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PROTHERM 455

User Manual

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MANUAL #: 204

Revision #	Revision Date	Revision Description
003	03/01/2017	
002	15/01/2015	

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TECHNICAL ASSISTANCE

For all questions or concerns regarding the operation of the **Protherm 455**, please consult the last page of this manual for contact information.

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1 INSTALLATION SAFETY REQUIREMENTS

This instrument is intended for industrial applications used in conjunction with carbon sensors and standard thermocouple types. Any installation must meet either CE standards for industrial safety and/or NEC standard wiring practices. Failure to observe these standards or the installation instructions in this manual may degrade the safety or electrical noise protection provided by the instrument. It is the installer's responsibility to ensure the safety and electrical noise compatibility of any installation.

1.1 Wiring

It is important to connect the PROTHERM 455 controller in accordance with the wiring data in the Technical Specifications at the end of this document. Take particular care not to connect AC supplies to the low voltage sensor inputs or other low voltage inputs or outputs. Use only copper conductors for connections (except for thermocouple inputs) and ensure that the wiring installations comply with all local wiring regulations. Be sure to note that the main power for the PROTHERM 455 is 24V DC.

1.2 Enclosure of Live Parts

To prevent hands or metal tools touching locations that may be electrically active, the PROTHERM 455 controller must be mounted in an enclosure.

1.3 Conductive Pollution

Electrically conductive pollution must be excluded from the cabinet in which the controller is mounted. For example, carbon dust is a form of electrically conductive pollution. To secure a suitable atmosphere in conditions where conductive pollution is an issue, fit an air filter to the air intake of the cabinet. Where condensation is likely, such as at low temperatures, include a thermostatically controller heater in the cabinet.

1.4 Routing of Wires

To minimize electrical noise, wiring for low voltage DC and analog input and outputs should be routed away from high current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at one end to reduce noise.

1.5 Over-Temperature Protection

When designing any control system, it is essential to consider what will happen if any part of the system fails. When dealing with temperature control, the primary danger is a heat source that is constantly on. This could lead to damaged parts, damaged machinery, or even human injury. Possible reason the heating could remain constantly on include:

- Temperature sensor becoming detached from the process
- Thermocouple wiring short circuiting
- The controller failing with heat output constantly on
- External valve or contactor sticking or failing in the heating position
- The controller set point is set to high

It is recommended that a separate over-temperature protection unit be installed. This device must use an independent temperature sensor, which allows for isolation of the heating circuit. NOTE: The alarm relays within the PROTHERM 455 will not give protection under all failure conditions. The PROTHERM 455 is not suited for over temperature protection and should not be used as a safety device.

2 CONTROL MENU:

The Control Menu is the display selected for general operation. Here the operator and select the available tabs for each controller, verify process values, set points, and outputs. Recipes can be started or the controller placed in standby mode.

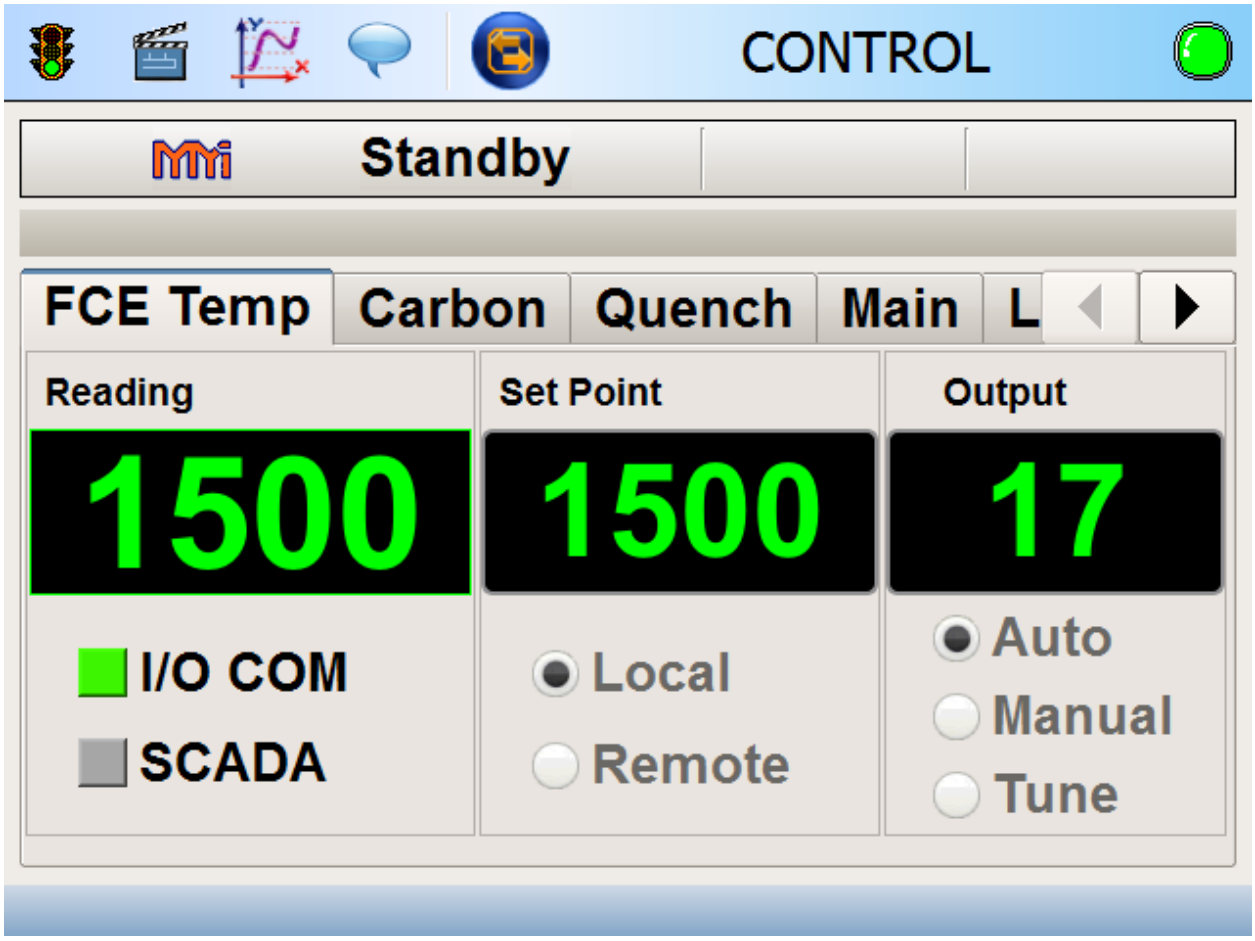


Figure 1: This screen shows a header bar, recipe information and parameter tabs.

2.1 Header Bar:

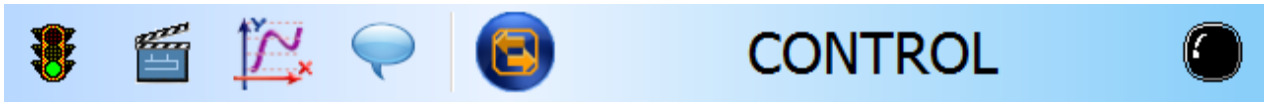
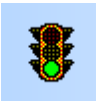


Figure 2: Standby Header Bar

Figure 3: Running Recipe Header Bar



2.1.1**Recipe Start:**
Tapping this will start a recipe.

2.1.2 **Clapperboard:**
The clapperboard is used to commence (or stop) logging during standby periods. (Note that logging is always active when running a recipe)

2.1.3**Line Graph:**
Use the line graph button to select what values to log during standby or during a running recipe.

2.1.4**Comment Bubble:**
Add a comment to the selected log file.

2.1.5**Go Back:**
Go back one screen.

2.1.6**Recipe Stop:**
Tapping this will stop the running recipe.

2.1.7**Recipe Pause:**
Tapping this put the currently running recipe on pause.

2.1.8**Recipe Edit:**
Edit the current running recipe.

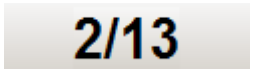
2.1.9**Alarm Status:**
Tapping this shows the current alarm status. Flashing red  means active, unacknowledged alarm, solid red means acknowledged alarms, green  means everything is okay, flashing purple means unacknowledged non-responsive I/O alarms and solid purple means acknowledged non-responsive alarms. This alarm light is displayed on all screens. Please refer to the section Alarm Menu: for more information.

2.2 Recipe Information:

Figure 4: Recipe Information Bar

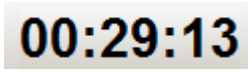
2.2.1 Recipe Name:

This area will show the currently running recipe number. If it is in standby mode, it will display “Standby”.



2.2.2 Step Number:

Tapping this will display the current step as well as the total number of steps. When in standby, this space will be empty.



2.2.3 Time:

Displays the remaining time for the current step of the recipe.

2.3 Parameter Tabs:

The number of tabs and their content is dependent on system configuration. Below is an example of for a typical configuration.

Figure 5: Parameter Tab

2.3.1 Left/Right Arrows:

These arrows will allow the user to scroll the parameter tab to show more available parameter screens.

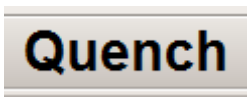
2.3.2 FCE Temp:

This shows the actual temperature of the furnace, furnace temperature set point, and percent output of the controller. Please see section for a Overview Screens:

Furnace Temperature Overview: detailed explanation.

2.3.3 Carbon:

This shows the actual carbon, carbon set point, and percent output of the controller. Please see section Carbon Overview: for a detailed explanation.



2.3.4 Quench:

This shows the actual temperature of the quench, quench temperature set point and percent output of the controller. Please see section Quench Overview: for a detailed.

Main

2.3.5 Main:

Shows the actual furnace temperature, carbon value, and quench temperature. Please see section Main Overview: for a detailed.

Layout

2.3.6 Layout:

Shows a picture representation of the furnace as well as essential IOs such as carbon, furnace temperature, and quench temperature. Please see section Layout Overview: for a detailed.

Details

2.3.7 Details:

This shows the status and actual values of various IOs. Please see section "Details Overview" for more details.

3 OVERVIEW SCREENS:

3.1 Furnace Temperature Overview:

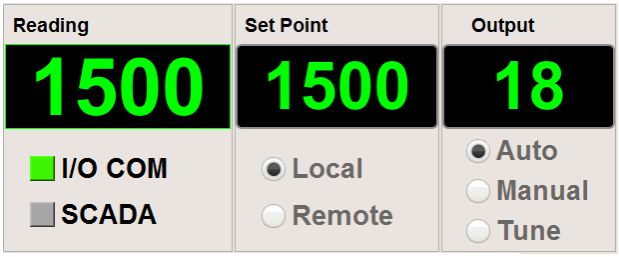


Figure 6: Furnace Temperature Overview

This is the furnace temperature overview screen. It displays the actual furnace temperature, the furnace temperature set point and the percent output of the controller. Below the actual furnace temperature there are two (2) indicator LEDs. The "I/O COM" LED shows if there is a missing input and will display a red LED. Examples are broken thermocouple wire or a faulty 4-20mA signal. The "SCADA" LED will turn green if a SCADA is configured.

The "Local" and "Remote" options will allow the operator to select where the furnace temperature set point source is. If in local and the currently logged in user has permissions, just press the current set point (1500 shown above) and enter in the desired new set point. If the set point mode is in remote, a SCADA system will be able to remotely write the set point only for the controller that set to "Remote" mode.

When in normal operation, the output should be in "Auto" mode to allow the controller to control temperature automatically. If manual mode is selected, a manual percent output can be entered by tapping the output percentage (18 shown above) and entering the desired percent output. If the controller requires the PIDs to be tuned, selecting the "Tune" option and then the desired tune temperature will start the controller's auto tune feature. The length of time for the

auto tune to complete can vary. To cancel, select either “Auto” or “Manual”. Refer to section **Error! Reference source not found.** for more information.

3.2 Carbon Overview:

This is the carbon potential overview screen. It displays the actual carbon potential, set point and controller output. The “Local”, “Remote”, “Auto”, “Manual”, and “Tune” work as described in section “Overview Screens:

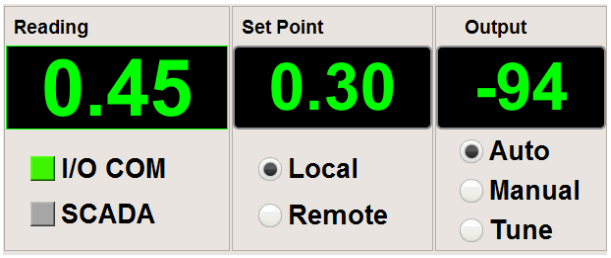


Figure 7: Carbon Potential Overview

Furnace Temperature Overview:” except that it effects carbon potential instead of furnace temperature. Also, the “I/O COM” and “SCADA” indicator LEDs operate as described in section “Overview Screens:

Furnace Temperature Overview:”.

3.3 Quench Overview:

This is the quench temperature overview screen. The actual quench temperature, set point and controller output are displayed. The “Local”, “Remote”, “Auto”, “Manual”, and “Tune” work as described in section “Overview Screens: Furnace Temperature Overview:” except that it effects quench temperature instead of furnace temperature. Also, the “I/O COM” and “SCADA” indicator LEDs operate as described in section “Overview Screens: Furnace Temperature Overview:”.

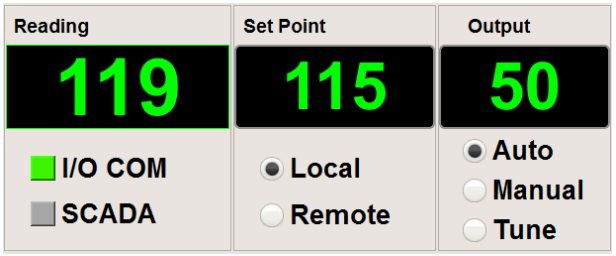


Figure 8: Quench Temperature Overview

3.4 Main Overview:

This is the main overview screen. It displays the current furnace temperature, carbon potential, and quenching temperature.

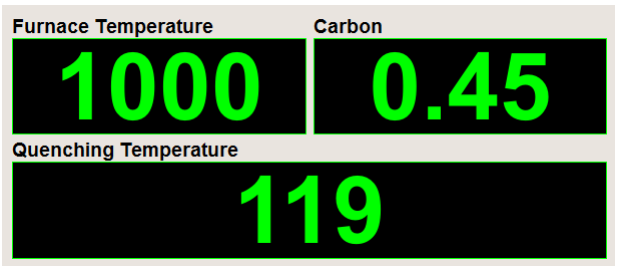


Figure 9: Main Overview

3.5 Layout Overview:

This is the layout overview screen. It shows a representation of the furnace along with important values such as carbon potential, furnace temperature, and quench temperature. The green values display actual values while the blue values display set points. This overview can also show conditions of discrete events such as air or gas outputs.

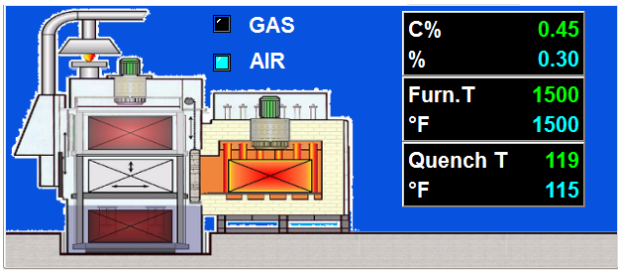
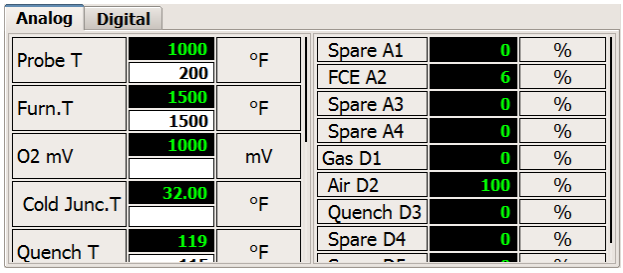


Figure 10: Layout Overview

3.6 Details Overview:



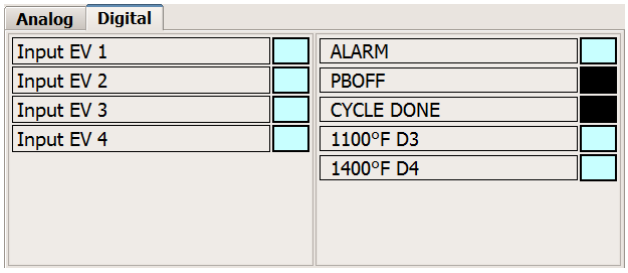


Figure 11: Details Overview

These are the analog and digital details overview screens. They show the current status of both analog and digital IOs. Refer to the Manual Mode Menu: for more details on how to manually change the outputs of the PROTHERM 455.

