LUXEL CORPORATION

User's Guide

Radak Dual Controller

Rev 2.0

5/9/2013

Contents

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2

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Thank you for choosing a Luxel RADAK Power Controller. We hope that you will find it simple to operate while offering advanced control options. Although specifically designed and optimized for controlling one of Luxel's line of RADAK evaporation furnaces, your RADAK Power Controller is also well-suited for many other power control applications, such as lamps, filament heaters, etc

Warnings

Before installing, operating, inspecting or maintaining this instrument, carefully read this manual and fully understand safety cautions, specifications and operating procedures.

The information contained in this manual is subject to change without notice due to any engineering change or modification of the product for improvement. Please visit www.luxel.com for any available updates.

Caution! Installation must be carried out by qualified personnel. Failure to install or operate this power controller in the manner described in this manual could result in injury of the operator and/or failure of the controller to meet its stated specifications.

Caution! Always unplug the power cord from the rear panel before removing any of the cabinet covers or components. Line voltage is present on exposed connectors and components inside the cabinet, and is capable of causing injury or death.

Whenever it is likely that function of the unit has been impaired, the unit shall be made inoperative, and secured against accidental operation. Luxel should be contacted for advice.

The unit must be wired according to the instructions in this manual.

Signal and supply voltage wiring should be kept separate from one another. Where this is impractical, shielded cables should be used for the signal wiring.

In addition to the restrictions of this manual, requirements of the Eurotherm 3504 Engineering manual must also be observed.

Warrantee

Your Luxel **RADAK** Power Controller is warranted to be free of defects due to materials or workmanship for 1 (one) year from date of purchase. This warranty excludes damage caused by improper installation and intentional or inadvertent misuse (e.g. operating into an unsuitable load).

In the event of a warranty claim, Luxel Corporation reserves the right to either repair or replace the unit at our discretion.

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3

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Introduction

The Luxel Dual Controller provides power, programming, and feedback capabilities for fully automated control of two Luxel RADAK thermal evaporation sources.

Based on Eurotherm's 3504 temperature controller/ programmer, the Dual controller has the flexibility needed to interface with your process control equipment, offering Ethernet communications, four programmable outputs, and five programmable inputs. Up to 20 additional logic inputs relay outputs can be added with the optional I/O expander board.

The following section provides a quick overview of system installation and setup. For detailed coverage of the Dual controller's programming and operation, please refer to the Eurotherm 3504 Engineering Handbook.

Front Panel
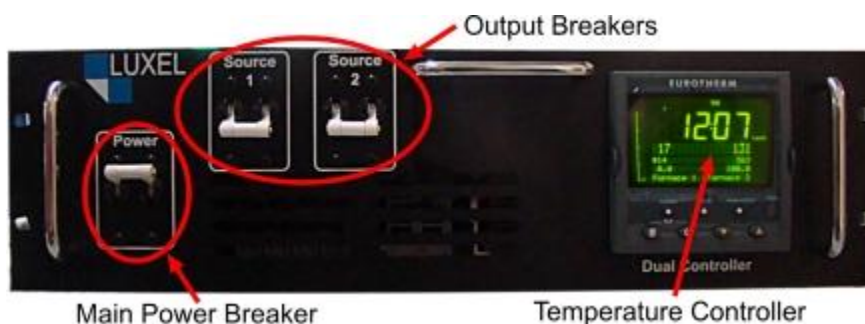
Main Power Breaker
The 15A main power breaker is the primary power shut off for the power controller.

Output Breakers
Two 30A breakers protect the controller in the event of a short in the power circuit outside of the controller. Placing the breakers in the off position (down) is also useful for controller setup allowing testing of programs and automation without applying power to the sources.

Temperature Controller

The Dual Controller is based on the Eurotherm 3504 temperature/ program controller.

The default display on the Dual Controller is a custom display different from the standard shown in the 3504 manual. This display allows monitoring of both furnaces simultaneously, and can be changed by the user as described in the 3504 Engineering Manual.

The main section of the display shows the time remaining in the current segment of the running program. Below the main section are two columns displaying pertinent information on Source 1 (left) and Source 2 (right).

Rear Panel
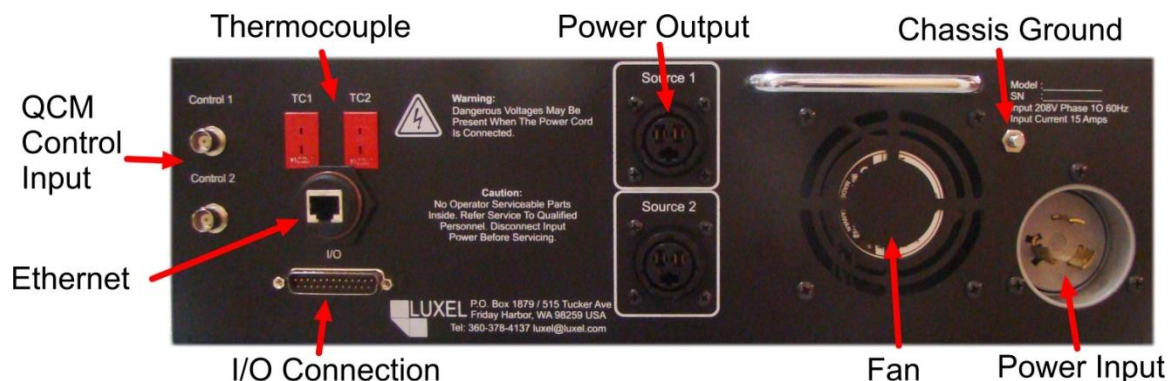
All external connection to the power controller are made via the back panel.

QCM Control Input
Input 0-10V signal to provide feedback from a deposition controller or other rate feedback mechanism.

Ethernet
Provides communication with the Eurotherm 3504 via Modbus TCIP protocol.

Thermocouple
Provides temperature feedback from each Radak Furnace being controlled.

I/O Connection
Digital input and output connection for process control equipment.

Power Output
Supplies the Dual Controller power output to the Radak Furnaces.

Power Input
NEMA L6-20 Connects the controller to 208VAC 1∅ 60Hz mains power supply unless otherwise specified.

Installation

1. Secure the Dual controller in the position intended for use. The Dual Controller fits a standard 19" full width rack space. When mounting in a rack, the back of the controller **must be supported**
Note: Supporting the controller with the front panel will result in damage to the controller case.
2. Connect the cassis ground to facility earth ground.
3. Connect the power output cables to your vacuum chamber feedthrough.
4. Connect the controller end of the power output cables to the Source 1 or Source 2 output connector. Output is protected above 30A, use AWG 10 wire or better.
5. Connect the thermocouple leads to connector TC1 or TC2 for source 1 or source 2 respectively. Be sure to rout the thermocouple leads away from high voltage sources which may induce signal noise.
6. Connect an Ethernet cable for access to the controller via your local area network.
7. Connect the I/O port to external equipment if desired. The I/O port may be connected to an Inficon SQC deposition controller directly using a standard DB-25 cable.
8. If using external setpoint feedback, connect a 0-10V signal using a BNC connector to Control 1 and Control 2 for remote setpoint trim on source 1 and source 2 respectively.

