NORECS AS
Haslevollen 3
NO-0579
Norway

1 Omega Temp Manual

2 Overview

Controlling a furnace can be difficult and there are a number of issues to make it so. Omega Temp is a program for operating your furnace intelligently and easily. The brain of the furnace is the PID controller, small box with led display, few buttons and a maze of menus and settings in it. The PID controller is very hard to use and lacks few crucial features. Omega Temp connects your computer to this PID controller and adds those missing elements and makes it easy to operate your furnace with few clicks of a mouse.

3 Features

- Easy to install

  Latest version of the program and manual are always downloadable from our web pages. http://www.norecs.com/files/software/Omega Temp/ The software runs on your computer without any installation process, all you need to do is double click the file.

  The program is native Windows program, meaning that the user never needs to install and (constantly) update things such as C++ redistributables, .NET frameworks, Java runtime environments or similar.

- Easy to setup

  Connect the USB port to the Furnace COM port with the provided cable (5 meters) and you are ready to go.

- Easy to use

  Normally all PID controlled furnaces are hard to handle: They have huge range of settings and features, all of which must be controlled from small 4 character led display with just 4 buttons. To get to any setting user must browse through long menus where the setting may or may not exist depending of the other settings.

- Graph

  The temperature, and optionally some other values are logged and drawn on a graph.

- Quick control

  Use quick control tab to get the furnace quickly to a desired temperature. All you have to type in is the desired temperature and the desired ramp rate.

- Temperature profiles

  Create temperature profiles for your furnace with few clicks. Define unlimited amount of individual steps: a setpoint, ramp rate, and dwell time for each.

- Define steady temperature

  With the stability settings, the user can pre-define what is considered a steady temperature. Define Maximum temperature oscillation, Rate of change observation length, Maximum rate of change °C/min and minimum steady time. The temperature will be declared steady only after the temperature fulfills the definitions.

- Broadcast steady temperature

  Once Omega Temp identifies a steady temperature, it starts the clock and counts the dwell time. In addition to this, it can broadcast a message inside Windows, to say that the temperature has been reached, it is steady, and we are counting down the dwell time. The benefits of this is that if you have another Omega family program, for example to do impedance sweeps, you can have that software waiting for specific broadcast message, and have it start measuring once it receives this message. This way you could make set of sweeps automatically, for example overnight.

- Option: Secondary thermocouple feedback & fine tune

  Sometimes the temperature given by the furnace controller does not represent the sample under test (SUT) temperature. This is a normal situation and can be due various reasons and can be remedied by adding thermocouple close to the SUT and reading the voltage with appropriate device and converting that to a temperature and manually compensating for the difference using the furnace PID controller. This however is labor intensive, inconvenient and error prone method.

  Another way to overcome this is to control the furnace with a thermocouple that is located at the sample, but not many furnaces allow this option. Such approach will void the warranty and risk overheating and melting the furnace. This method also introduces a very big delay for the heating action and the heat reaching the SUT thermocouple and the feedback the PID controller receives, thus confuses the PID algorithm, causing big overshoots and oscillation in the temperature.

  An optional feature in Omega Temp can solve all this automatically and safely for the user. The solution includes a small instrument with temperature reader (to a thermocouple located at the sample) and a cable to connect that instrument to Omega Temp. The program will then automatically adjust the furnace controller so that the sample temperature will override the furnace temperature.

- Limitations

  Omega temp provides such control over the furnace what adjusting the setpoint and ramp rate manually would provide (Modbus addresses 2 and 35). Safety limits for setpoints, units of setpoint and ramp rate, PID parameters, cutoff values etc. are still responsibility of furnace user.

4 Requirements

- Omega Temp is software for Windows computers. It will run on any version of Windows since Windows 98.