4 MAIN MENU:

Figure 12: Main Menu

The main menu is accessed by tapping the back button. The number of times the back button must be tapped depends on which screen the operator is currently viewing.

4.1 Control:

This will show the operator the main screen and is default at boot up. Refer to section Installation Safety Requirements

4.2 Recipe:

This is where an authorized user can build recipes and modify stored recipes. Please refer to Recipe Menu: for more information. Only the administrator group and metallurgists groups can access this.

4.3 Maintenance:

This is where authorized users can perform maintenance on the PROTHERM 455 controller. Please refer to Maintenance Menu: for more information. All groups except operators have access to various options in this menu.

4.4 Configuration:

This is where users can configure the PROTHERM 455 controller. Please refer to Configuration Menu: for more information. All groups have access to various options in this menu.

4.5 Users:

This is where a user can log on, log off, and edit users. Please refer to Users Menu: for more information. All groups have access to various options in this menu.

4.6 View Logs:

This is where a user can view logs that have been saved to the PROTHERM 455. Please refer to View Logs Menu: for more information. All groups have access to this menu.

5 RECIPE MENU:

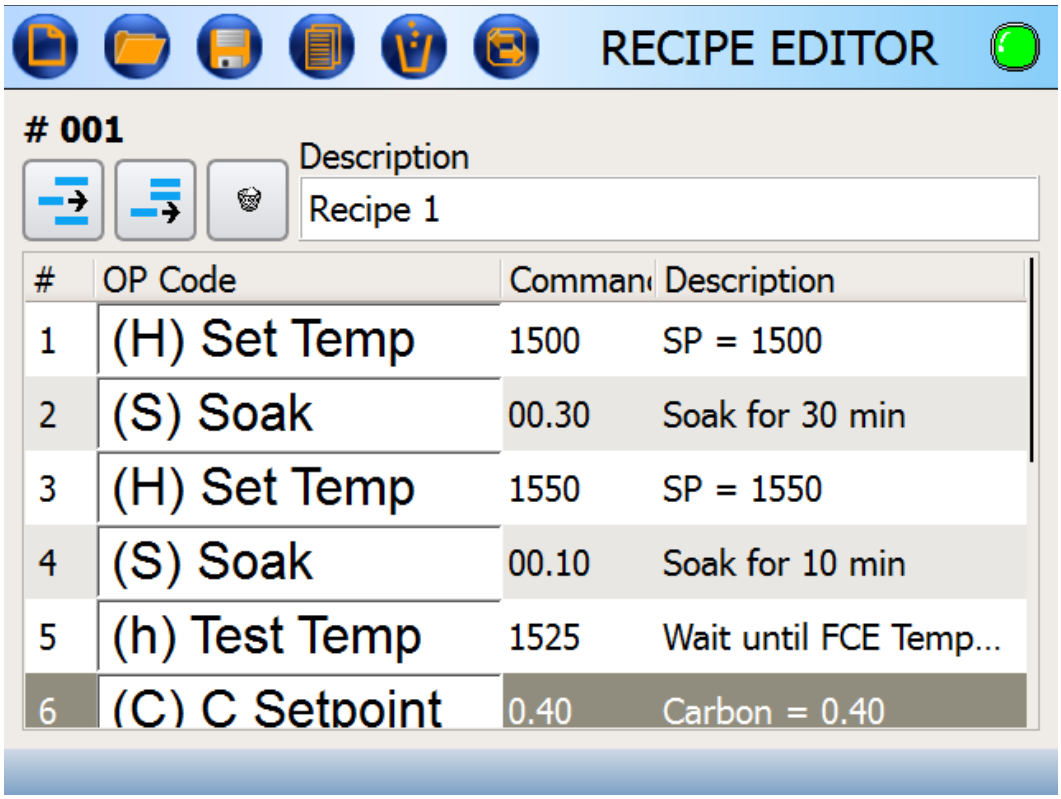


Figure 13: Recipe Creation Menu

The recipe menu is where an authorized user can create, edit, and delete recipes on the PROTHERM 455 controller. The PROTHERM 455 uses the MMI Dualpro and Carbpro op codes for recipe creation to keep backwards compatibility with SCADA systems.

5.1 Recipe Header:

Figure 14: Recipe Header Bar

5.1.1 New Recipe:

This will create a new, empty recipe for a user.

5.1.2 Open Recipe:

This will show a list of existing recipes on the controller and allow a user to open one of them for editing for copying.

5.1.3 **Save Recipe:**
This will allow a user to save changes to the currently opened recipe.

5.1.4 **Copy Recipe:**
This will copy the currently opened recipe into a different recipe number. When pressed, the user will be shown a list of all recipe slots. Once a slot is selected, the original recipe will be overwritten with the currently opened recipe.

5.1.5 **Delete Recipe:**
This will delete the currently opened recipe.

5.1.6 **Go Back:**
This will go back to the previous screen.

5.2 Step Modification:

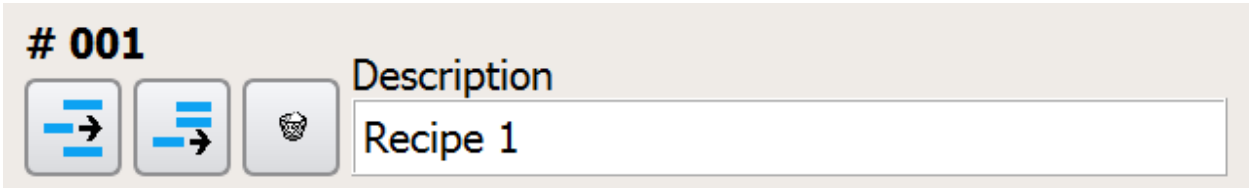
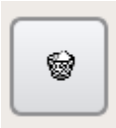


Figure 15: Modify Selected Step

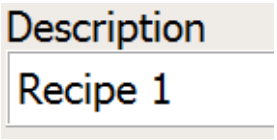
5.2.1 **Recipe Number:**
This shows the currently opened recipe number. There can be a total of 254 recipes stored on the PROTHERM 455. (Note: Some SCADA systems are limted to the original 200 recipe capability of the MMI Dualpro)

5.2.2 **Insert Step:**
This inserts a step above the currently highlighted step.

5.2.3 **Add Step:**
This adds a step at the end of the recipe.



5.2.4 **Delete Step:**
This deletes the currently highlighted step.



5.2.5 **Recipe Name:**
This is where a user can enter a description for the recipe.

5.3 Step List:

A user sees an organized list of four columns, line number, op code, data, and description with the scroll bar on the far right as a thick black line. Tap on the line number to open a step.

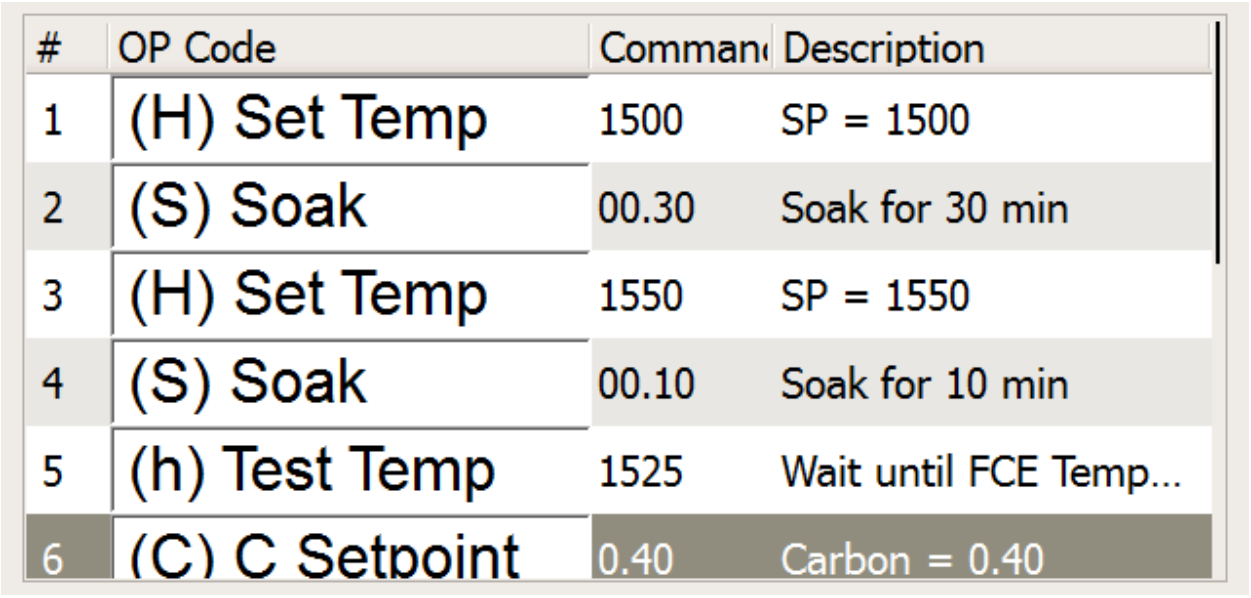
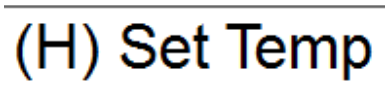


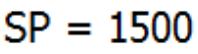
Figure 16: Recipe Step Editor

5.3.1 **Step Number:**
This shows the step number in the currently opened recipe.



5.3.2 **Step OP Code:**
This is where the user can select the op code. By tapping here, a list of is displayed to the user of available op codes. Please refer to 0 for more information.

5.3.3 **Step Command:**
This is the command for the selected OP Code. By tapping here, a user can edit the command.



5.3.4 **Step Description:**
This is where a user can enter a description for the selected step.

5.3.5 **OP Codes:**

Table 1: OP Codes lists all available OP codes

Op Code	Description
-	No Operation
A	Set ALARM number
B	BRANCH, true step 0 – 19 and false step 0 - 19
C	Set Carbon or dew point set point, implied decimal place xx.xx for carbon and xxx.x for dew point
c	Check carbon or dew point, implied decimal place xx.xx for carbon and xxx.x for dew point
d	Add to reference number
E	Event, event number 0 to 63, OFF or ON
F	Flag set, flag number 0 to 47, OFF or ON
G	Gosub to another recipe and return
H	Set temperature set point
h	Check actual temperature
i	Insert delay, time in seconds
J	Jump to another recipe
L	LIMIT, time in hours and minutes, implied decimal place xx.xx
m	Test Input A
n	Set reference number
o	Test input B (typically sensor mV)
P	Set process factor
q	Test reference number
r	TIME TO RAMP, time in hours and minutes, implied decimal place xx.xx
S	SOAK, time in hours and minutes, implied decimal place xx.xx
T	Set master timer, time in hours and minutes, implied decimal place xx.xx
t	Test master timer, time in hours and minutes, implied decimal place xx.xx
U	Test temperature control % output
u	Test carbon control % output
W	Wait for FLAG, flag number 0 to 47, OFF or ON
Y	Test INPUT C (Typically furnace temperature)
Z	Data Z1 for ‘F’ op code

Table 1: OP Codes

6 MAINTENANCE MENU:

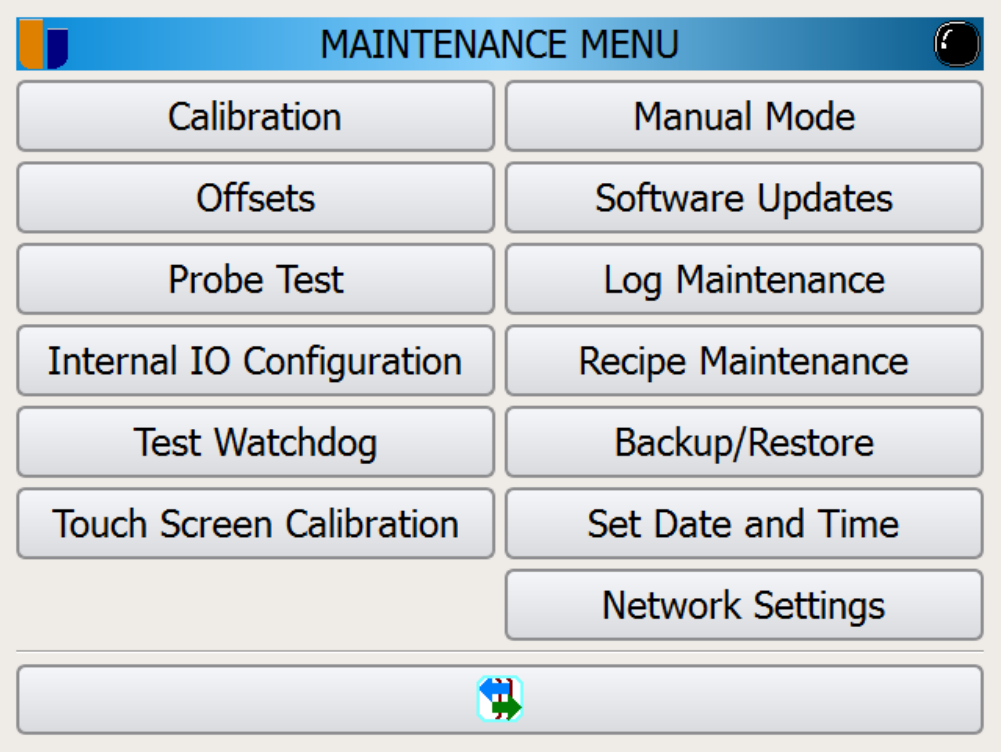


Figure 17: Maintenance Main Menu

6.1 Calibration:

Calibration

This is where an authorized user can do an onsite calibration of the analog input signals.

6.2 Offsets:

Offsets

This is where an authorized user can enter offsets to the analog input signals.

6.3 Probe Test:

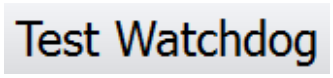
Probe Test

This is where an authorized user can do a probe test as well as view the previous test results.

6.4 Internal IO Configuration:

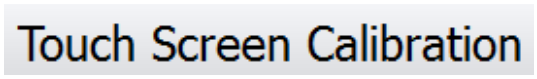
Internal IO Configuration

This is where an authorized user can modify the internal IO such as thermocouple type, voltage or current output and do factory calibrations. Only UPC authorized users can access this menu.



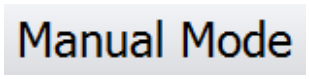
6.5 Test Watchdog:

This is where an authorized user can verify the internal watchdog is working properly. The expected effect is that the controller will reboot.



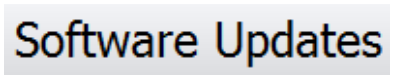
6.6 Touch Screen Calibration:

An authorize user can calibrate the touch screen.



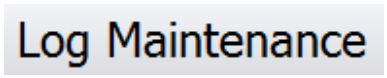
6.7 Manual Mode:

An authorized user can set the PROTHERM 455 to manual mode and control individual outputs.



6.8 Software Updates:

An authorized user can perform a system update to the PROTHERM 455.

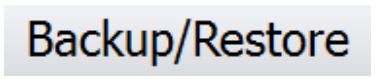


6.9 Log Maintenance:

An authorized user can export or delete log files.