Dual Controller 3504 Operation

The home page, default on startup, is a custom page for the Dual Controller and is not addressed in the 3504 manual. You can return to this page at any time by pressing Page + Scroll ( ) except when in Config mode. The display will automatically return to the home page after 1 minute of inactivity. This can be adjusted in the config mode under Instrument.Display.HomeTimeout.

When not being actively controlled by a running program, the 3504 has two basic operating modes: Auto and Manual. In auto mode, the 3504 varies power as required to achieve and maintain the current setpoint. In Manual mode the operator sets the output power directly.
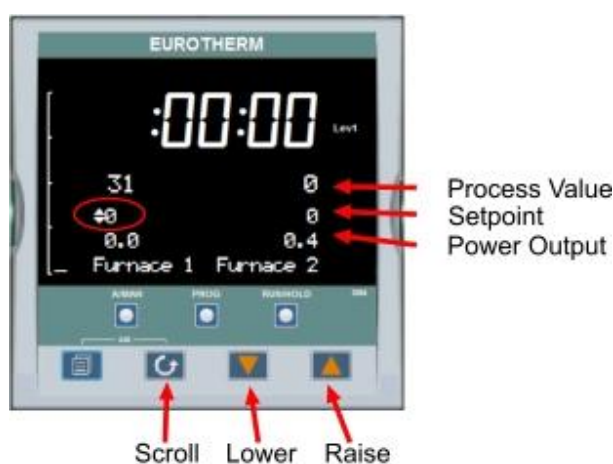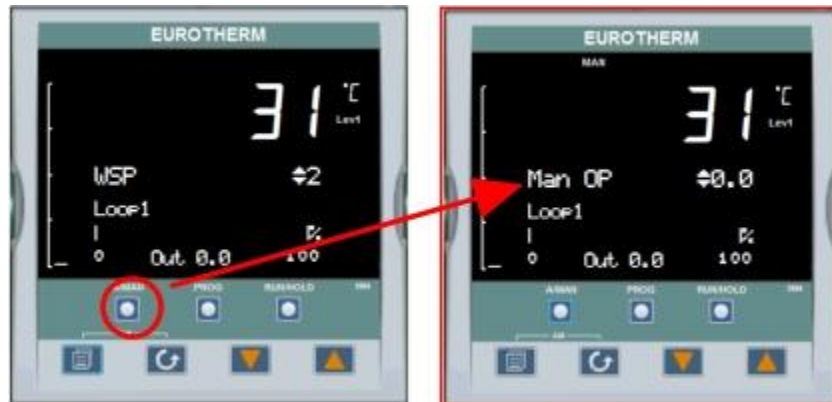

Auto mode

In Auto mode, the temperature setpoint can be changed using the Lower and Raise buttons on the front panel. Pressing the Scroll button advances to Furnace 2. Press the Scroll button three times to return to the Furnace 1 setpoint. Pressing Page + Scroll - will also return to the Furnace 1 setpoint. Pressing Page + Scroll will return to the home page from any screen except when in Config mode.

Manual mode

Caution should be used when operating the controller in manual mode as there is no temperature feedback and improper operation can result in damage to your sources. The controller is toggled between Auto and Manual mode by pressing the A/MAN button. **Important Note:** As of this writing, switching from Auto mode to Manual mode from the home screen changes to a display of furnace 1 in auto mode. To avoid confusion we recommend using the page button to advance to the desired furnace (or loop) then using A/Man to switch to manual mode.

Pressing the Page button will advance to Loop 2 (furnace 2). To return to Auto mode, press the A/MAN button.

Program Selection

Press the page button three times to advance to the Program Status Page. Use the Lower and Raise buttons to select the active program.
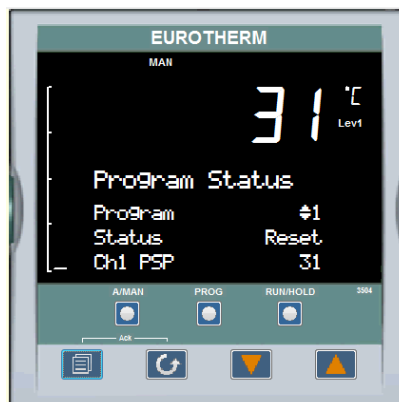
Program

The Dual Controller comes with 10 programs with up to 500 segments each standard (upgradeable to 50 programs). A program consists of segments with a temperature setpoint and a segment type (ramps, steps, and dwells). The following is a discussion of a basic program setup using the Program Editor function inside iTools; for a complete description of the 3504 programming features refer to the 3504 Engineering Manual.
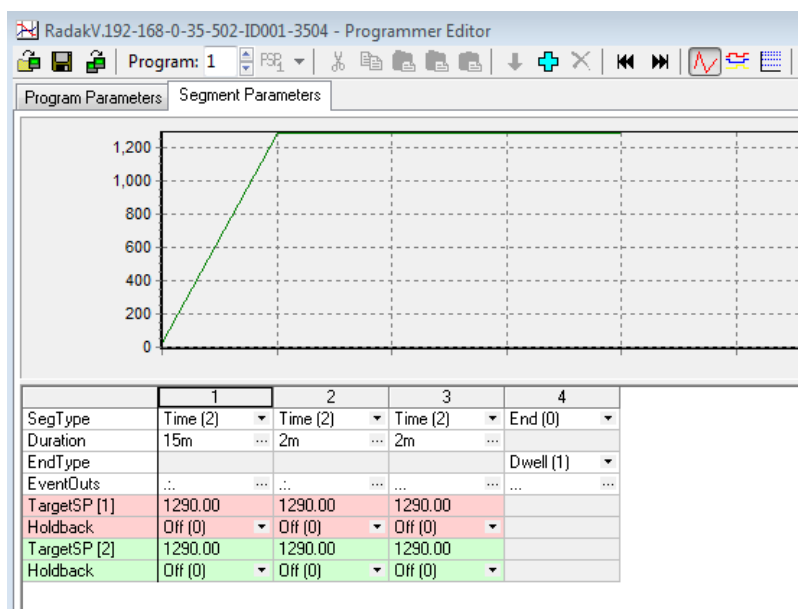
In the program above, both furnaces are ramped to 1290C over 15 minutes (segment 1), the sources dwell at 1290C for 2 minutes (segment 2), run at 1290C for 2 minutes (segment 3) and ends (segement 4) dwelling indefinitely at 1290C. TargetSP [1] and TargetSP [2] correspond to Output 1 and Output 2 respectively.