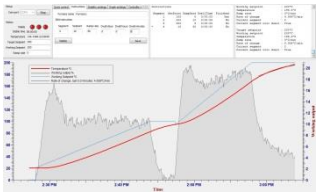
- Two free USB ports. An USB license dongle, that must be connected to another USB port for the software to function. USB based serial port cable, either type RS-232 or RS-485

- Regardless of the type of the USB to RS232 or RS485, the driver the cable adapter requires is the same: the cables are based on FTDI chipset and use virtual COM port divers from https://ftdichip.com/drivers/vcp-drivers/ Or the CD folder /drivers/CDM v2.12.06 WHQL Certified/

- A furnace with Eurotherm controller capable of communicating with MODBUS protocol and a serial port (Sometimes called COM or RS-232 port). All Eurotherm controllers from series 2200, 2400 and 3200 can do this, some versions might require a small communications chip replaced.

5 Installation

• All FM3 – ProboStat furnace models must be set to Software operation mode – See Appendix B Or See software after the setup, it has buttons to change this mode.	
• Open your computer	Representation of your computer 
• Download and install VCP (Virtual com port drivers) from https://ftdichip.com/drivers/vcp-drivers/ Easiest to download setup executable and	
• Depending on the furnace you have, the part 'USB to serial port cable' may be two different things: • An USB-RS232 • Set of two items; an USB to RS485 adapter and regular USB Am-Af cable of 3 meters	USB-RS232 cable  USB-RS485 and extension 
• Locate the serial port on your furnace.	Furnace back panel serial port 
• ~~On Elite furnaces, plug a 'Null modem adapter' to the furnace. Plug the 'USB to serial port cable' cable to the furnace. Jump over the next step.~~	~~Null modem adapter~~ 
• ~~On all other furnaces, try plugging the 'USB to serial port cable' cable to the furnace. If it doesn't fit, use the 'Mini~~	~~Mini gender changer~~

~~gender changer' to succeed.~~ ~~*Sometimes both the furnace and the 'USB to serial port cable' have small nuts to screw the counterpart onto with small screws. When both cable and the device have these nuts, they do not fit together! For your convenience we have included this small part.*~~	
• Unpack the USB license dongle and plug it to your computer.	USB license 
• Make a folder for the program on your computer. (The user needs to have full privileges to the folder) • Download and save the software from our home page to the folder you created. http://www.norecs.com/files/software/Omega Temp/	Omega temp software 
• Double click the Omega Temp.exe to start the program. Please read the whole manual before clicking anything.	
• After clicking connect, and making contact with the furnace, go to device configuration tab, and click "Programmer Off" until you see the value is 0.	

6 Features

Refer to Glossary chapter end of this manual for explanation of terms.

6.1 Screen

The program main window is freely resizable for your needs. It is also possible to change the proportions on the main items on the form; drag the horizontal or vertical white divider lines with mouse cursor to adjust the individual sizes.

6.2 Setup and status explained

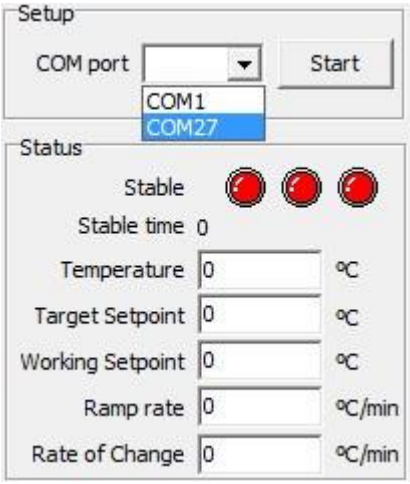
6.2.1 Background

Some computers have serial communications port(s). The ports are designated with COM and a number, for example COM1 or COM3. Modern computers do not always have these COM ports, but they do have

USB ports. A smart SUB device or a cable can tell the computer to treat it just as if it was a COM port. This is what the cable shipped with Omega Temp does.

Note – On Windows XP, plugging in the USB-RS232 cable creates two ports. One of them (Usually the one with the higher number) is just a loopback port that does not communicate with the furnace. Such loopback port may falsely indicate that the furnace was found, and indicate temperatures and setpoints of tens of thousands. These readings are of course not true, since the program is not actually communicating with the furnace.

