On the right, there are on/off buttons of the machine, Emergency button, Buzzer and process start button.

Rear view

On the rear panel, in the lower left part, there are the power supply cable and the power socket for the chiller. Above them, on the left, there are the ports for connection to a PC, the connector of the Display, the user's interface and the connector for medium vacuum gauge. On the right, there are the connectors of the 4 gas lines, 1 compressed air line, 1 cooling gas line, 1 formic acid refill line, manual needle valve for line 4, chamber port, 4 thermocouples connectors, the inlet and outlet for water cooling loop.

Left side view

Under the left side is the lamp cooling blower. Keep this side min. 30cm free for proper ventilation of the hot air flow.

Right side view

Under the right side cover is the electronics of the device.

Connecting the vacuum pump

Connect the vacuum pump to the vacuum port of the machine. The port is a standard NW16 (KF16). Use flexible vacuum tubing to avoid transfer of vibrations from the pump to the machine. It is recommended that the distance between the pump and the machine shall be kept at minimum. This improves the pump rate of the system.

Connecting the aspiration

Use flexible polyurethane or PVC tubing for the aspiration. The aspiration tubing must have internal diameter of minimum 42mm. Slide the aspiration tube onto the exhaust check valve and aspiration sense tube. Fix it above with a cable tie, so that it stays in place. It would be good if the aspiration works constantly, even when the machine is off. This will protect the exhaust check valve from getting plugged by particles and will eliminate the need for cleaning it, which is a complicated task.

Connecting gas lines and comp. air

Connect nitrogen supply at 5-6 bar (abs) to all gas lines. Even if you don't use some of the lines, connect it to nitrogen supply. This is a requirement for correct operation of the valves on the line.

Connect compressed air supply, 5-8 bar (abs).

The gas lines are connected by 6mm tubes.

Connect nitrogen supply at 5-6 bar (abs) to the cooling line, 8mm tube.

Connecting power

See installation procedure.

Chiller power supply

This output is connected after the device main contactor and is powered when the device is switched on. Connect water chiller here.

Auxiliary output (optional)

Auxiliary output is provided for power supply of a small 230V consumer or for connection of a bigger consumer through a contactor. For example, the auxiliary output can be used to supply power to a small membrane pump.

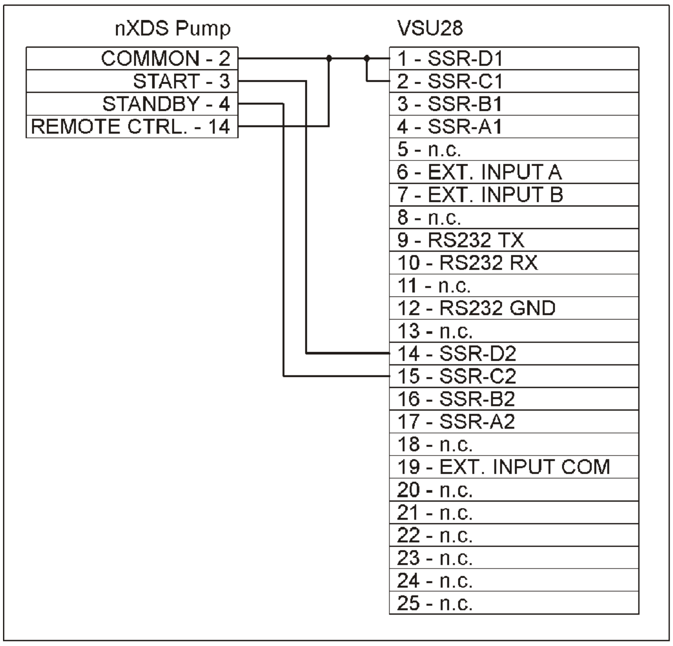
Warning: AUX Output in not fused. The consumer's rated current, added to VSU28 rated current shall not exceed 16A in total.

User interface

User interface is provided by 25-pin D-SUB 25 female connector. Below the pinout:

No.	Pin Description	Function
1	SSR-D1	vac. pump start
2	SSR-C1	vac. pump standby
3	SSR-B1	turbo pump
4	SSR-A1	aux1
5	n.c.	n.a.
6	EXT. INPUT A	n.a.
7	EXT. INPUT B	n.a.
8	n.c.	n.a.
9	RS232 TX	n.a.
10	RS232 RX	n.a.
11	n.c.	n.a.
12	RS232 GND	n.a.
13	n.c.	n.a.
14	SSR-D2	vac. pump start
15	SSR-C2	vac. pump standby
16	SSR-B2	turbo pump
17	SSR-A2	aux1
18	n.c.	n.a.
19	EXT.INPUT COM	n.a.
20	n.c.	n.a.
21	n.c.	n.a.
22	n.c.	n.a.
23	n.c.	n.a.
24	n.c.	n.a.
25	n.c.	n.a.

Connecting the backing vacuum pump



Consumption data

Acceptable power supply voltage: 200-240VAC

Maximum consumed power: 8kW

Auxiliary output consumption is not included.

Dimensions and weight

Width - 550mm, Depth - 650mm, Height - 500mm, 60 kg

Connection to VSU28

Connect the machine to a computer using a serial cable. In case you don’t have a serial com port available you can use an USB-to-Com adaptor.

Connection setup

Type in the name of your serial communication port in the respective field **Main Menu** / **Options** / **Connection** using CAPITAL LETTERS. For example COM1. If you don’t know which com port you have connected the machine to, you can check and set it up by entering Windows Start Menu, right-click on Computer, Manage. This opens up a window called Computer Management. Click on Device Manager, Ports (COM & LPT). Here you can see what com ports you have mapped on your system. If you want to change the com port number, you can double click on Communications Port, tab Port Settings, Advanced button.