In this program, EventOut 2 is on in the first two segments then turned off in the third segment. The Dual controller is configured with EventOut 2 driving IO.Mod 2 B. Turning on EventOut 2 closes the contact between I/O connector pins 3 and 4. In the example above, this is used to trigger the Hold command in an attached deposition controller.

Once the source is at temperature and conditioned properly, EventOut 2 is turned off (segment 3) allowing the deposition controller to continue with the deposition.

With segment 4 (End) set to Dwell, the Dual Controller would maintain the furnace at 1290C indefinitely. In this example, an external signal from the deposition controller is used to reset the Dual Controller at the end of the deposition causing the temperature setpoints to return to 0 and the run is complete.

iTools

The 3504 controller is a feature rich device. Though all of the features of the 3504 can be accessed via the front panel, using iTools is *highly* recommended for anything but the most basic operations.

iTools is a free utility provided by Eurotherm. For the most current version, download and install iTools from www.eurotherm.com/products/controllers/itools/.

To set up the controller for TCP communications over Ethernet, please follow the guide at the end of this document.

I/O Wiring and Programming

The Dual controller has three options for communication: Ethernet, dedicated I/O port, or optional I/O expander. Ethernet connection is discussed in detail in the

Ethernet configuration section below. Use of the I/O expander is discussed in the I/O expander documentation.

The 3504 is fitted with up to six modules to provide the various function needed for Radak furnace control and system integration. These modules (one through six) each have four terminals which may or may not be used depending on the modules configuration and function. Below is an illustration of the module layout.
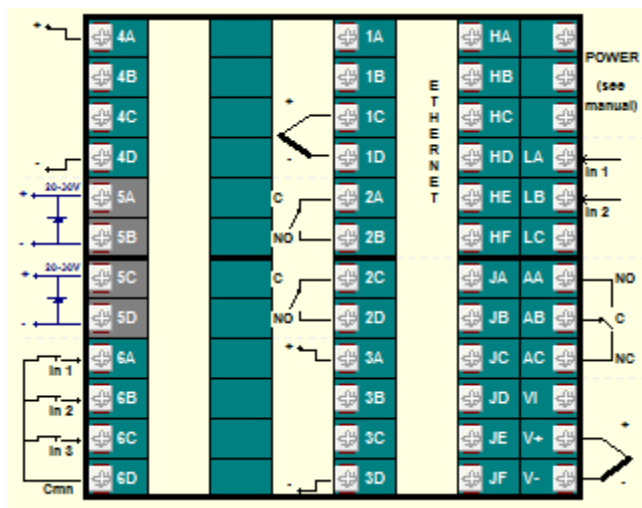
In addition to the standard logic, alarm, and thermocouple functions, your controller is fitted with Ethernet communications and six additional modules:

Module	Function
1	Analog Input (TC-2)
2	Dual Relay Output
3	Analog Input (IP-1)
4	Analog Input (IP-2)
5	Dual DC Output (Output power control)
6	Triple Contact Input

Communications with a PLC or other system controller can be made via the I/O port on the rear of the controller. The I/O port is a DB-25 connector with the following pinout:

Input				Output		
Module	Function	Pin(s)		Module	Function	Pin(s)
6A	Run	1,2		AA (NO)	Available	16,24
6B	Remote Setpoint 1	3,4		AC (NC)	Available	13,24
6C	Reset	5,6		2A*	Event 1	17,18
LA	Remote Setpoint 2	11,12		2C*	Event 3	19,20
LB	Available	14,15				

Table 1 Wiring refers to the associated module in the 3504. The function can be changed by editing the settings of the respective module.

The input is triggered by a contact closure between the respective pins. In the factory default configuration, the active program is run by making contact between pins 1 and 2. This contact should be momentary to prevent conflict with the reset logic.

*The output circuitry for 2A-C is configured at the factory for either contact or TTL logic. In the TTL logic configuration, a 5VDC signal is present between the associated pins when active. For contact configuration there is continuity between the pins.

Both inputs and outputs can be user re-assigned. Please refer to the 3504 Engineering manual for logic configuration.

Outputs can be triggered via alarms, program events, or any other aspect of the controller which has a value that changes. Logic statements and math statements can be combined to accomplish many useful tasks.

Ouputs 2A, 2B, and 2C are pre-programmed to work with program events 1, 2, and 3 respectively. These events are turned on and off in each segment of the program.
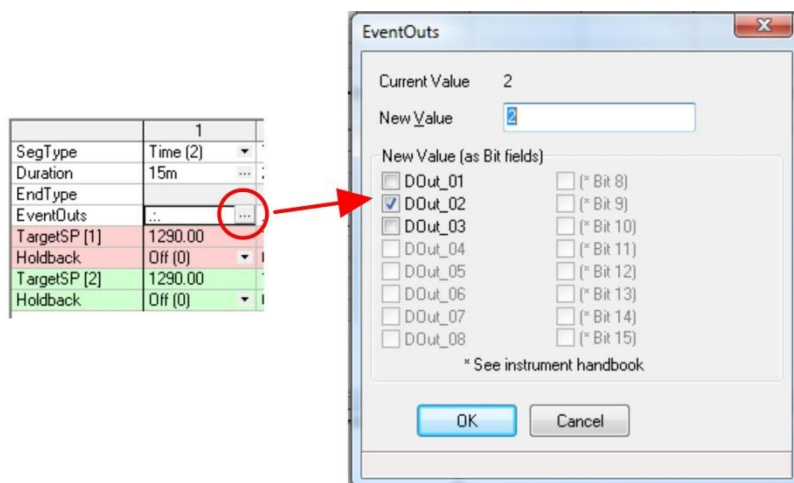
In iTools, edit the program to establish ramps and soaks as needed. In each segment, the status of the events is displayed in the EventOuts row. To set the events for that segment, click the ellipsis (…) button next to the events display. This will show the EventOuts window pictured above. Select the events to be on or off and click OK to update their status.

Internal Breakers

In addition to the breakers on the front panel, there are two breakers internal to the unit. These breakers protect the fan on the rear of the case and the 3504 controller itself. If it becomes necessary to reset these breakers, turn the unit off at the main power breaker, disconnect all power cables and remove the unit to an area where it is safe to remove the top cover. Remove the 9 screws holding the top cover in place and remove the top cover. Once the cover is removed, the breakers can be reset, the cover reinstalled and the unit returned to service. If the breakers continue to trip, contact Luxel for additional support.