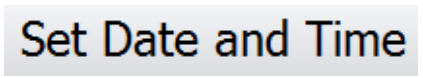
6.10 Recipe Maintenance:

An authorized user can export, import or delete recipes.



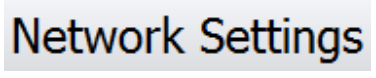
6.11 Backup/Restore:

An authorized user can back up the PROTHERM 455 or restore a previous backup from a USB drive.



6.12 Set Date and Time:

An authorized user can set the PROTHERM 455 internal clock to the correct date and time.



6.13 Network Settings:

An authorized user can set the PROTHERM 455's IP address to allow network connectivity.

6.14 Go Back:

Takes the user back to the previous screen.

6.15 Calibration (User):

The calibration menu allows authorized users to do onsite calibrations of analog inputs. These include thermocouples, current, and voltage inputs. Only authorized maintenance and administrator groups have access to this menu. During a calibration, a calibrated source is needed to correctly complete the calibration. When calibrating a temperature input, it is necessary to connect the calibrator with the correct thermocouple extension wire and use the cold junction compensated output of the calibrator.

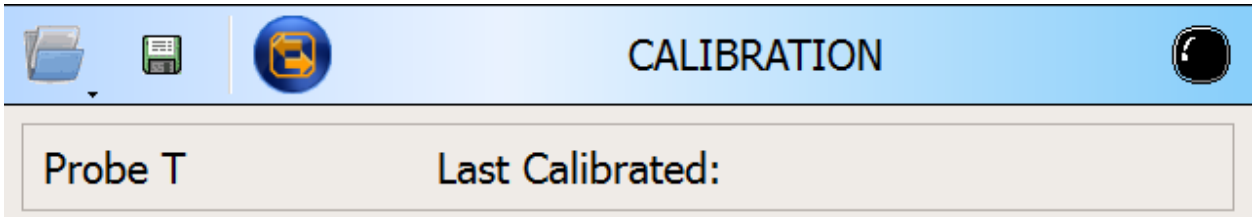


Figure 18: Calibration Header

6.15.1 Open Calibration:

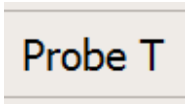
This button will allow an authorized user to open an analog input to calibrate.

6.15.2 Save Calibration:

This will save the currently opened calibration.

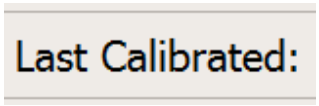
6.15.3 Go Back:

This will go back to the previous screen.



6.15.4 Calibration Name:

This shows the currently opened calibration analog input.



6.15.5 Last Calibrated:

This shows the last date the opened analog input was calibrated.

6.15.6 **Calibration Information:**

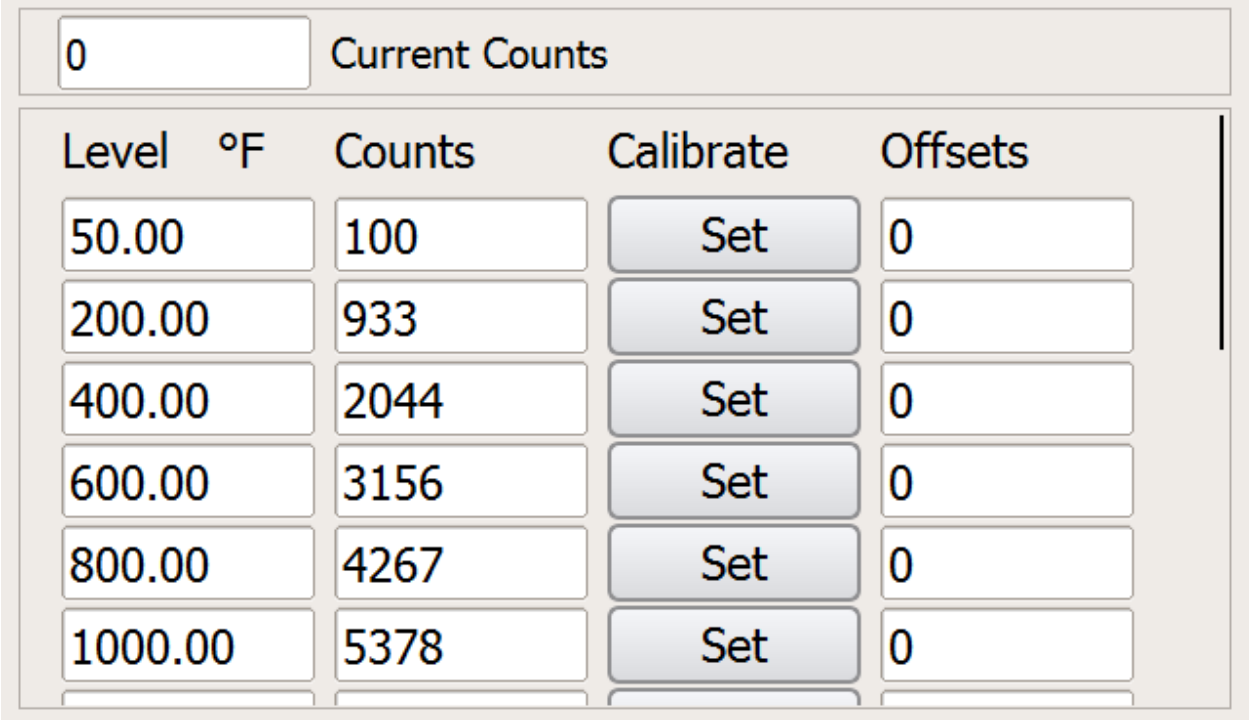
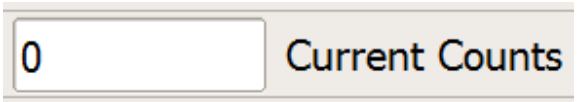
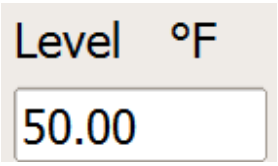


Figure 19: Calibration Information



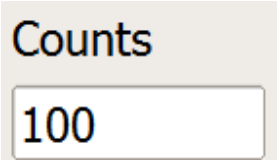
6.15.6.1 Current Counts:

This field represents the current reading of the selected input. The value, represented in counts, the smallest step a channel can read. This is not the value in temperature, current, or voltage.



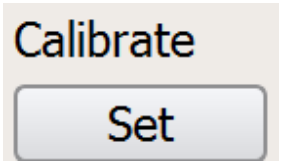
6.15.6.2 Level:

This is the predefined value of the input, in units of measure. The value represents how to set the calibration instrument when adjusting the particular level. Example: If the displayed value is “50”, the calibration instrument should output a signal of 50 °F.



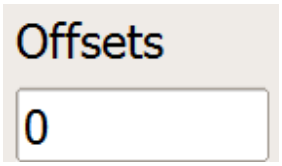
6.15.6.3 Counts:

This is the counts for the specified level. The value represents how many counts the controller needs to read in order to interpret that signal at the specified level. Example: when the controller reads 100 counts, it will represent it as 50 °F.



6.15.6.4 Calibrate:

Before tapping the calibrate button, make sure the calibration instrument is set to output the requested level. Once the calibrator is set, compare the values in the current counts field with the saved value in the counts field. If the two values match, a calibration is not required. This button wil start the calibration procedure for this signal level. Once finished, the controller will display “Done” and the count field updates with the new value. The user can proceed with calibrating the remaining level.

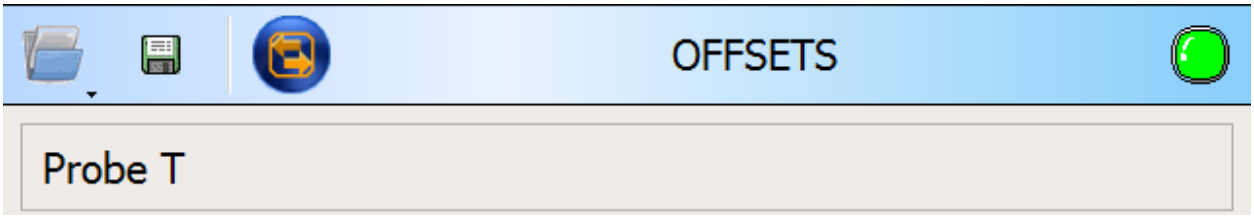


6.15.6.5 Offsets:

This will display any current offsets for the respective level, if there are any. A user can also change the offsets for that level by simply tapping on it. The offsets are changes to the end calculations. For example, an offset of 20 at level 1500 would change the temperature from 1500 °F to 1520 °F.

6.16 Offsets Menu:

The offset menu is similar to the Calibration Information: in functionality except the calibration option is not available. Actual values between levels are affected by the levels the values fall between. For example, 300 °F would be affected by the offsets of 200 and 400 in the example below.



6.16.1 **Open Offsets:**

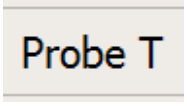
This button will allow an authorized user to open an analog input to calibrate.

6.16.2 **Save Offsets:**

This will save the currently opened calibration.

6.16.3 **Go Back:**

This will go back to the previous screen.



6.16.3.1 Offset Name:

This shows the currently opened calibration analog input.

6.16.4 **Offsets Information:**

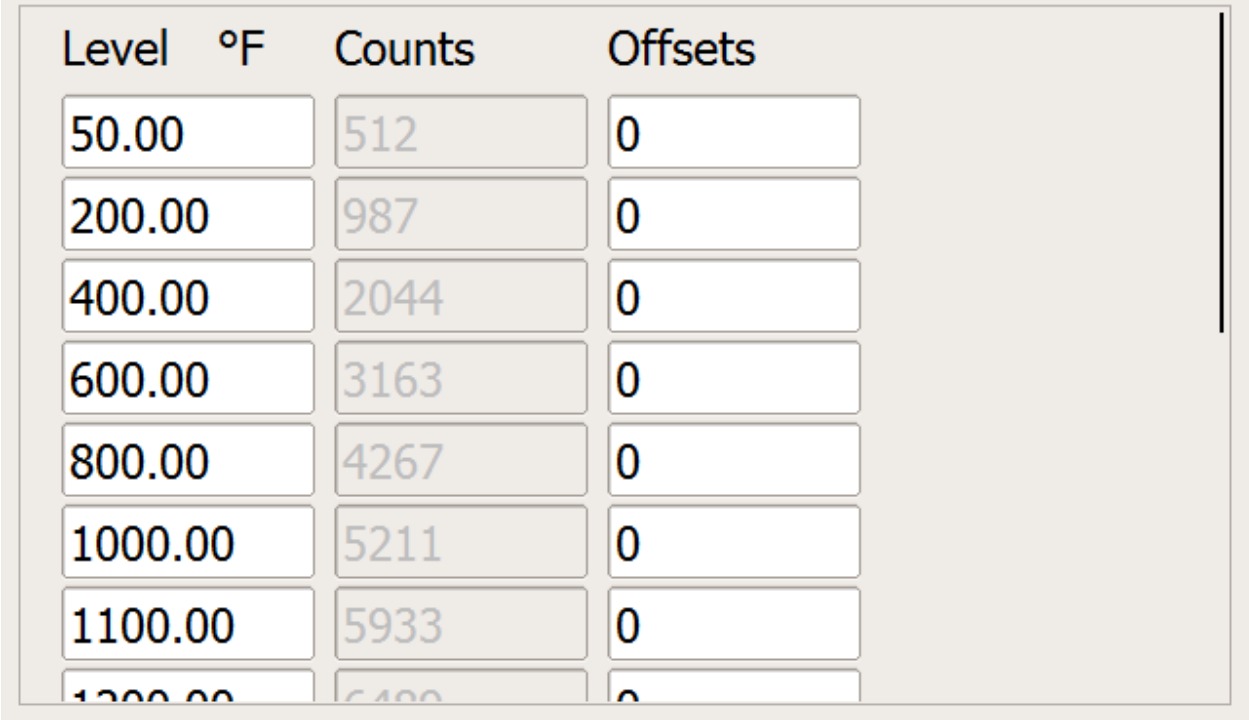
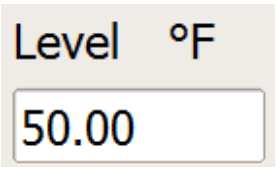
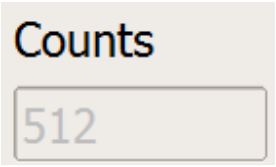


Figure 20: Offset Information



6.16.4.1 Level:

This is the level at which the offset is applied to. The closer the actual value is to this level, the more the offset affects the actual value.



6.16.4.2 Counts:

This is the number of counts that correspond to the respective level.

6.16.4.3 Offsets:

This is the where the user would enter the offset. The offset is entered as an end value and not as a count.

6.17 Probe Test Menu:

An authorized administrator, maintenance, or metallurgist user can access this menu.

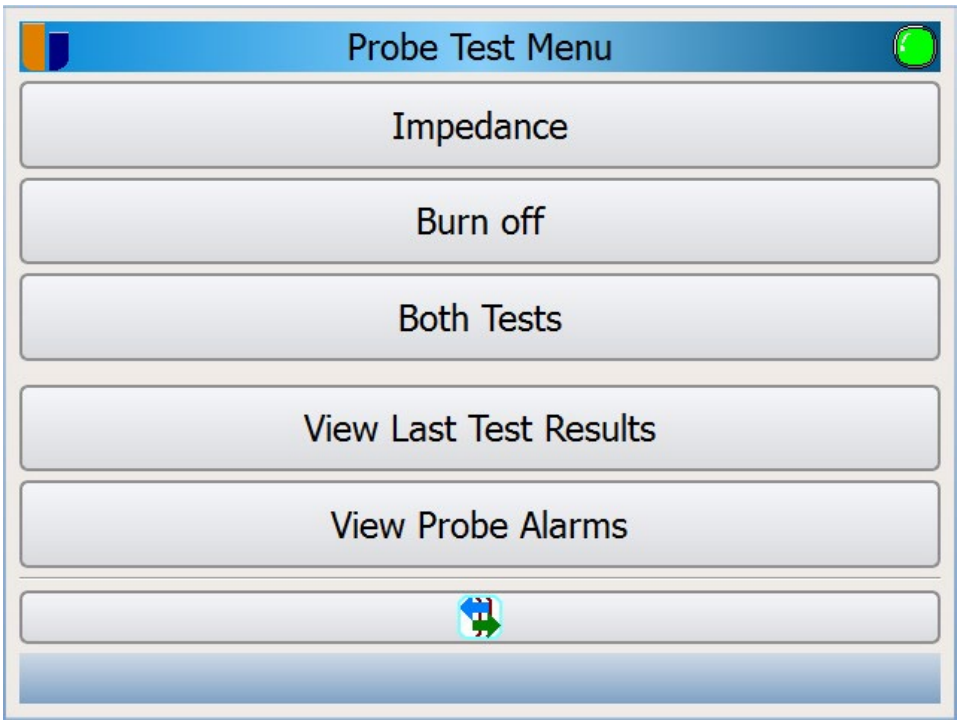
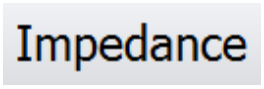
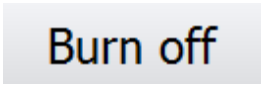


Figure 21: Probe Test Menu



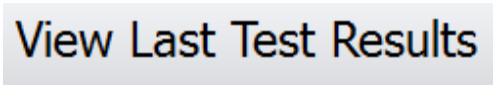
6.17.1 **Impedance:**

This button will start a probe impedance test on the probe. A pop up will be displayed when the test has finished. By doing regular impedance tests, an operator can detect a failing sensor before it completely fails. It is recommended in high reducing atmospheres, the impedance be checked at least once a month while other operations can be checked less regularly. A new sensor typically has an impedance of less than 1 kΩ and as it ages, the impedance will rise. Any sensor with impedance over 20 kΩ should be carefully watched and a impedance above 50 kΩ requires replacement. A high impedance (>50 kΩ) indicates that the electrode contact on the zirconia sensor has deteriorated and the sensor requires replacement. Handle the sensor with care, the sensor may be able to be rebuilt. Please contact United Process Controls, Inc. for information on rebuilding the sensor.