Logging

VSU28 sends information about its actual status in the form values of various parameters. These values are represented on a time-diagram in the main field of the window. If these values represent temperatures, they are located in the upper part of the screen; if they represent different parameters other than temperatures, they are shown in the lower part of the screen.

Scales and scales setup

Temperature scale. The temperature scale is shown on the left side of the screen. It can be customized by clicking **Options** / **Graphic**. Here you can change the range of the scale and the step of the scale. You can also change the color of the line and the color of the numbering. Both colors can be changed from the same field under the word **Color**. To change the color of the numbers, click on the number in the field and select your preferred color; to change the color of the lines, click on the right side of the field, on the line, and select a color

Pressure scale and Percentage Parameters Scale: This scale is displayed in the lower part of the screen. The pressure values are indicated on the left (in mbar). The percentage scale is shown on the right side of the screen.

Time scale: The parameters of the Time Scale can be customized by going to **Options** / **Graphic**. Here you can modify the Time between Marks, the zero point of Time (time relative to) , the color and the time format.

Zooming: Rolling your mouse scroll button zooms in and out.

Slide bar: Use the slide bar to move left and right along the recipe.

When the **Status** tab is selected, and the VSU28 is streaming data, the newest data is displayed in the right side of the screen. In order to continuously observe the new data, you need to slide to the right-most end of the screen and zoom-in. This way, the screen will be constantly shifting and the newest data will always be displayed. If you haven’t slid to the right-most end of the screen or you haven’t zoomed in, the screen will remain static.

Parameters

In the left pane of the window you can select which parameters to be displayed by clicking in the square box in front of the parameter. When the **Status** tab is active, the current selected configuration of displayed parameters can be saved so that the next time when you start up the Data Logger you have the same configuration displayed. The configuration can be saved by right-clicking anywhere on the Parameter pane and selecting **Set Current Selection as Default**.

Managing logs

Saving the log file can be performed in several ways. The first way is to click on **File** / **Save** (or press **Ctrl-S**), while the **Status** tab is active. This will save the current **Status** in a file, which will be stored in the location you specify in the Save File dialog window. If you have started a recipe, the STATUS tab will be named with the name of the recipe being executed.

If you would like to save the data logged till the present moment and continue to log data in a new **Status** tab, you can do so by clicking **File** / **New Status Window**. This will move the logged data to a new tab but will not save it automatically. You need to select the new tab and then click **File** / **Save**. Meanwhile, the data coming from VSU28 continues to be logged in the previous **Status** tab.

Working with a static tab

In a static tab, you can perform the following actions:

- Move the mouse cursor near to any graph line - this will display a small blue window with the values of the parameters described by the respective line. You will also see their variation rate/ramp (only for temperature parameters).

- Click anywhere within the static window - this will draw a vertical line and will display (in the left pane) the values of all the parameters participating in the graph at the exact moment of time which the vertical line represents.

- Select an interval of time by clicking and dragging the mouse cursor - this will highlight the selected period of time. If you now move the cursor over the highlighted portion of the graph, you will see a small blue window with mean values and absolute variation of the values of the parameters participating in the graph.

Selection In a static tab, you can select a period of time with left mouse button. Right-click on it will give three options:

Crop selection - clicking on this option will open a new tab with the data only from the selected period of time.

Export bitmap - Clicking on this option will cause a dialog window to open, asking you to select the size (width and Height) of the exported bitmap image. Checking the option **Print Version** will invert all colors in order to make the image printer-friendly.

Create balloon - This option allows you to place comments on the actual graph. Selecting the Create Balloon option opens up a dialog window, in which you are prompted to type in the text of your comment. You can also select the color of the text by clicking on the **Select Color** button. When you have typed in your comment, click **OK**. A balloon with your comment will appear on the graph. You can move the balloon around the fixed point you initially selected. This is done by simply clicking and dragging the balloon around. You can also move the initially selected fixed point by pressing and holding the SHIFT key, while dragging the balloon around.

Loading log file - You can load a previously saved Log File by clicking **File** / **Open** or pressing the **Ctrl-O** combination.

Managing recipes

Open a recipe from your computer From the **Main Menu** click **Recipe** / **Open Recipe** navigate to the file of the recipe you want to open and double click it. The recipe will be opened in a new tab.

Download a recipe from VSU28 internal memory - From the **Main Menu** select **Recipe** / **Download** (or press **F7**). This will bring up a window showing all recipes stored in your VSU28. Select the ones you would like to download by clicking in the check box to the left of each recipe and click **Download**. Each of the recipes you have selected will be opened in a separate tab. After that you can manually save them to your computer. The recipes are not automatically saved.

Editing recipe - Editing a recipe here is identical to creating a recipe on VSU28 itself. In the top of the screen you can see the tabs representing each step of the recipe. In each tab you can edit the values of temperature, pressure, time and ramp. Checking the box to the right of these value fields will tell VSU28 to move on to the next step immediately after achieving the set value. If you put a check, for example, next to both Pressure and Temperature, VSU28 will move on to the next step immediately after achieving one of these set values, whichever happens first. The check boxes on the right side of the screen enable and disable vacuum, different lines, the auxiliary power output and cooling.

Uploading a recipe - After you have completed editing your recipe, you can upload it to your VSU28. From the **Main Menu**, click **Recipe / Upload** or press **F8**. This will bring up a screen, in which are shown all your currently open tabs. You may notice that some of the recipes are highlighted in yellow, and some are not. The ones highlighted in yellow are already present in the VSU28 internal memory. If you upload them, they will automatically overwrite the recipes with the same names in the VSU28 internal memory.