6.2.2 Setup panel



When the USB-RS232 cable is plugged onto the computer, Windows will see that cable as a COM port. Each time the program is started it lists the found COM ports under a dropdown menu called 'COM port'. (So plug in the cable before starting the program) Select one COM port and click the 'Start' button. The program will try to find the furnace on that COM port and will give you feedback. In case a furnace was not found, try the other ports listed here. Normally it is the port with the largest number, since the cable and the COM port was added most recently.

The 'Stop' button does just what it says; it stops the program from doing anything and releases the assigned COM port.

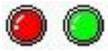
Finding the furnace, and if successful, measuring the first 3 points may take up to 20 seconds. Follow the program log on the right to see the feedback from the program.

About finding the furnace

Refer to appendix B to check if a null-modem adapter is required for your furnace. In most cases finding the furnace will go automatically without any problem. For troubleshooting purposes more technical details follows.

The furnace controller must be a model of Eurotherm 2200, 2400 or 3200 series, fitted with Modbus protocol communications and with RS-232 cable wiring. The scan tries to find the furnace controller from the address 1. In case furnace controller is not found, the whole Modbus defined address space is written with command 'Reset address to 1'. Again the scan tries to find the furnace controller from address 1. If furnace controller is not found, the search fails.

6.2.3 Status panel



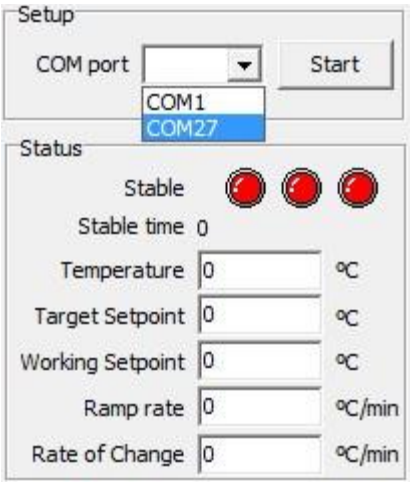
The three leds lamps define if the desired temperature has been reached in a stable manner. When satisfying a specific condition the led turn from red to green. The conditions for the leds from left to right are as follows:

1. The measured temperature is close enough to the desired target setpoint.
2. If the rate of change of the temperature (over a specified amount of time) is low enough.

3. If the first and second conditions have been true longer than a specified time.

The parameters for each of these conditions can be altered under the stability settings tab. Once all three conditions are true, aka the leds are green; the program knows it has reached the desired temperature in a (user specified) stable manner. The program can then for example start to count how long to dwell there and to inform Omega measurement software that it is suitable to start measuring the scheduled measurements.

Below the leds are five read-only fields with the most important data.



- Temperature is the latest measured temperature from the furnace.
- Target Setpoint is the temperature we have instructed the furnace to go to.
- Working Setpoint is the temperature the furnace is trying to reach just now. The working setpoint will eventually reach the Target Setpoint.
- Ramp rate is the desired rate of change that the furnace tries to achieve and maintain in heating or cooling.
- Rate of change is the measured rate of change.

6.3 Tabs

The user can control and configure the program and the PID controller from the tabs.

6.3.1 Quick control

When quick control tab is selected, the program is in quick control mode ignoring any other possible instructions it may have. It only tries to reach the provided target setpoint, using the provided ramp rate. Click on update button to submit new values. It might take one program loop (roughly 5 seconds) before you can see the submitted values being read back from the furnace appearing on the status panel. In case they do not appear, click again and wait for 5 more seconds, or until they do.

Low and high limit for setpoints (for quick control, instructions and power transition) throughout the program are defined by settings in the controller. These limits are defined by the furnace manufacturer and will remain unchangeable in the program for safety reasons.

Some old models of 2200 series controllers have ramp rate in degrees per hour even if their manual states degrees per minute. Enable display of working setpoint on graph settings tab to find out.