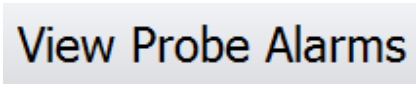


6.17.2 **Burn Off:**
This button will start a probe burn off on the probe. A pop up will be displayed when the burn off is complete. A sensor burn off is performed by flowing air around the oxygen sensor. This air creates a flame at the tip of the sensor that will burn off any accumulated carbon or soot. This test will keep the sensor healthy and increase the longevity. The recommended minimum temperature of a burn off should be no less than 1300 °F but cannot exceed 1800 °F. Exposing the tip of the sensor to the burn off flame for long periods can damage the sensor. The typical burn off is 30 to 45 seconds.

6.17.3 **Both Tests:**
This button will run both the impedance test and burn off in that order. A pop up will be display when the tests are finished.



6.17.4 **View Last Test Results:**
This button will allow a user to see the previous test results for both the impedance test and burn off.



6.17.5 **View Probe Alarms:**
This button will show the user a history of all past and present probe alarms. Please see 13.1 for a list of system alarms and possible solutions.

6.18 Manual Mode Menu:

Entering manual mode will allow an authorized user to control all outputs configured in the PROTHERM 455. A warning is displayed before entering manual mode to confirm that the user wants to proceed. Tapping yes will display the menu below. To exit manual mode, simply hit the back button to return to the previous screen. Only users in the maintenance or administrator groups can access this menu.

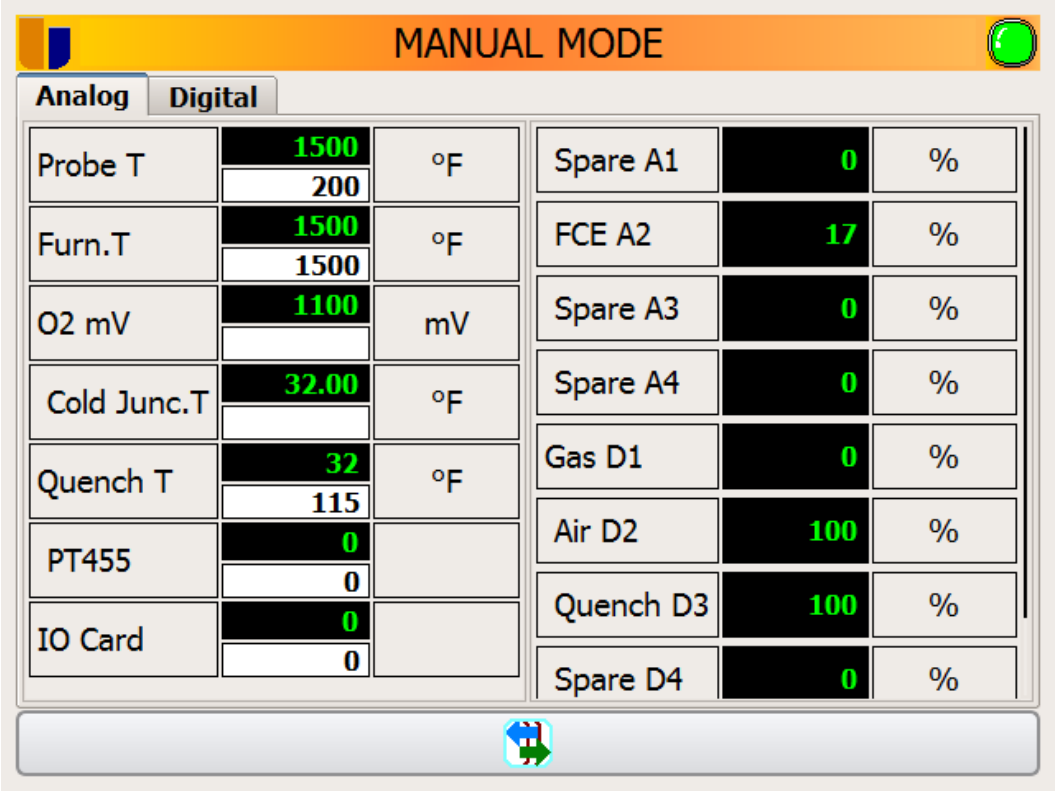


Figure 22 Details Page of the Control Display

6.18.1 Analog or Digital:

Here a user can select either analog outputs or digital outputs to control.

6.18.2 Go Back:

This takes the user back to the previous screen.

6.18.3 **Manual Analog Controls:**

The left of the analog information screen shows the current analog input values as well as the set point of the values that have them. The right shows the current percent output of all analog outputs configured in the PROTHERM 455. To change the output percentage, simple tap on the number.

WARNING: All outputs modified while in manual mode will continue to stay at the modified value until either a recipe changes it or a user enters a new value while in manual mode!

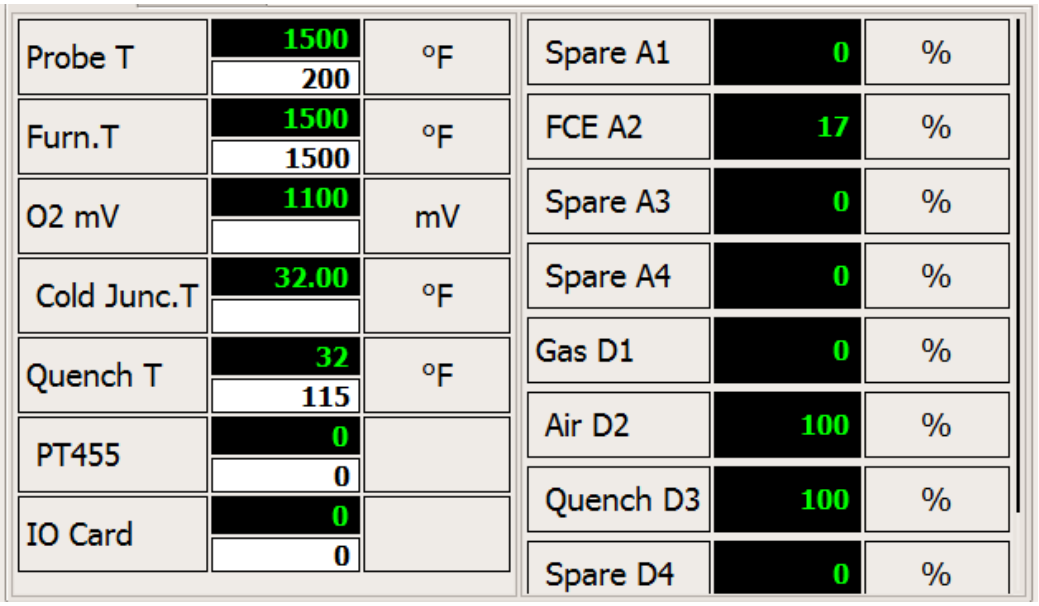


Figure 23: Manual Mode Analog Menu

6.18.4 **Manual Digital Controls:**

The manual digital controls function similar to the Manual Analog Controls: explained above. On the left are the statuses of the configured inputs and on the right are the available configured digital outputs. A user may simple tap on the black box next to the digital output to turn it on and tap it again to turn it off.

WARNING: All outputs modified while in manual mode will continue to stay at the modified value until either a recipe changes it or a user enters a new value while in manual mode! Safety outputs, such as the 1400 °F safety, will immediately change back to the proper state if manually changed.

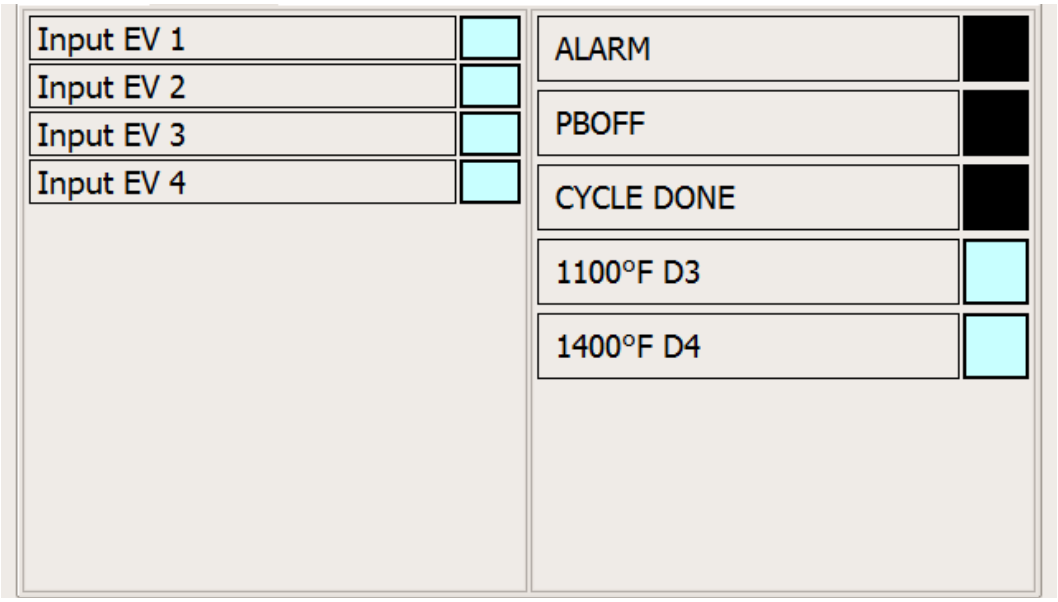


Figure 24 Manual Mode Digital Status Page

6.19 Software Updates Menu:

Authorized users in the maintenance and administrators group can only perform software updates. Files for the software updates are placed in a folder named MMIUpdates on the root of a USB flash drive. A list of these files are created using the PROTHERM 455 update tool. The PROTHERM 455 can detect if the list has been modified and will halt the update. Software updates will only come from authorized UPC personnel, please contact UPC for the most up to date version of the software.

6.20 Log Maintenance Menu:

Here an authorized user can export any log file that is stored on the PROTHERM 455 to a USB drive. Also, log files can be deleted from the PROTHERM 455 as well. Both options operate the same by selecting one or multiple log files and tapping the checkmark to either delete or export the selected log files. A user can also select all the logs or unselect all logs with a touch of a button. Tapping the red “X” will cancel the current operation and take the user to the previous screen. All groups except operators can access this menu.

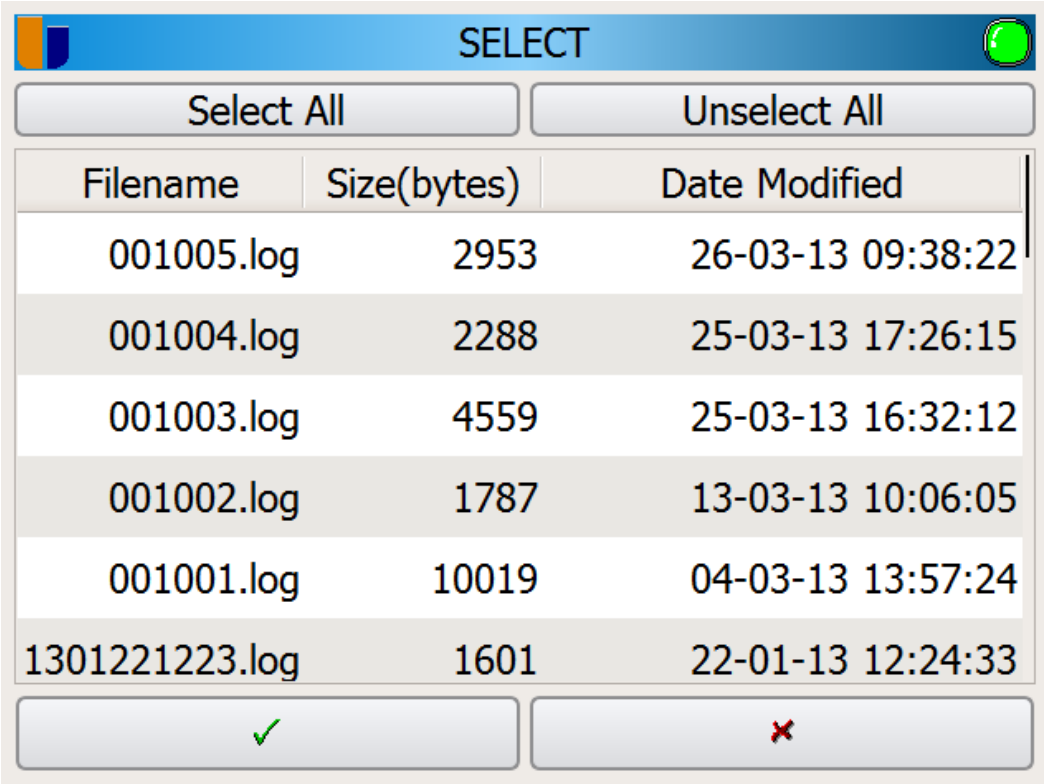


Figure 25 Log Maintenance Selection Screen

6.21 Recipe Maintenance Menu:

Here an authorized user can export recipes to a USB drive, import recipes from a USB drive, and delete recipes from the PROTHERM 455. To successfully import a recipe file, the files must be located in “/XXXX/Recipe” where XXXX is the equipment code. Please refer to the Equipment Code: section for details. The recipe files must have a name of “YYY.recipe” where YYY is the recipe number. The functionality of these features is similar to Log Maintenance Menu.