Ethernet configuration

- Excerpt from the Eurotherm iTools Version 7 Help Manual -

18 PORT SETUP
18.1 iTOOLS CONTROL PANEL

The iTools control panel applet allows access to system-level configuration items. These include Serial and TCP communications, and the ability to enter a product code to enable additional iTools features that have been purchased.

When setting up communications, it is normally necessary to have access to IT personnel in order to obtain some of the required information (e.g. IP addresses).

The control panel can accessed in three ways:
1. It appears at the end of the installation process.
2. It can be accessed using the host pc Start menu
3. It can be opened from within iTools itself.

### 18.1.1. Access from the Start menu

1. Operate the keyboard Start key or click on 'Start' at the bottom left of the screen.
2. Click on 'Control Panel'.
3. If the control panel opens in 'Category View, click on 'Switch to Classic View'
4. Find the iTools logo and double click it to launch the Registry Settings window.

18.1.1. Access from within iTools
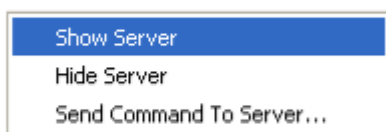
This opens the Server. The server window may appear on the screen, or may appear only as a new item in the task bar, according to the Windows operating system in use. Click on the Server item in the task bar if necessary to open the Server window.
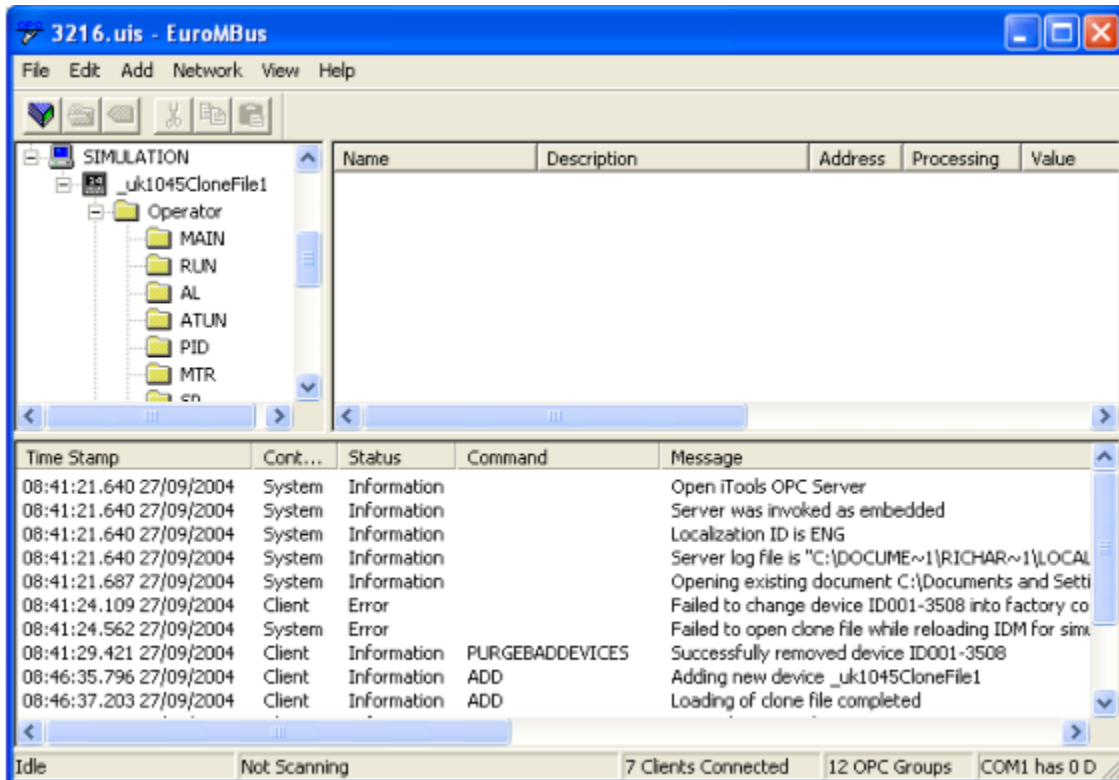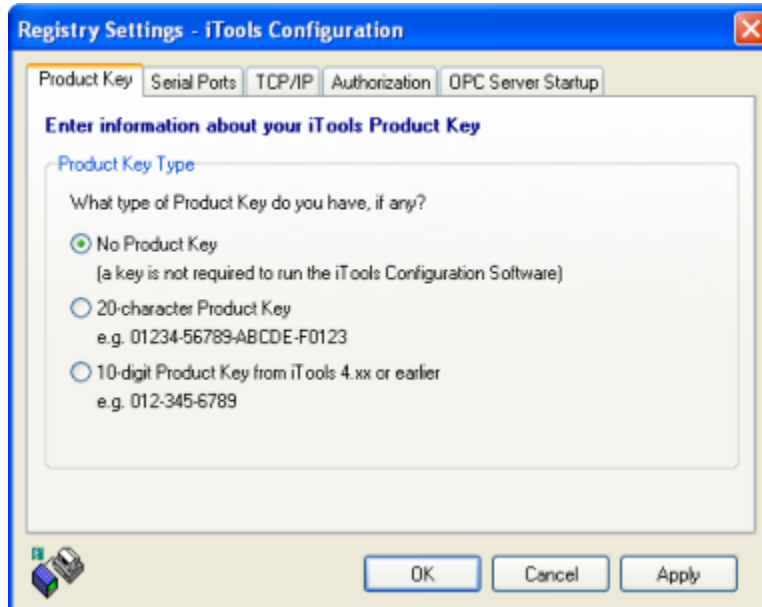
In the Edit menu, selt 'iTools Control Panel'.
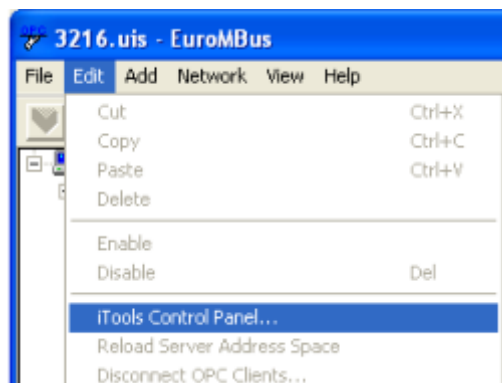
This opens the 'Registry Settings' window:
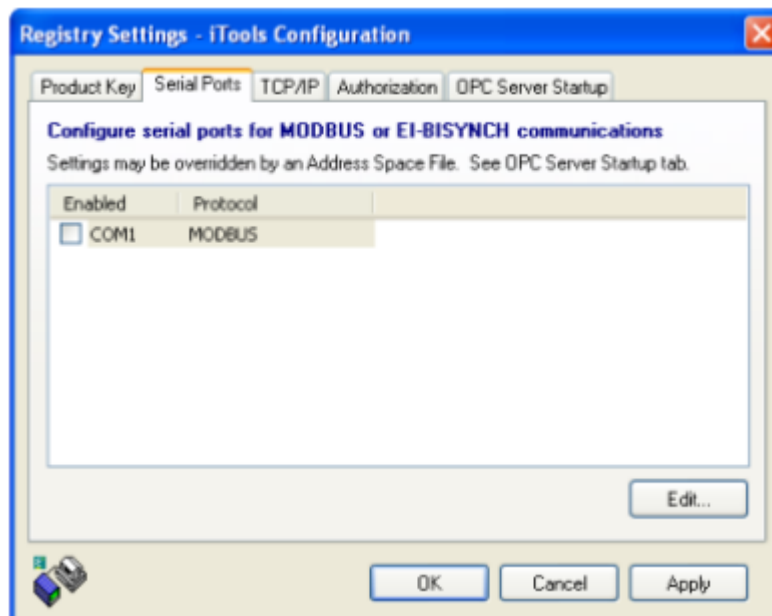
18.1.3. Registry Settings window