6.3.2 Instructions – a temperature program

With instructions tab it is possible to create a temperature profile of any length. The program will process the given instructions and try to reach the given setpoints using the given ramp rate. Once the setpoint is

reached, and stable, the program will dwell at the temperature for given time, before proceeding to the next instruction. Following details are needed to create an instruction: segment number, target setpoint, ramp rate, dwell days, dwell hours and dwell minutes. Once satisfied click the save button and add as many instructions as needed. List of instructions are shown in the instructions log area when the instructions tab is selected. Use up and down arrows to get values for other saved points for editing, just click save to store the changes. Clicking delete button will delete all points onward from the currently selected instruction. Segment 1 cannot be deleted.

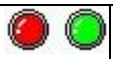
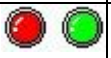
If a segment is defined with 0 dwell time, the next segment is started without the need for the temperature to stabilize. If such case, next segment is started after the measured temperature has reached within 5 degree of target setpoint.

Some old models of 2200 series controllers have ramp rate in degrees per hour even if their manual states degrees per minute. Enable display of working setpoint on graph settings tab to find out.

6.3.3 Stability settings

The optimal values for these settings depend of your process and setup. If you are using a furnace controlled by its own thermocouple, these values are of no big significance.

However, if you control the furnace with additional thermocouple coming from within your sample setup, the suitable values for these parameters depend highly on what materials and how much mass you have in the furnace, what is the temperature, is the heat radiated, convected or conducted and so on.

	Maximum temperature offset defines how much off the measured temperature can be from the target setpoint, the desired temperature, for the first stability condition.
	Rate of change observation length defines for how long duration the rate of change is calculated. The rate of change coefficient is also displayed on the graph as dotted black line. The length of the line represents the observation time, and the angle of the line represents the rate of change. The coefficient is calculated using standard linear least squares of the latest measured temperature values for the specified duration. The optimal length should cover at least two full temperature oscillations.
	Maximum rate of change defines the threshold limit for the second stability condition.
	Minimum steady time defines how long the two first led/conditions must have been satisfied until the third condition is fulfilled. Once all three conditions are fulfilled, the program starts the dwell period, defined in the instructions of a temperature program.

6.3.4 Graph settings

Time axis length

Select either a specified length of time or all using the radio button and provide the desired time in hours on the adjacent box.

A list of checkboxes define the visibility of following items: Legend (names and examples of all plots visible), target setpoint, working setpoint and for curiosity working output (the amount of power the PID controller is sending to the heater of the furnace). The temperature and the rate of change indicator are always visible.

6.3.5 Controller settings

Under this tab, values for Proportional, Integral and Derivate are shown. Below the PID values is a drop down menu to change thermocouple type. In case thermocouple type is changed, the controller resets; it takes about six seconds for this and all activity during this time is impossible.

Varying output power limit

Maximum output power setting on the controller is can be automatically adjusted by the program for faster and more precise control of the temperature. Fill in the transition temperature field, and the low and high power output values. Below the transition temperature, the furnace will be limited to the low power setting as its maximum power output, and to the high power setting when above the transition temperature.

The program will gradually (2.5% each third reading loop, approximately every 15-20 seconds) change the furnace maximum output power to high and low settings, with hysteresis of +/- 25ºC. This functionality will not take place unless the enable checkbox is checked.

For example for Lenton CSC 12/300PTAT the transition temperature is 600ºC and low value 45% and high value 75%. Find out the recommended output power values from your furnace manual and do not exceed that value.

6.3.6 Save

Under save tab resides two buttons to save an image of the graph and one to save a semicolon separated text base .csv file.

6.3.7 Debug

The debug tab and its functionality is meant only for advanced users for sorting out specific issues with PID controllers. The debug tab stops all operation of the temperature program for the duration it is selected.

6.4 Instructions

A memo will display the list of instructions, each segment with the indicator if the segment has been finished or not, and a star * character indicating which segment is under edit on the instructions tab.

6.5 Log

The log displays running messages.

6.6 Graph

- The label box is free to drag around the graph area.

7 Operation

7.1 Tips and remarks

7.1.1 2400 series controllers

When you are done using the software with 2400 series controller, and if you want to go back using the controllers own segment programmer, the controllers SP menu, parameter SPrr must have value OFF. Alternatively, just use the Quick control tab and apply Ramp rate 0 when you are finished.