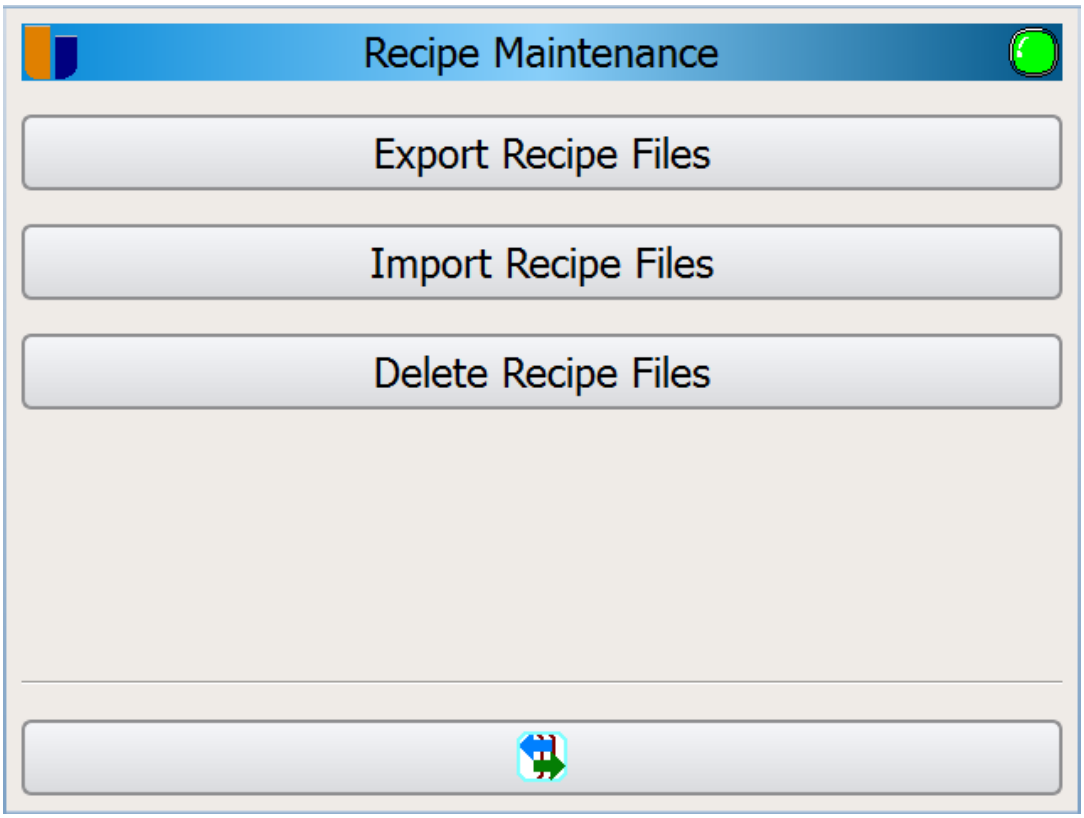


Figure 26 Recipe Maintenance

7 CONFIGURATION MENU:

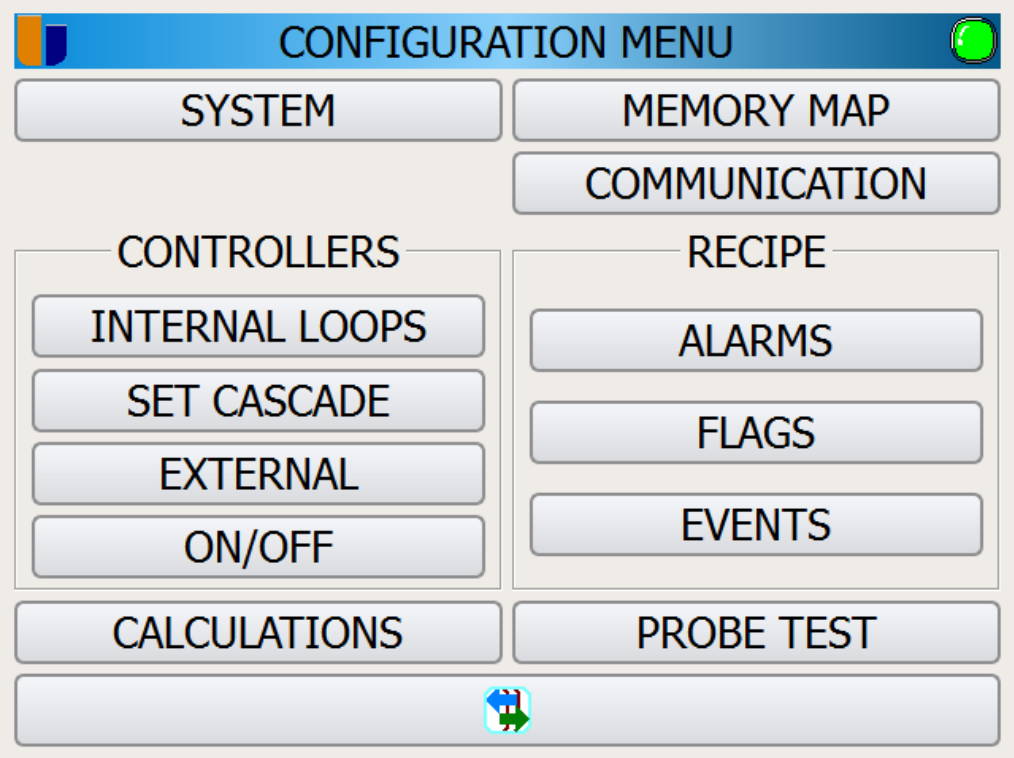
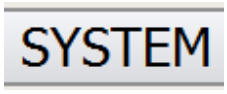
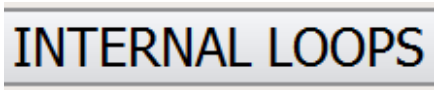


Figure 27: Configuration Menu



7.1.1 System:

Here a user can set PROTHERM 455 system parameters such as log encryption, language, system name and many others. Only users in the administrator group and maintenance group can access this menu.

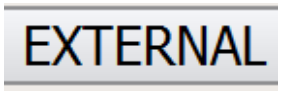


7.1.2 Internal Loops (Controllers):

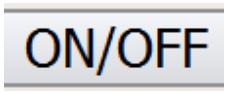
Here a user can manually edit the internal PIDs for each control. Users can also edit other settings such as control mode and control action. Only users in the administrator group and maintenance group can access this menu.

7.1.3 Set Cascade (Controllers):

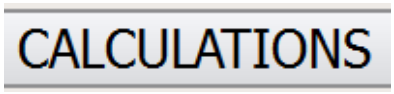
Here a user can set up internal controllers as cascade. The PROTHERM 455 will only allow a cascade controller to be set up when there are at least two (2) controllers defined as cascade under Internal Loops (Controllers):. Only users in the administrator group and maintenance group can access this menu.



7.1.4 **External (Controllers):**
Here a user can define external controllers. Only users in the administrator group and maintenance group can access this menu.

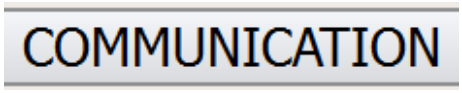


7.1.5 **On/Off (Controllers):**
Here a user can add or delete on/off flags. An example of a flag is 1400 °F for safe admissions. Only users in the administrator group and maintenance group can access this menu.



7.1.6 **Calculations:**
Here a user can modify the calculations of the PROTHERM 455 such as carbon potential, dew point, or oxygen percentage. Only users in the administrator group and maintenance group and metallurgist group can access this menu.

7.1.7 **Memory Map:**
Here a user can edit the SCADA memory map for the IOs, current job, probe test data, and controller status. Only users in the administrator group and maintenance group can access this menu.

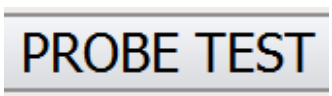


7.1.8 **Communication:**
Here a user can set up communications via the serial ports and specify the type of communications, slave address, baud rate as well as others.

7.1.9 **Alarms (Recipe):**
Here a user can define what alarms sound as well as view the system set alarms that are available in recipe creation.

7.1.10 **Flags (Recipe):**
Here a user can modify the flags that are available in the recipe creation.

7.1.11 **Events (Recipe):**
Here a user can modify what events are available in recipe creation.



7.1.12 **Probe Test:**
Here a user can define the options and requirements for a probe test.

7.1.13 **Go Back:**
This takes the user back to the previous screen.

7.2 System Menu:

Here an authorized user can modify system settings. The lists of available options, shown below, require a restart of the PROTHERM 455.

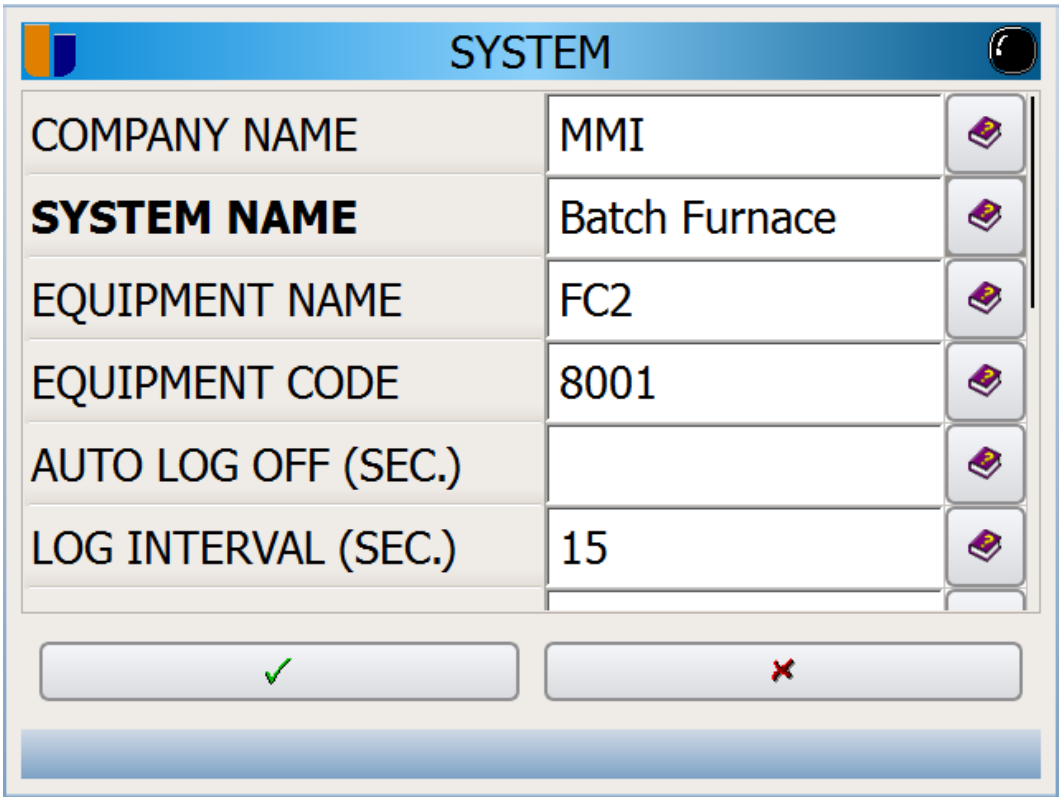


Figure 28: System Settings Menu

Company Name:
Enter in the company name here.

System Name:
Enter in the type of furnace such as a “Batch Furnace”.

Equipment Name:
Enter in the furnace number here such as “FC2”.

Equipment Code:

Enter in the equipment code. An example would be the workplace ID in a PT9800 system (if applicable). This code is also used to generate log file folders when log files are exported to a USB stick.

Log Interval (sec):
Enter the interval at which the PROTHERM 455 logs data in seconds.

External Drive:
Enter the external drive mount point. Do not change unless instructed to do so. The default is "/mnt/usbfront"

Max Graph Value:
Enter the maximum value of the y-axis on graphs.

Log Encrypted:
Define if the logs are to be encrypted on the PROTHERM 455. Encryption is the default setting to comply with CQI9 requirements.

Watchdog Type:
This should always be set to "PROTHERM 455" unless otherwise specified by a UPC employee.

Watchdog Enabled:
Set to yes to enable the above watchdog. This should always be set to yes.

Show Cursor:
Set to yes to show the cursor at all times. This is useful if you are using a tracker ball or mouse to control the cursor location.

Show Titlebar:
Set to yes to show the title bar at the bottom of the screen. This bar will display system information. This value should always be set to no for proper operation.

Furnace Volume:
Enter the furnace volume in liters. This field is not mandatory for carburizing or tempering furnaces.

Language:
Enter the desired language displayed to the user.

Disable All WDGS
Set to No by default

AI Filtering

Can be set to None, Moving Average, or Purified Average. For most practical processes, Moving Average is preferred. The window time of the moving average is fixed.

TCP Connections
Sets the number of slave devices connected to the PROTHERM 455, default is 10.

TCP Port Number
Default port number of the TCP connection is 5001.

Comp ID for OpCode Y
The ID number of an assigned input used of the recipe test opcode 'Y'. The default is 10, which is the mV signal of the oxygen sensor.

Internal Loops Menu:

An authorized user can add, delete, or modify the current internal loops as well as that loop's PID settings by hand.

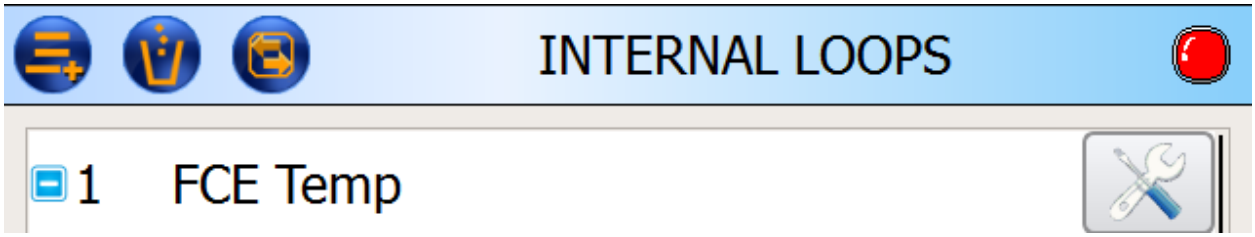


Figure 29: Internal Loops Menu

By tapping the settings button (wrench), the control loop menu is shown allowing the user to modify control loop settings. A description of each setting is below.

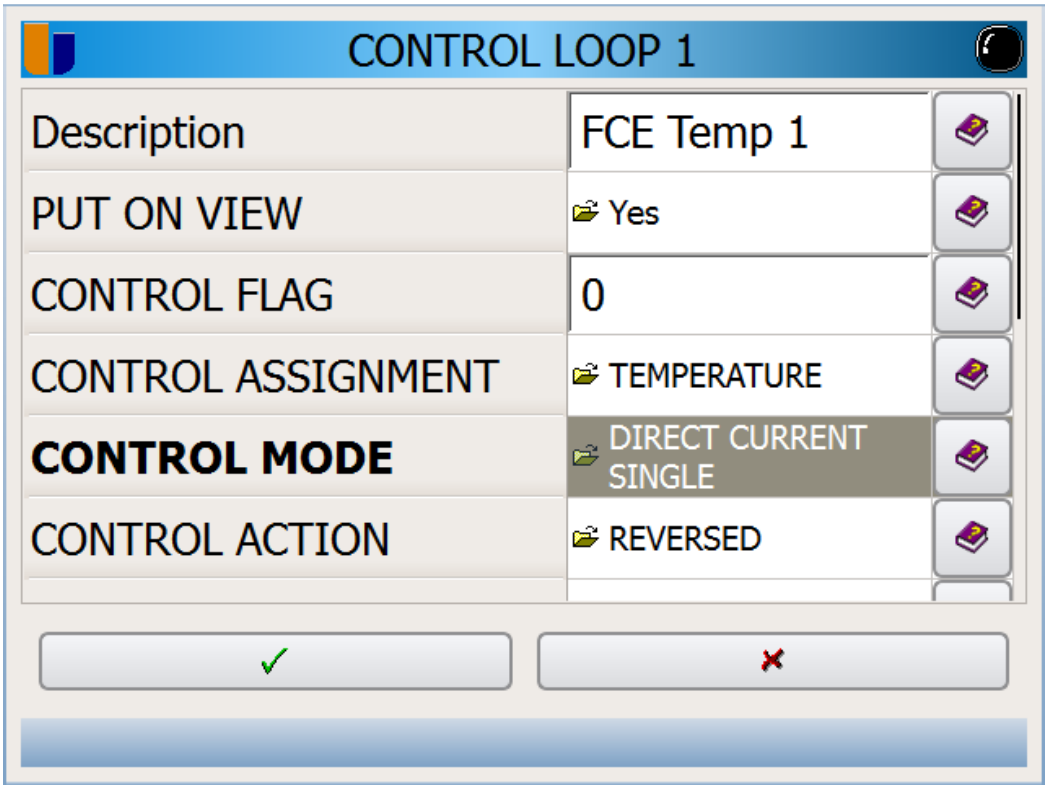


Figure 30: Control Loop Menu

7.2.1 **Description:**
Enter the internal loop name.

7.2.2 **Put On View:**
A value of yes will show this loop information as one of the Overview Screens: on the Control menu.

7.2.3 **Control Flag:**
This is a unique number for each control loop. The value of zero (0) is reserved for furnace temperature and carbon potential.

7.2.4 **Control Assignment:**
Defines the type of control this loop is controlling. Available options include quenching, carbon, dew point and many others.

7.2.5 **Control Mode:**
Here a user can defines the type of controlling output for the control loop. Options include time proportional, direct current and dual mixed.

7.2.6 **Control Action:**
Here a user can define if the control is a direct control or a reversed control.

7.2.7 **Hierarchy:**
Here a user can define if the control loop is independent or cascade. Cascade options can be set in the cascade controller configuration.

7.2.8 **PID Parameters**
PID parameters are common to any type of controller configured for PID.

Input Comp ID:
Here a user can define the input of the control loop.

First Output ID:
Here a user can define the first output of the control loop. An output is required. This output has to be defined as an analog output even if it is physically a digital type output.