The registry window opens. In order to edit the contents of more than one tab, the 'Apply' key should be clicked on before the next tab is accessed. Clicking on 'OK' in any of the tabs, loses the window

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15

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PRODUCT KEY TAB

This allows users with Product keys to enter the key number to allows access to iTools features.
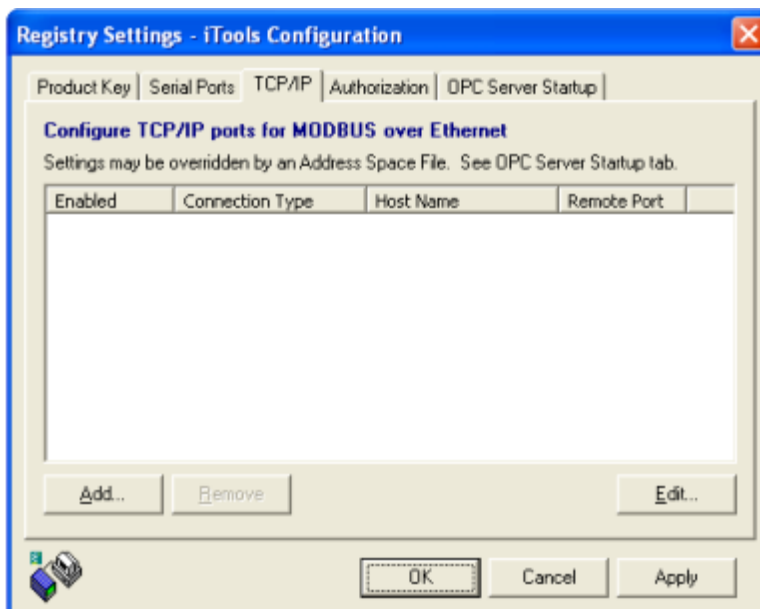
SERIAL PORTS TAB

Click on the relevant port to enable it for use by iTools. Port characteristics can be edited if required (Edit... key), but this facility should be used only by advanced users.

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16

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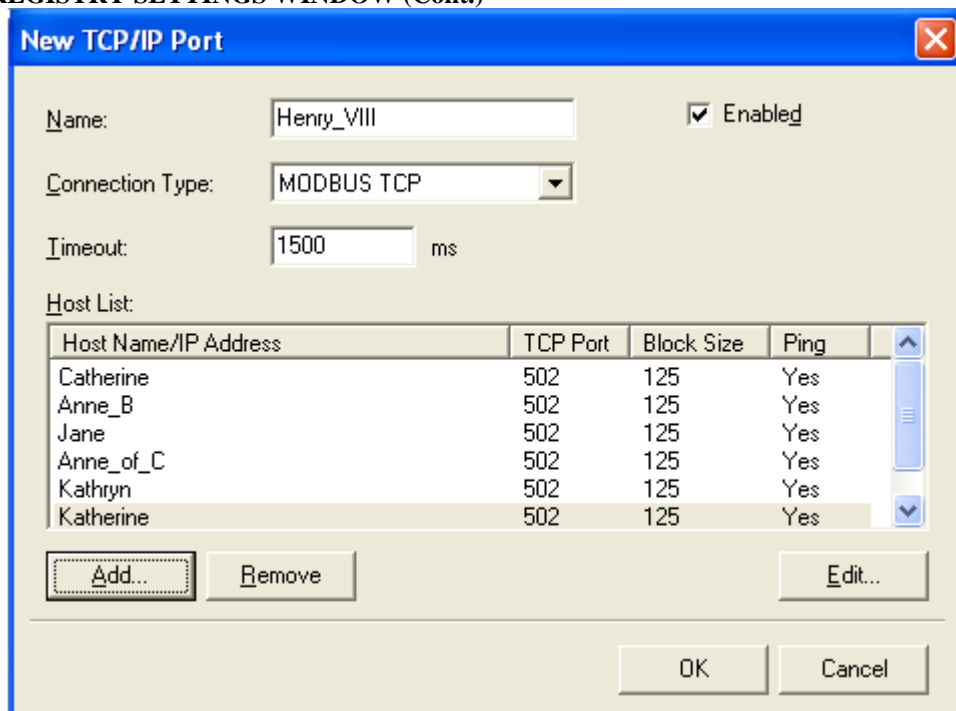**18.1.3 REGISTRY SETTINGS WINDOW (Cont.)**

TCP/IP TAB

Clicking on 'Add' calls the 'New TCP/IP Port' configuration window. This window is initially empty. New ports can be added to the list by clicking on the 'Add' key, and typing in a name for the Port in the 'Edit Host' window which appears.
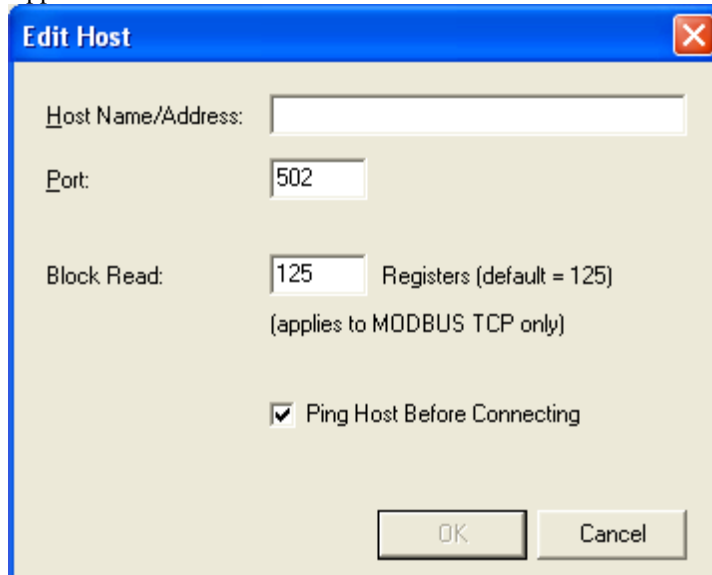
Once a name has been entered for the Port (Henry_VIII), the with the relevant port selected, clicking on the Add key allows the user to enter the names or IP addresses of one or more hosts to be associated with the new Port.