7.1.2 Preventing overshoot

To prevent overshooting use additional segment below the desired temperature, and a slow ramp rate to reach the desired temperature.

8 Glossary

Term	Explanation
Eurotherm	Most furnaces have PID controller (or several) manufactured by Eurotherm ltd.
Dwell time	Duration to hold at the current temperature.
PID controller	The controller is the brains of a furnace and calculates the required heating power from various parameters and thermocouple feedback.
Ramp rate	Ramp rate is the desired rate of change that the furnace tries to achieve and maintain in heating or cooling. Furnace cooling is passive; the cooling rate is limited by the thermal mass and heat dissipation, aka it can be slowed by ramp rate, but not speeded. Too fast heating or cooling will cause overshooting and thermal shock for items in the furnace. Recommended rate for ceramics is 5 degrees per minute. Ramp rate of 0 disables the working setpoint. The PID controller aims directly to Target setpoint.

Rate of change	Rate of change is the measured change of temperature per minute.
Target Setpoint	The desired temperature we wish to reach eventually. This will be informed to the PID controller that will try to reach it.
Working Setpoint	For many reasons, it is important to control the change of the temperature, not just the end temperature. Working setpoint is a temporary sliding setpoint from the current temperature (at the moment when a Change to Target setpoint was made) to the desired (Target setpoint) temperature. The speed of the change of working setpoint is defined by Ramp rate. To demonstrate this essential part of understanding temperature ramping, the software allows plotting all three values on the plot: Current temperature, Target setpoint and Working setpoint. Enable these from the 'Graph settings' tab.
Working output	How much of the maximum possible power is applied to the furnace.

9 Appendix A – Description of broadcasting and waiting functions

In order to allow synchronization with other processes and programs, a simple signaling system between Omega temp and other applications is described here. The system has two features; broadcast steady state and wait for. The former signals out when a steady state is received for a given segment and the latter holds the current dwell until a wait for condition have been cancelled. In order to keep this communication simple and accessible for other programs and programmers, it is implemented using windows registry.

9.1 Registry path

All messages are written to registry under: HKEY_LOCAL_MACHINE\Software\NorECsAS\Omega\

9.2 Broadcast steady state

When a setpoint segment is deemed stable, the program writes a name-value pair under the above key, with following rules:

Name: Prefix of 'FS_' + the furnace name specified in the Omega temp program designates Furnace Segment.

Value: The number of the segment that is currently stable, as string value. Where between setpoints, or otherwise, a value of '0' is used.

Example: Furnace named 'MyBlueFurnace' have reached and stabilized at segment 5. Name-value pair in registry under mentioned key exists at that time: 'FS_MyBlueFurnace': '5'

9.3 Wait for

Omega temp monitors for a name-value pair under given key. The name of the wait for key is prefix 'FW_' + the furnace name specified in the Omega temp program. If such key exists during a dwell segment, and the value is something else than an empty string, '', the program will extend the duration of the dwell until the key does not exist or its value is an empty string ''.

Example: During a programmed dwell segment of 15 minutes, some other program writes a name-value pair to the mentioned registry key, for example: 'FW_MyBlueFurnace', 'SomeUserSpecifiedProgram', Omega Temp will dwell for at least 15 minutes but also until the mentioned name-value pair ceases to exist.

10 Appendix B – FM3 ProboStat furnace operation mode

Some furnaces are delivered with default settings to have operation mode that allows four temperature segments to be programmed and used from the controller front panel.

When the furnace is used with software, it is easier to let the software take care of the segment programming, but for this to work, the controller mode of operation must be changed to a simpler mode of operation where the furnace always and only tries to reach and maintain the user defined setpoint, with possibility for user defined ramp rate.

Press and hold button A until “Level 1 goto”. Use Key D to change the value to “Level 2 goto”. Wait until “0 code” appears. Change the text to “1234 goto” with keys C and D. If the text disappears start over from the beginning.

Using key B, (10 clicks) navigate until “Prog TM.cfg”. With key D change the text to “None TM.cfg”.