Second Output ID:
Here a user can define the second output of the control loop. An output is only required if the Control Mode: is set to dual. This output has to be defined as an analog output even if it is physically a digital type output.

DO Cycle Time (Sec):
Here a user can set a cycle time for the pulse width modulation.

Ident. Coefficient:
This is the auto-tune identification coefficient.

Ident. Hysteresis:
This is the auto-tune hysteresis coefficient.

Ident. Interval Gain:
This is the auto-tune interval gain coefficient.

7.3 Set Cascade Menu:

Here a user can define the master loop and the slave loop for a cascade controller. At least two (2) controllers must be set as cascade under the Internal Loops Menu: for the cascade to work correctly. In cascade mode, the master loop is given a set point by an operator, and then the master loop will calculate the set point for the slave loop by taking into consideration the master loop’s input value.

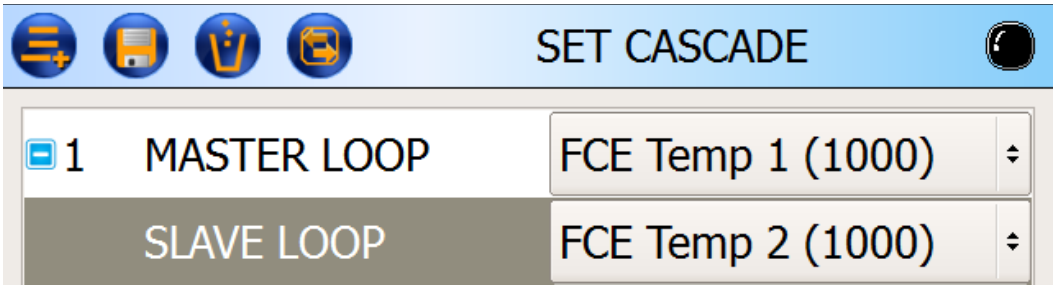


Figure 31: Cascade Control Menu

7.3.1 **Description:**
Enter the internal loop name.

7.3.2 **Put On View:**
A value of yes will show this loop information as one of the Overview Screens: on the Control menu.

7.3.3 **Control Flag:**
This is a unique number for each control loop. The value of zero (0) is reserved for furnace temperature and carbon potential.

7.3.4 **Control Assignment:**
Defines the type of control this loop is controlling. Available options include quenching, carbon, dew point and many others.

7.3.5 **Control Mode:**
Here a user can defines the type of controlling output for the control loop. Options include time proportional, direct current and dual mixed.

7.3.6 **Control Action:**
Here a user can define if the control is a direct control or a reversed control.

7.3.7 **Hierarchy:**
Here a user can define if the control loop is independent or cascade. Cascade options can be set in the cascade controller configuration.

7.4 External Controllers Menu:

Here a user can define an external controller. The setup options are similar to the Internal Loops Menu: but require local/remote inputs and outputs. The parameters for this type of controller are mapped addresses based on the type of communications protocol assigned to the controller.

A controller can be an Ethernet enabled flow meter for example. Not all of the parameters may be available but most controllers have functions such as local/remote. These ID's must be

created in the configuration files of the controller where the slave address and register numbers are assigned.

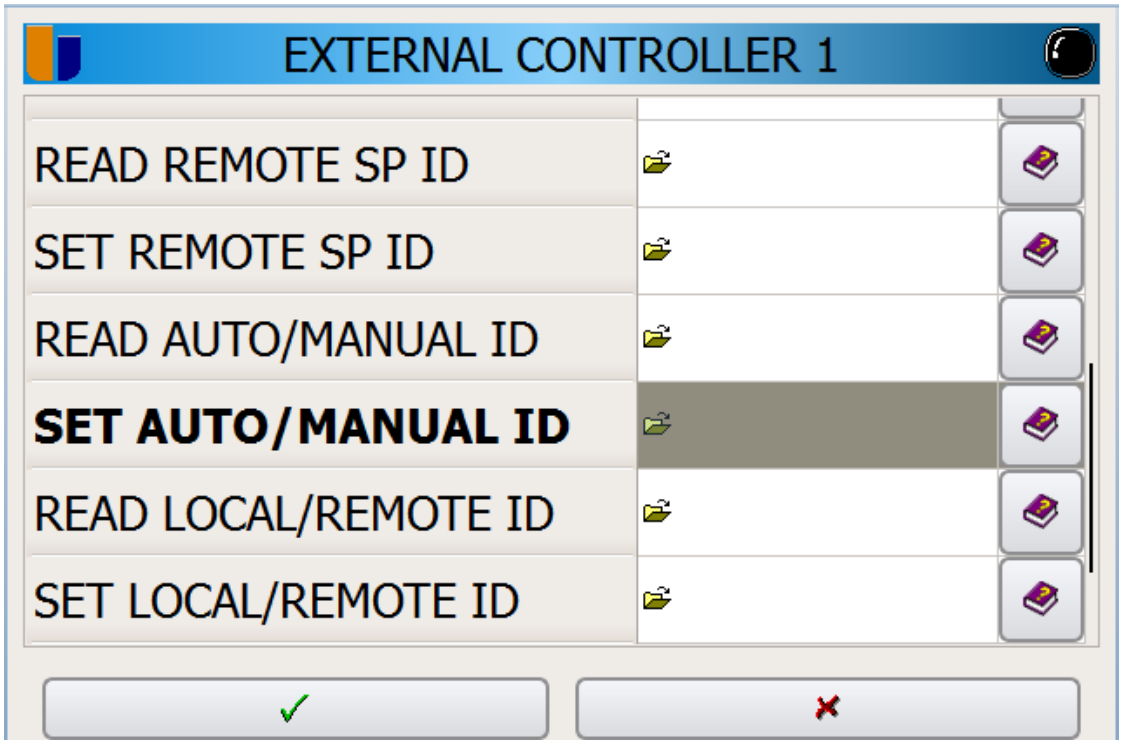


Figure 32: External Controllers Menu

7.4.1 **Description:**
Enter the loop name.

7.4.2 **Put On View:**
A value of yes will show this loop information as one of the overview screen of the Control menu.

7.4.3 **Control Flag:**
This is a unique number for each control loop. The value of zero (0) is reserved for furnace temperature and carbon potential.

7.4.4 **Hierarchy:**
Here a user can define if the control loop is independent or cascade. Cascade options can be set in the cascade controller configuration.

7.4.5 **Actual PV ID**
Mapped address of the process values read by the PROTHERM 455.

7.4.6 **Output ID**
Mapped address of the actual output values read by the PROTHERM 455.

7.4.7 **Local SP ID**
The mapped local set point of the controller changed manually by the operator.

7.4.8 **Read Remote SP ID**
The mapped remote set point read by the PROTHERM 455.

7.4.9 **Set Remote SP ID**
The mapped parameter the PROTHERM 455 writes to in order to change the set point on the external controller.

7.4.10 **Read Auto/Manual ID**
The mapped parameter the PROTHERM 455 reads to determine if the external controller is in auto (set point control) or manual (direct manual output control).

7.4.11 **Set Auto/Manual ID**
The mapped parameter the PROTHERM 455 writes to in order to change the external controller's control mode.

7.4.12 **Read Local/Remote ID**
The mapped parameter the PROTHERM 455 reads to determine the control mode of the external controller.

7.5 On/Off Controllers Menu:

Here a user can define an on/off controller. Available options include control action, set point type, dead bands, delays, and the input and output of the controller.

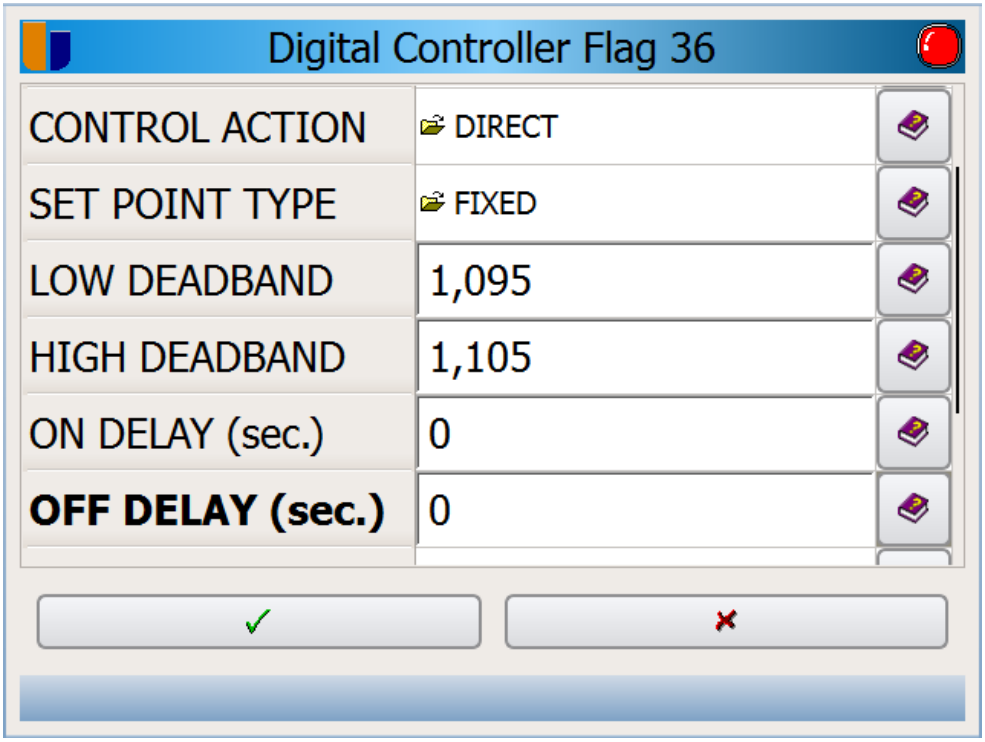


Figure 33: On/Off Controller Menu

7.5.1 **Description:**
Enter the internal loop name.

7.5.2 **Control Action:**
Here a user can define if the control is a direct control or a reversed control.

7.5.3 **Mode:**
An ON/OFF controller is very similar to an alarm. The two control modes are Limit and Deviation. The LOW and HIGH deadband parameters define the process points that enable the control.

7.5.4 **Low Deadband:**
The process value where the control output turns off as the process is dropping.

7.5.5 **High Deadband:**
The process point and above where the control output turns on.

7.5.6 **Input Type:**
Select either digital or analog depending on the source of the process value.

7.5.7 **Input Comp ID:**
The selected source of the process value. The available selections depend on the input type.

7.5.8 **Output Com ID:**
The available outputs for the controller. These must be defined as digital outputs to appear on the selection list.

7.5.9 **MMI Multiplier:**
The number scales the displayed process value. When reading analog values from MMI controllers it will be necessary to enter 8 to properly read the process value. Other values may require other scaling or conversion factors.

7.5.10 **Put On View:**
Select Yes or No to display the controller on the Control screen. Typically ON/OFF controllers are not displayed. These outputs can be seen on the Details screen in the Control screen.

7.6 Calculations Menu:

Here a user can modify the PROTHERM 455 calculations. The available settings depend on which calculation is required. The calculations (MMI) that can be set are carbon, dew point, oxygen, redox, and True-Carb. The calculations (DIN) that can be set are carbon, dew point, and oxygen.

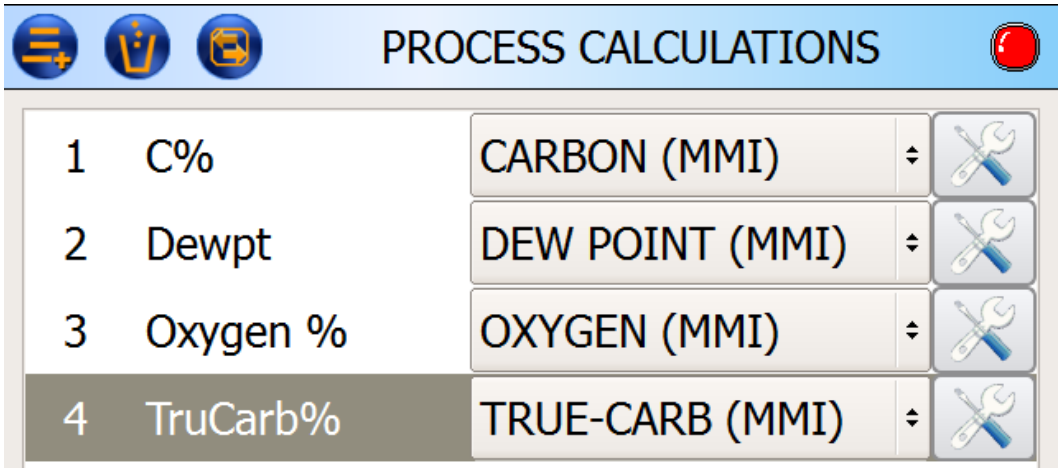


Figure 34: Calculations Menu

7.7 Memory Map Menu:

Here a user can set up memory mapping to allow SCADA control. Each PROTHERM 455 is configured with a Dualpro SCADA compatible mapping to allow for an immediate drop in replacement without additional SCADA modifications. If additional or alternate SCADA mappings are required, modify them here.

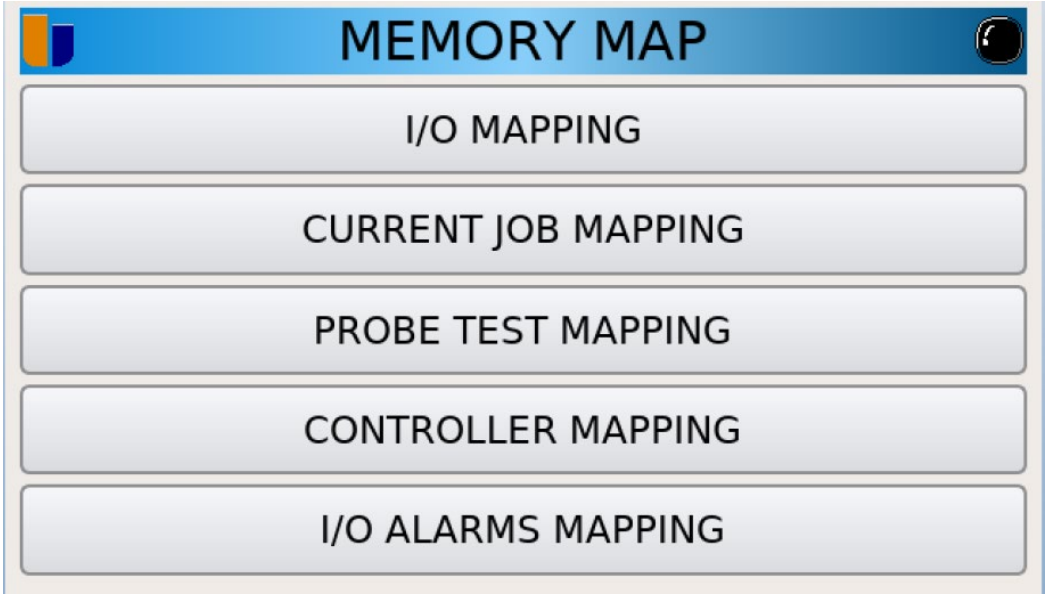


Figure 35: SCADA Mapping Menu

7.7.1 **I/O Mapping:**

Normal process values, set points, and instrument parameters can be assigned register numbers that correspond to the register numbers used by a SCADA system. The SCADA system protocol has to be defined in the Communications page of the Configuration Menu. Default values are shown in the following figure.