18.1.3 REGISTRY SETTINGS WINDOW (Cont.)

AUTHORIZATION TAB
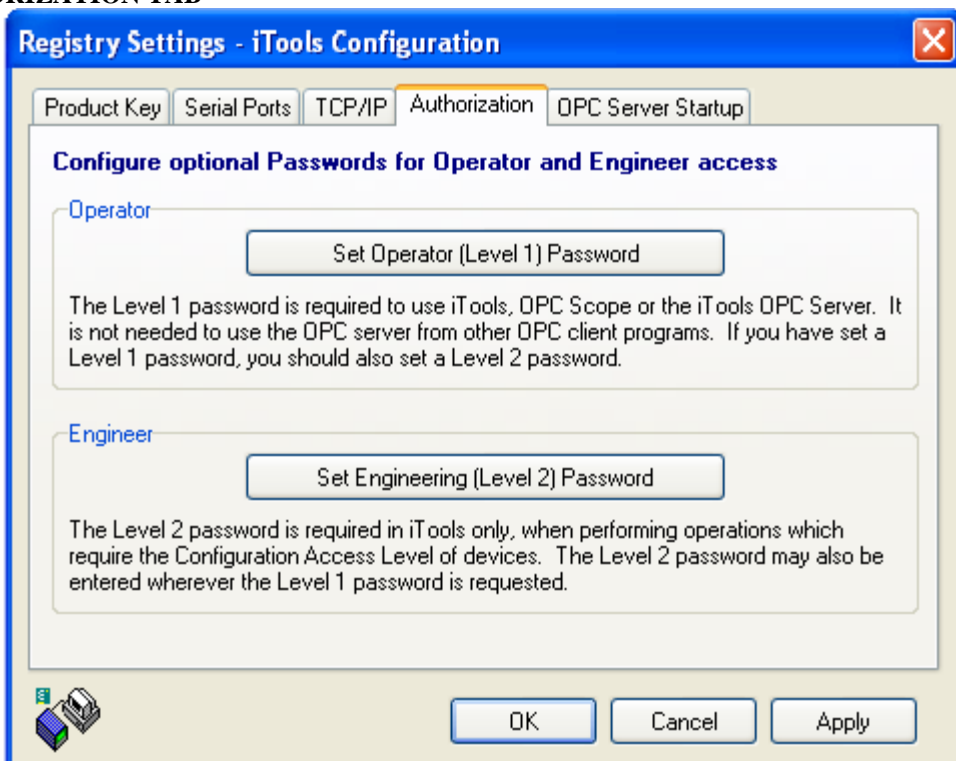

This allows passwords to be entered, but the fields can be left blank if so desired.

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18

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18.1.3 REGISTRY SETTINGS WINDOW (Cont.)

OPC SERVER STARTUP TAB
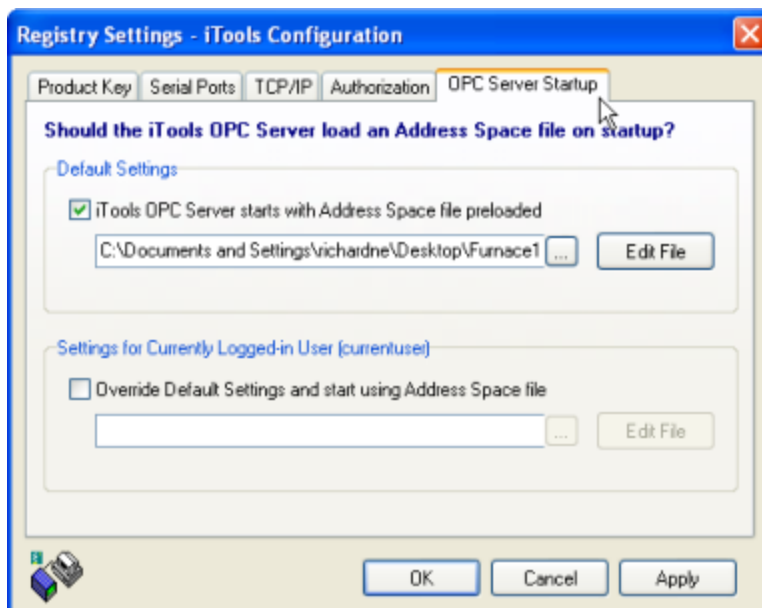
If the server configuration has previously been saved, then a saved file path name appears in the Default settings field. The ellipsis key can be clicked on to allow an alternative default to be selected. If required, the default setting can be overridden, for the current user, by clicking on the 'Override Default Settings.....' area and browsing to the required filename. When saving the server configuration to a new name (Server File menu Save As...), the user is asked whether this new name is to become the default, and if so, whether it is to be the default for all users or only for the currently logged in user.

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19

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Soft Wiring

General soft wiring layout. This view shows the relationship between input and output modules and the furnace control loops.

This section of code controls the interactoin between the programmer and Furnace 1.

IO.PV
ThermoCouple (1)
C (9)
SBrkOut
PV
6

Loop 1
PID (2)
Off (0)
Main.AutoMan | Main.PV
Main.PV | Main.WorkingSP
Tune.AutotuneEnable | SP.RangeHigh
SP.SPSelect | SP.RangeLow
SP.SP1 | SP.TrackPV
SP.SP2 | SP.TrackSP
SP.AltSPSelect | OP.Ch1Out
SP.AltSP
SP.SPTrim
OP.ManualMode
OP.ManualOutVal
7

Programmer 1 handles I/O with SQC

Instrument.Display.BarVal
Instrument.Display.BarMax
Instrument.Display.BarMin

IO.Mod 5.A.PV

Programmer 1
Setup.SyncIn | Setup.Sync1
Setup.PVIn | Setup.ProgRun
Setup.SPIn | Setup.EventOut1
Setup.ProgReset | Setup.EventOut2
Setup.ProgRun | Setup.EventOut3
Setup.ProgHold | Run.PSP
Setup.ProgRunHold
Setup.ProgRunReset
Setup.PrgIn1
Setup.PrgIn2
Setup.PVWaitIP
Run.CurProg
3

Programmer 2.Setup.SyncIn

IO.Mod 6.C.PV
IO.Mod 6.A.PV

IO.Mod 2.A.PV
IO.Mod 2.B.PV
IO.Mod 2.C.PV

24.31

IO.Mod 4.A
AnalogIP (6)
Volts (15)
Linear (11)
A.SBrkOut
A.PV
4

In1 = 0.00

Math2 1
Mul (3)
In1 | Out
In2
5

IO.Mod 6.B.PV

0.00

In2 = -100.63

Analog in (Mod4) is the chanel 1 remote setpoint trim value from external Controller.
If the external controller calls for remote trim (via mod.6.B) then In 1 = 1 (true).