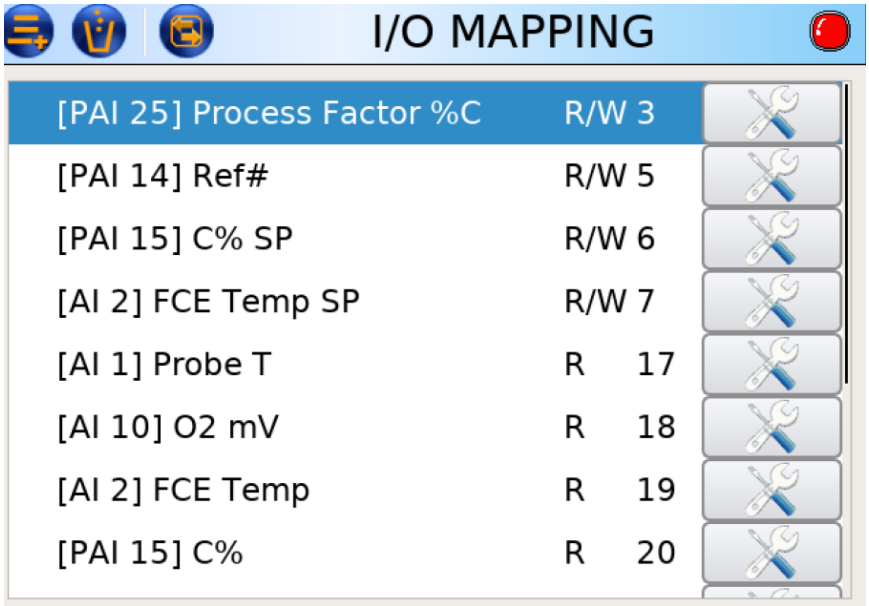


Figure 36 Typical I/O Assignments

7.7.2 **Current Job Mapping:**

Current Job parameters are special functions used to communicate with other control devices such as PLCs that would be used to control the operation of recipes in the PROTHERM 455. These functions are selected from a list and assigned the appropriate address corresponding to the mapping in the other connected device.

PT455 Special Functions		
Register Name	PLC R/W	Function
Stop Job	W	PLC writes 1 to stop running job otherwise 0
Start Job	W	PLC writes a 1 to start the job current job that has been placed on hold
Hold Job	W	PCL writes 1 to hold running job otherwise 0
Start/Stop	W	PLC writes the recipe number to start or writes a -1 to stop a running recipe
Job is Running	R	Shows job number that is running otherwise shows 0
Job is on Hold	R	Shows 1 if job is in Hold mode othewise 0
Job Number	R	Shows running job number or 0
Recipe Number	R	Shows running recipe number or 0
Recipe Remaining Time	R	Shows soak countdown timer in seconds
Master Timer	R	Shows Master Timer countdown
Current Program Alarm	R	Shows the active program alarm displayed on the controller
Recipe Step Number	R	Shows current step number of a running recipe

Figure 37 Special Functions for Current Job Mapping

7.7.3 **Probe Test Mapping:**

Probe test mapping gives external devices access and control of the PROTHERM 455 probe testing functions. The addresses must match the corresponding address in the external device. Important tests such as burnoff and impedance tests can be initiated by an external device and the resulting data read back using these parameters.

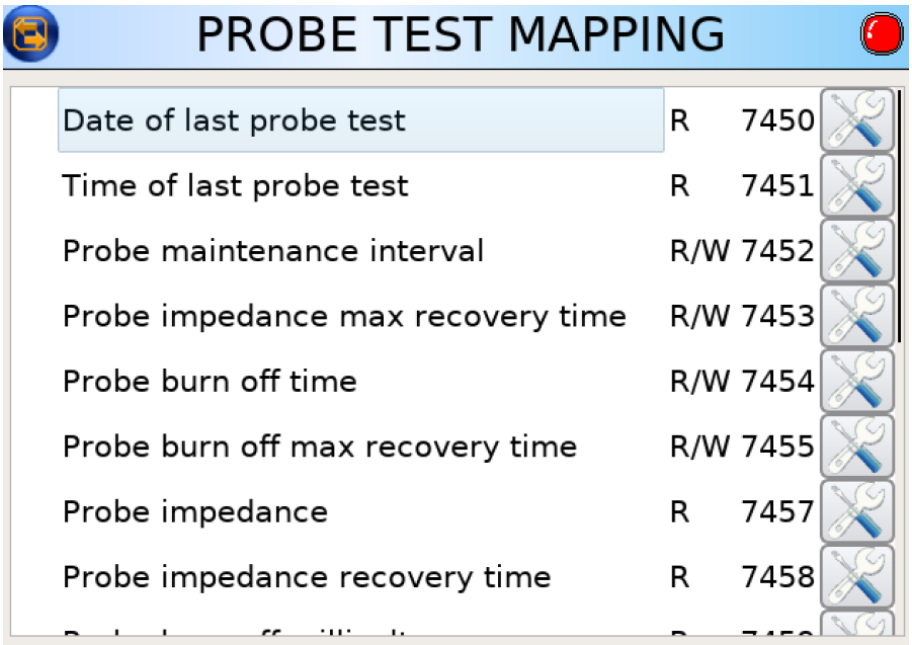


Figure 38 Probe Test Data and Commands

7.7.4 **Controller Mapping:**
External controller information can be mapped here so a connected SCADA system has access to the process values and parameters of connected devices.

7.7.5 **I/O Alarms Mapping:**
Configured alarms can be mapped here.

7.8 Communication Menu:

Here a user can define the commutations type for each port as well as options for each type such as slave address, baud rate, parity, data size, stop bit, timeout and consume echo. IO ports are for communications with non-SCADA devices such as other PLCs while the SCADA

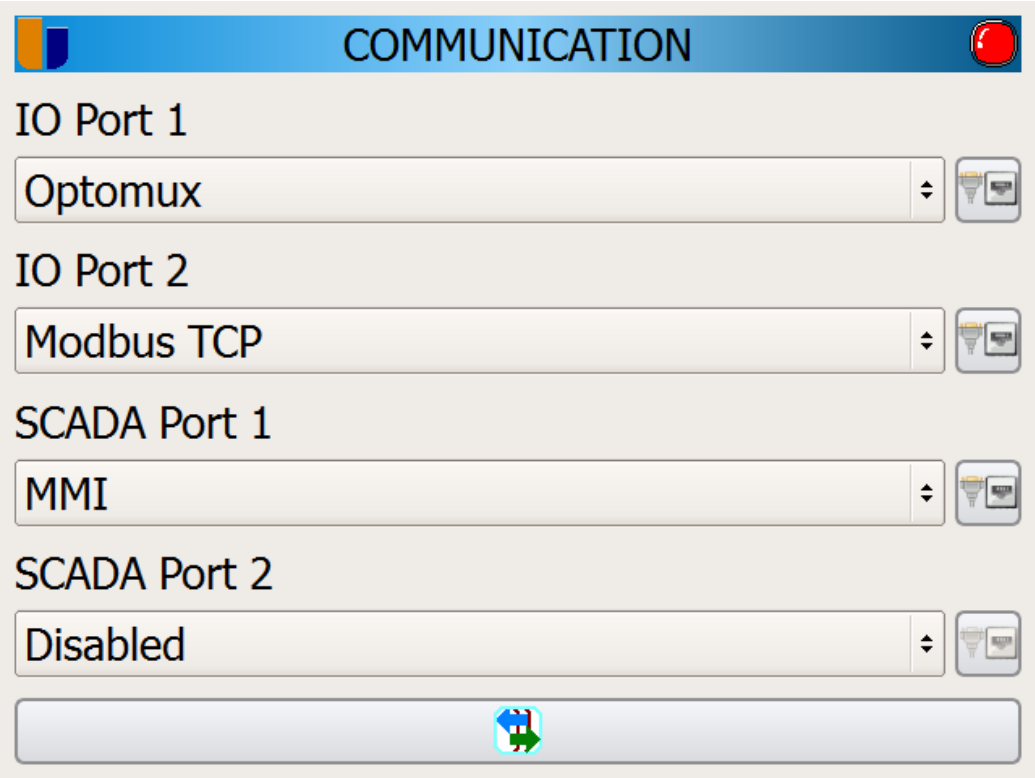


Figure 39: Communication Menu

7.9 Recipe Alarms Menu:

Here a user can view the defined system alarms as well as set up their own user-defined alarms. Each alarm must have a unique ID and has options of the alarm staying even after acknowledgement and/or stopping the recipe from proceeding to the next step. Please refer to 13.1 for a list of system alarms.

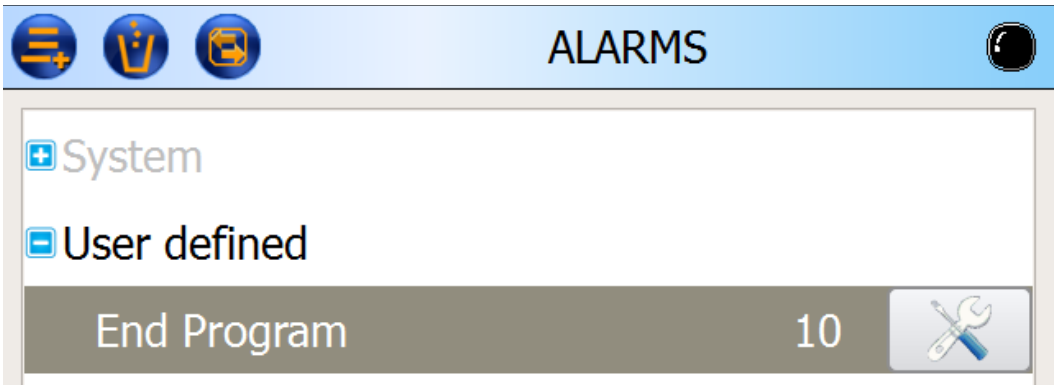


Figure 40: Alarms Menu

7.10 Recipe Flags Menu:

Here a user can modify the PROTHERM 455 flags including the description, the flag ID, and the flag type. Each flag must have its own unique ID.

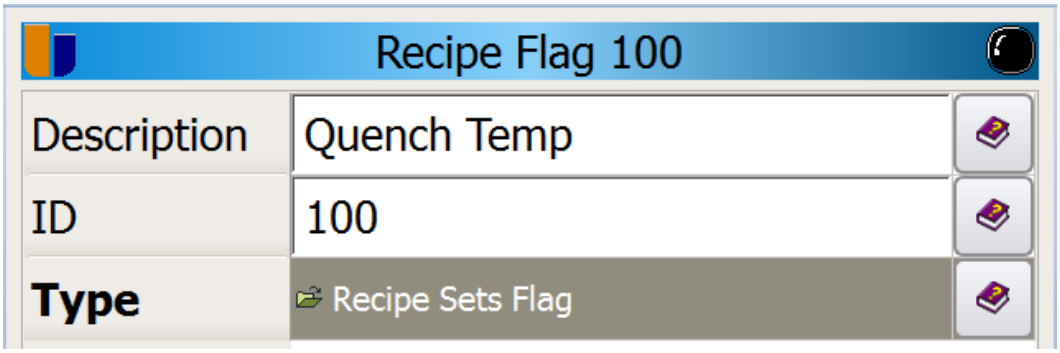


Figure 41: Flags Menu

7.11 Recipe Events Menu:

Here a user can modify the PROTHERM 455 events. There can be a total of 80 events programmed into the PROTHERM 455.

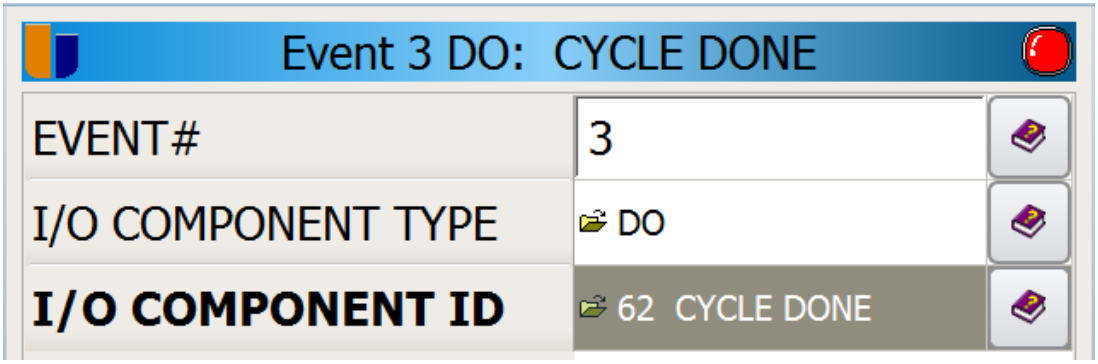


Figure 42: Events Menu

7.12 Probe Test Settings Menu:

Here a user can modify the probe test requirements. There are three (3) options, general settings, impedance settings, and burn off settings.

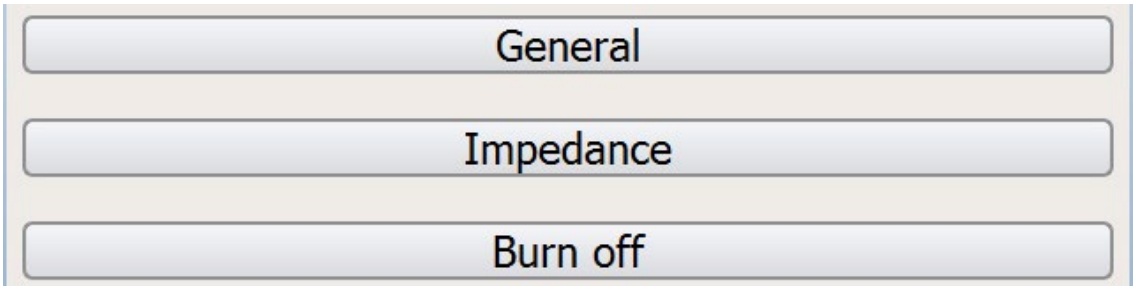


Figure 43: Probe Settings Menu

7.12.1 General Probe Settings:

Here a user can set a test interval in seconds. This will define how often an automatic probe test is performed with a value of zero (0) disabling the function. In addition, the automatic test can perform a probe impedance test and a burn off or a user can specify just a single test. Finally, a user can set the minimum temperature at which these tests can occur.

7.12.2 Impedance Probe Settings:

Here a user can set the maximum impedance allowed before there is a probe impedance fault. The recovery time in seconds to allow the probe to recovery from the test can be set. Finally, the shunt resistor value can be specified with the default being 10 KΩ.

7.12.3 Burn Off Probe Settings:

Here a user can set the length of the burn off time in seconds and the maximum recovery time of the probe. Finally, the maximum temperature of the probe that allows a burn off to be performed.

8 USERS MENU:

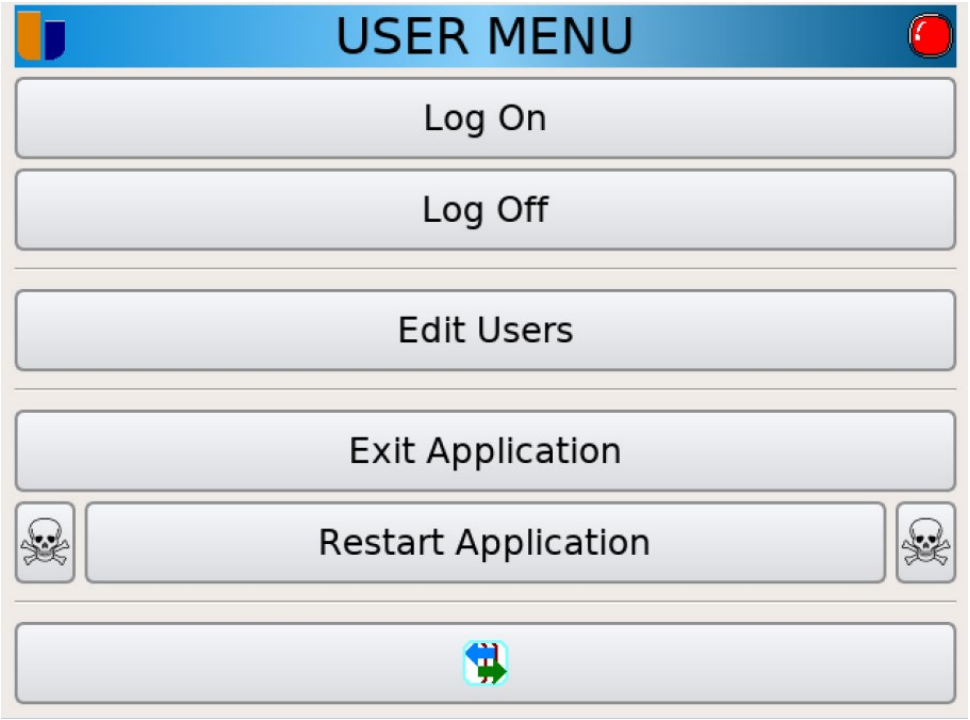


Figure 44: Users Main Menu

8.1.1 **Log On:**
This will allow a user to log on with their username and password. All groups have access to this option.