This section of code controls the interactoin between the programmer and Furnace 2.

IO.Mod 1.A
AnalogIP (6)
ThermoCouple (11)
C (9)
A.SBrkOut
A.PV
11

Loop 2
PID (2)
Off (0)
Main.AutoMan | Main.PV
Main.PV | Main.WorkingSP
Tune.AutotuneEnable | SP.TrackPV
SP.SPSelect | SP.TrackSP
SP.SP1 | OP.Ch1Out
SP.SP2
SP.AltSPSelect
SP.AltSP
SP.SPTrim
OP.ManualMode
OP.ManualOutVal
16

IO.Mod 5.C.PV

Programmer 2
Setup.SyncIn | Setup.ProgRun
Setup.PVIn | Run.PSP
Setup.SPIn
Setup.PVWaitIP
12

Programmer 1.Setup.Sync1

IO.Mod 3.A
AnalogIP (6)
Volts (15)
Linear (11)
A.SBrkOut
A.PV
13

Math2 2 In2
IO.LgcIO.LA.PV
IO.Mod 3.A.PV

Math2 2
Mul (3)
In1 | Out
In2
15

Out = -100.63

A.PV = -100.63

Analog in (Mod3) is the chanel 2 remote setpoint trim value from the external Controller.
If the external controller calls for remote trim (via Logic A) then In 1 = 1 (true)."

Furnace 1 and Furnace 2 softwire sub-sections.

The 3500 series controllers internal functions are controlled via soft wiring. High level functions can be created using math, logic, user variables and other function blocks. The Eurotherm 3500 user manual covers all blocks and usage of the graphical wiring interface. It is highly recommended that you familiarize yourself with these functions prior to making any changes to your controller. Also, it is recommended you save a clone file of the current configuration prior to any new programming.
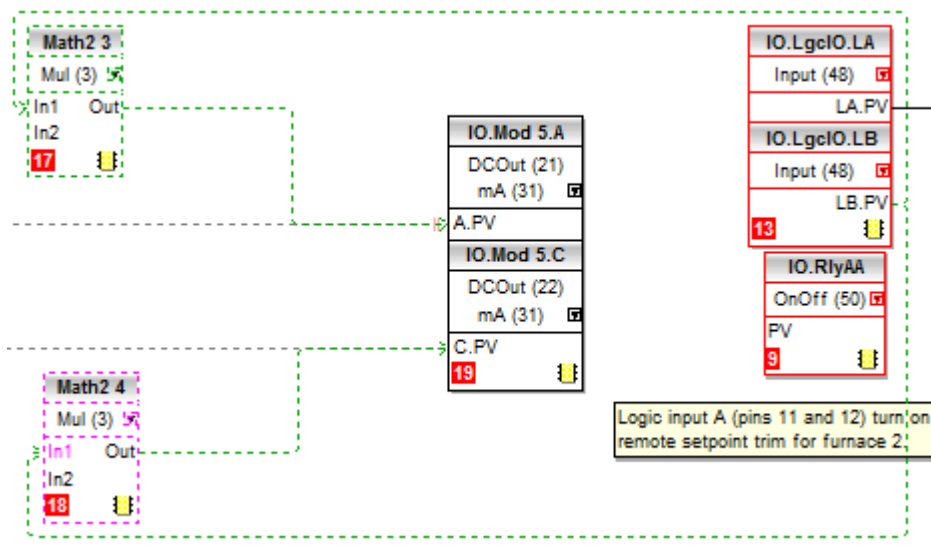
Vacuum interlock
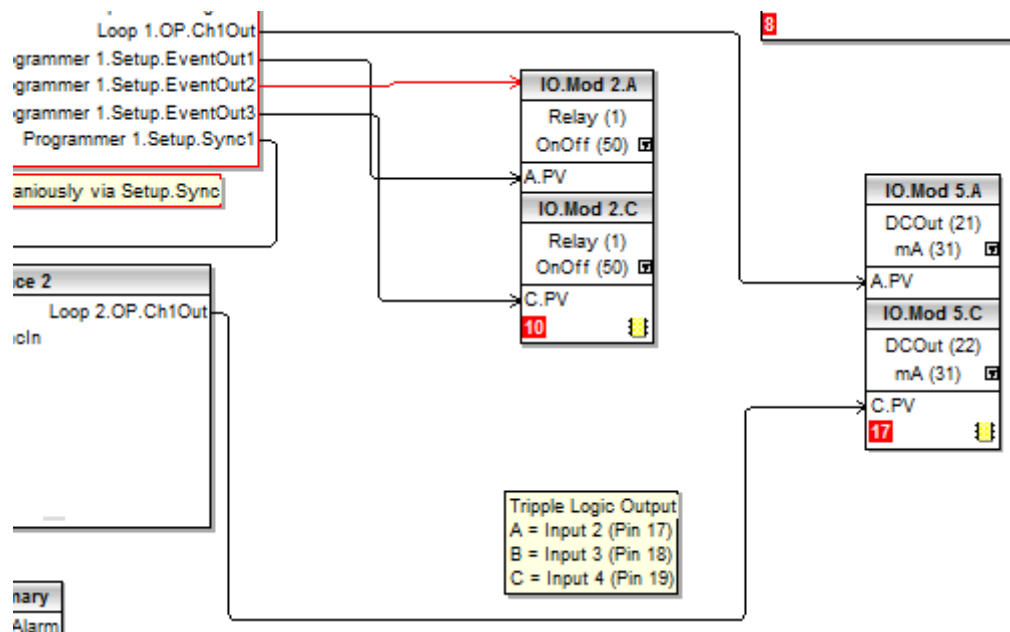
To illustrate the basics of soft wiring, well set up an interlock to prevent power output unless the interlock is met. We'll use Logic B (pins 14 and 15) for the interlock input. This can be accomplished in many ways but we'll use the logic input and a math block to interrupt the signal from the loop output and dc output module setpoint. It is recommended that you save a copy of the current clone file before making any changes to controller programming.
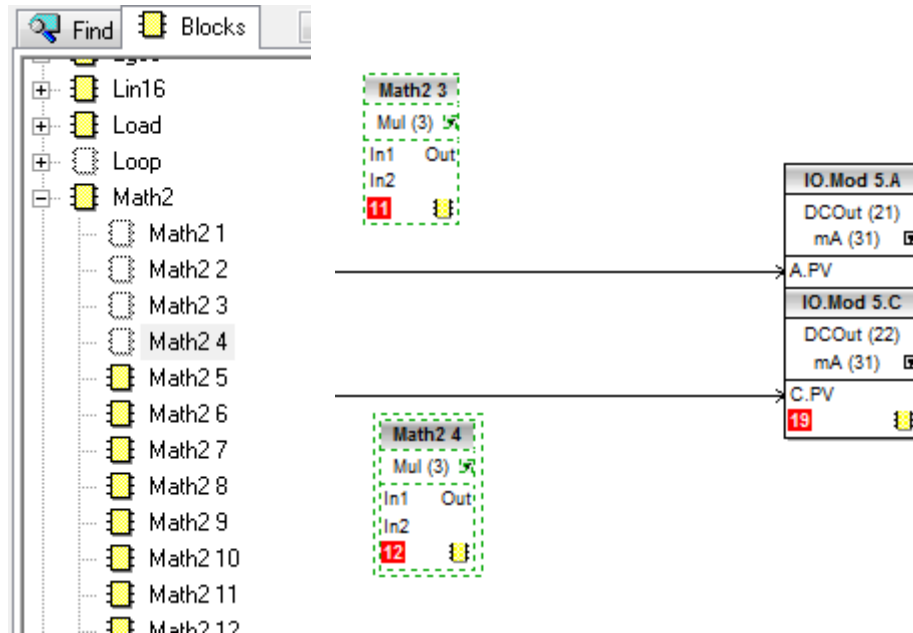
First, drag the IO.Mod 5, IO.LgcIO, and IO.RlyAA blocks over to give some room to work. Next, drag math blocks 3 and 4 from the Blocks section into the graphical wiring workspace. Change the math block function to math by double clicking the arrow to the right of the function (initially set as off).

To use the value of logic b, click to the IO.LgcIO.LB block to the right of LB.PV (logic b process value) the cursor will change from an arrow to a wiring connector. Move the connector to Math2 3 and click In 1, this will multiply the value we wire to In2 by either 1 or 0 depending on the state of logic input b (true or false). Connect LB.PV to Math2 4 using the steps above. Note: the inputs can have only one wire attached but outputs can be connected to as many outputs as needed.

Next, connect the outputs from Math2 3 and Math2 4 to IO.Mod 5.A and IO.Mod 5.C process values (A.PV and C.PV). You'll be prompted to replace existing wire, answer yes.

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23

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To finish the circuit, wire Furnace 1 and Furnace 2 Ch1Out to In2 on their respective math modules (shown below).
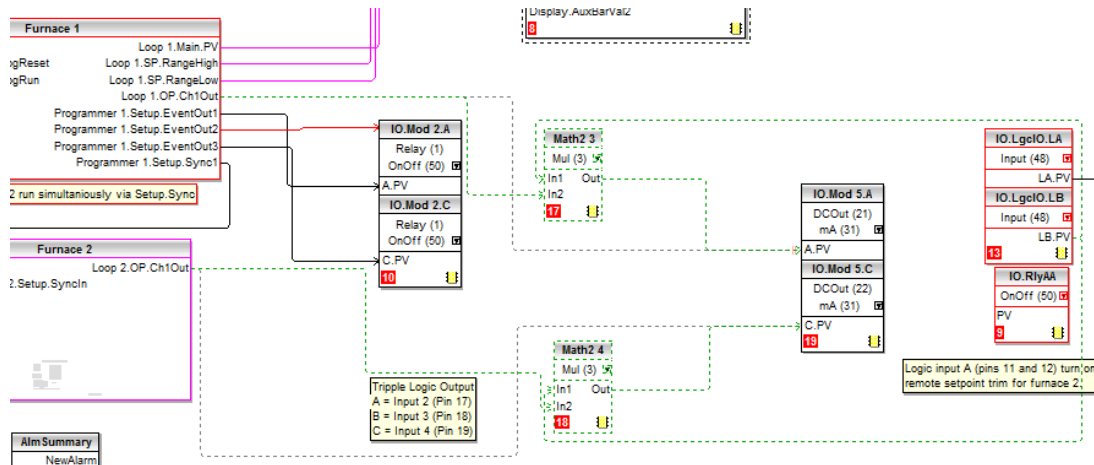
All wire and block changes are shown as dashed lines until the changes are saved or downloaded to controller memory using the download button. Once the wiring has been saved to the controller all lines are drawn solid reflecting the current status of the controller programming.
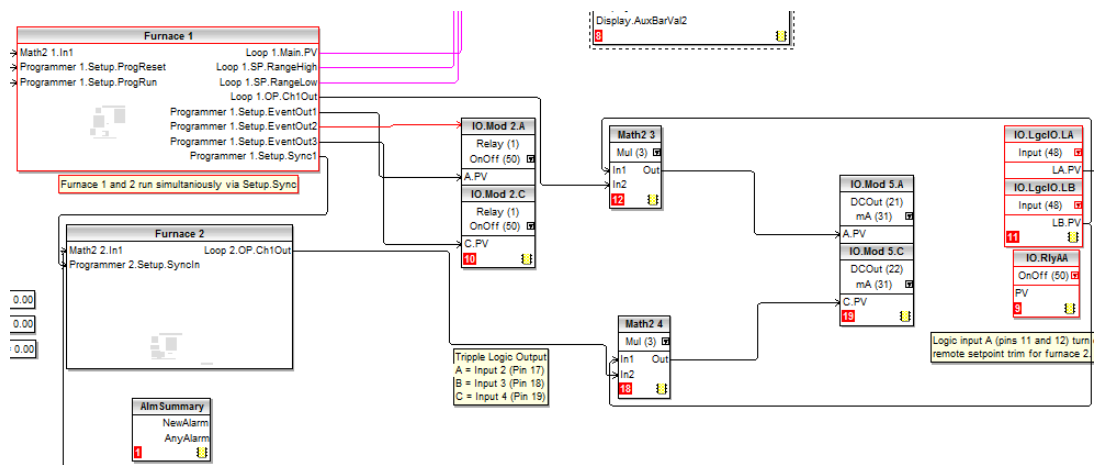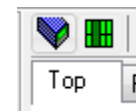
The controller comes with 60 wires. This example consumed 4 wires (two were deleted) leaving a total of 29 remaining. Additional wires and function blocks can be purchased as needed.