8.1.2 **Log Off:**
This will log off the currently logged on user. All groups have access to this option.

8.1.3 **Edit Users:**
This will allow an authorized user to add, delete, and modify user accounts. Only the administrator group has access to this option.

8.1.4 **Exit Application:**
This will quit the PROTHERM 455 application. Only authorized UPC employees have access to this option.

8.1.5 **Restart Application:**
This will restart the PROTHERM 455 application. Only the administrator group has access to this option.

8.1.6 **Application Reboot:**

Pressing this button on either side of the Restart Application button will force a rewrite of the backup files in the instrument and clear all set points. This mode should be used if any changes are made to the configuration of the instrument to insure the update is properly registered in the multiple backup files of the instrument.

8.1.7 **Go Back:**

This will go back to the previous screen.

8.2 Edit User:

Here is where an authorized user can set up other user accounts. A user can be assigned to one of four (4) groups with the floor operator being the group with the least access and the administrator being the group with the most access. The Oem user is used by an authorized UPC user to access all functions of the instrument and bypasses all other passwords. Named users can be created and assigned access based on the four standard members of the group. Individual passwords can be assigned to each user. The default user name and passwords are shown in the User column of the next figure.

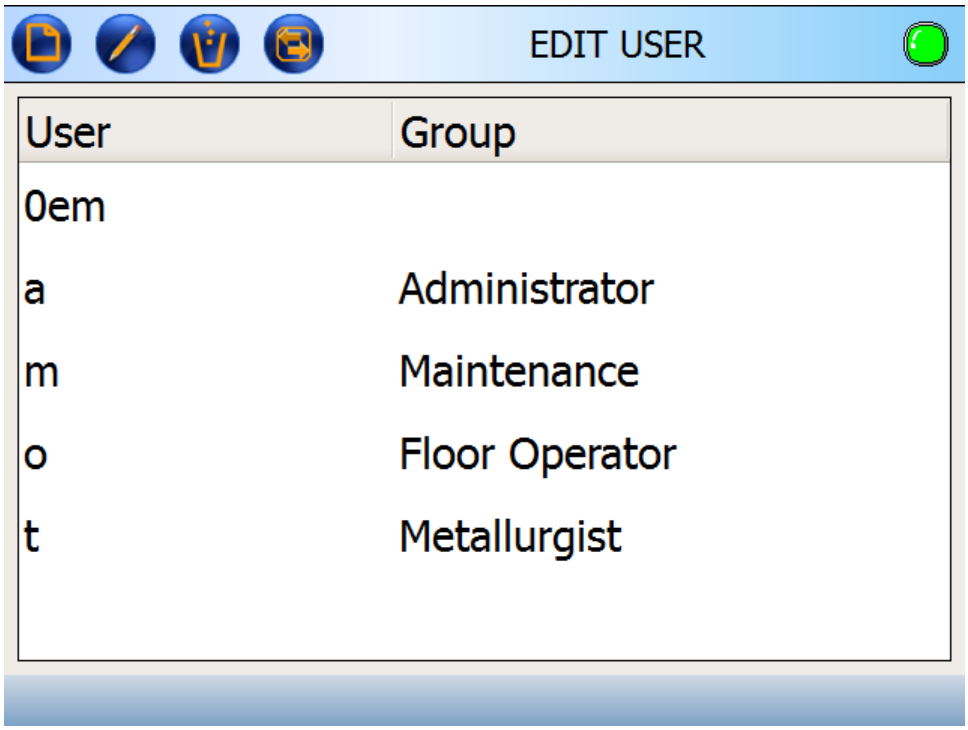


Figure 45: User Editor Menu

8.3 Access Level Assignments

The Protherm 455 is configured with six levels of access. Five of these are named, the last one is the default setting when the instrument is first turned on. The following table outlines the user types and assigned access.

PT 455 Password Levels					
	Administrator	Maintenance	Metallurgist	Operator	Default
Default User Name	a	m	t	o	
Default Password	a	m	t	o	
Ack Alarms	✓	✓	✓	✓	✓
Backup/Restore	✓	✓			
Calibration	✓	✓			
Configure Cascade	✓				
Configure Comms	✓	✓			
Configure Control	✓	✓			
Configure Digital	✓	✓			
Configure External Controller	✓	✓			
Configure I/O Points	✓	✓			
Configure Probe Tests	✓	✓	✓		
Configure Proc Cal (FULL)	✓		✓		
Configure Proc Cal (PARTIAL)	✓				
Configure Recipe Alarms	✓		✓		
Configure Recipe Events	✓				
Configure Recipe Flags	✓				
Configure System Parameters	✓	✓			
Edit Recipe	✓	✓	✓	✓	✓
Enter Manual Mode	✓	✓			✓
Internal I/O Configuration					
Log Maintenance	✓	✓	✓		✓
Memory Map	✓				
Modify Current Job	✓	✓	✓	✓	✓
Analog Offsets	✓	✓			
Probe Tests	✓	✓	✓	✓	✓
Recipe Maintenance	✓	✓	✓		
Restart Application	✓	✓			
Set Date/Time	✓	✓	✓		
Shut down application					
Start/Stop Recipe	✓	✓	✓	✓	✓
Test Watchdog					
Touch Screen Cal					
Update System	✓	✓			
User Manager	✓				
View Debug Screen					
View Log Files	✓	✓	✓	✓	✓

These assignments can be changed with the Windows based application Configuration Utility included on the USB stick shipped with the instrument.

9 VIEW LOGS MENU:

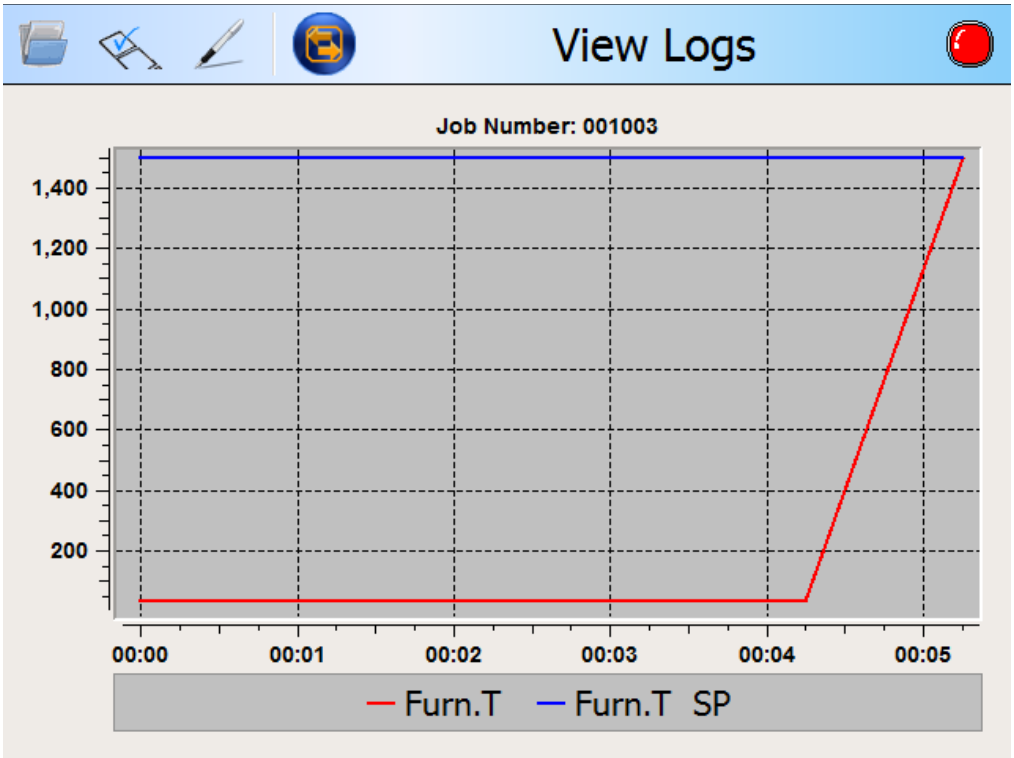


Figure 45: Log Viewer

9.1 Open Logs:

Here a user can open a log. Tapping this button will show a list of all current logs stored on the PROTHERM 455.

9.2 Modify Legend:

Here a user can modify what values are shown on the graph and whether to show the scale on the left or right y-axis.

9.3 Pen Style and Color:

Here a user can select the width, style, and color of the pens as well as the style and color of the symbols. Also, a user can select a background color for the graphs.

10 ALARM MENU:

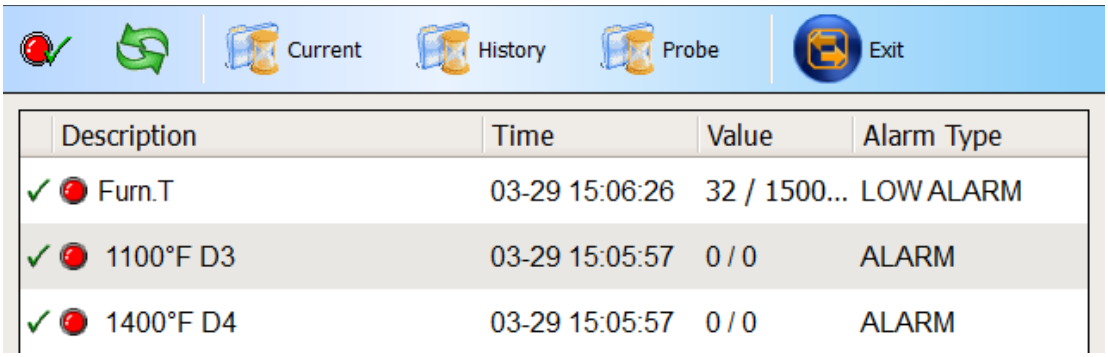


Figure 46: Alarm Menu

10.1 Acknowledge Alarms:

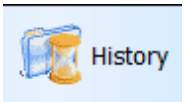
A user can acknowledge all alarms by tapping this button. Acknowledged alarms will display a green check mark next to the description. Alarm colors can denote the type of an active alarm. Red indicates a process alarm and high limit conditions. Yellow indicates warning levels. Purple indicates failures in I/O levels such as open input conditions or hardware failures.

10.2 Refresh Alarms:

A user can refresh the current list of alarms if the user thinks the currently shown list does not show the complete alarm list.

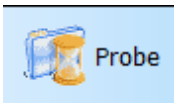
10.3 Current Alarms:

This will show a user a list of all currently active, acknowledged but still active, and inactive but unacknowledged alarms.



10.4 Alarm History:

This will show a history of all previous alarms.



10.5 Probe History Alarms:

This will show a user all previous alarms for the probe tests only.

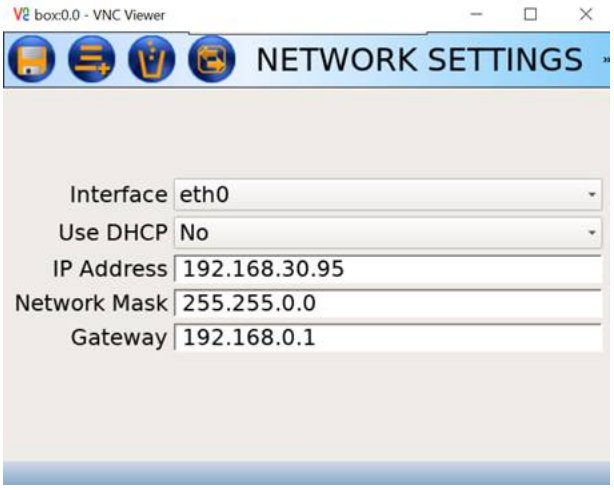
10.6 Exit Alarms:

This will return the user to the previous screen.

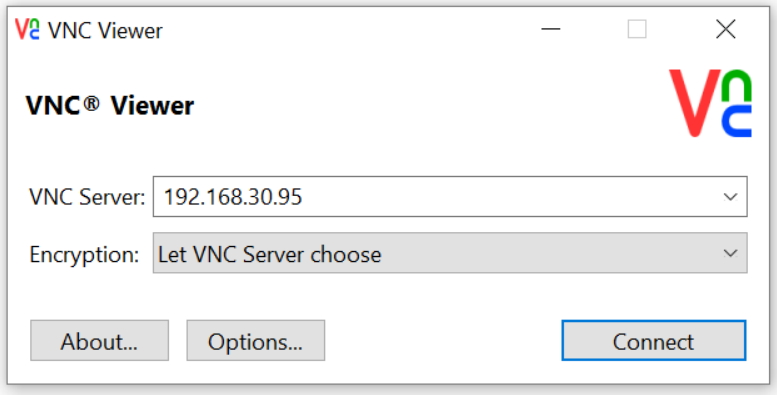
11 REMOTE ACCESS

The PROTHERM 455 has an embedded Virtual Network Computing (VNC) server that allows remote access to the instrument using the front screen of the instrument, or deeper levels of the instrument operating system are available for advanced users.

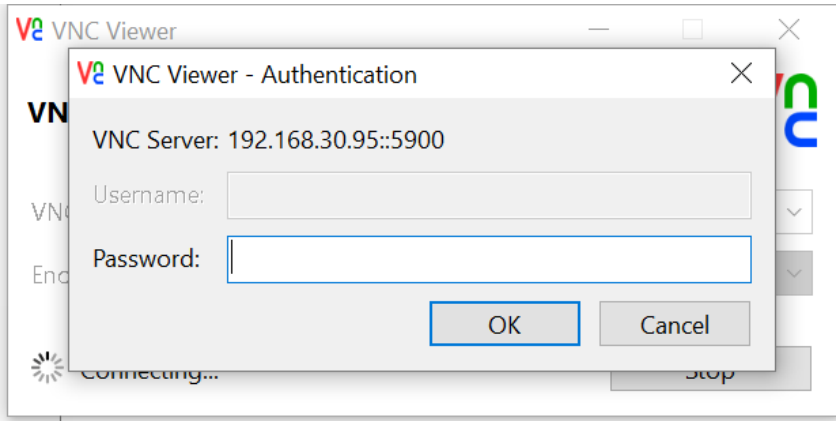
The PROTHERM 455 instrument must be connected to an Ethernet switch through the top RJ45 jack on the rear panel of the instrument. The instrument's IP address setup is at Network Settings in the Configuration menu. The top RJ45 jack is identified as 'eth0'. The bottom jack is 'eth1'. Each instrument must have a unique IP address on your network are sub-net. An example of these parameters is shown below. Your address and gateway settings will probably be different.



Install VNC Viewer (http://www.realvnc.com/download/) and run this program. The following screen will appear asking for the IP address of the instrument. The default settings usually work.



Enter the instrument's IP and click on Connect. If it connects to the instrument it then asks for the password.



The password is: **x11vncpwd**

If the program does not ask for the password than the connection has failed. Check the IP setup to make sure these parameters are correct. Also make sure you are using a known working connection. It may take a minute for the screen to update or for the mouse to start working once the connection has been made.

VNC allows remote access to each PROTHERM 455. You can run multiple VNC connections to multiple instruments but it is recommended you use these connections for troubleshooting purpose only and not for datalogging. A local operator will see the screen changes you are making so notify floor operators of the situation before make any remote changes. Operation is exactly as if you were standing in front of the instrument. It is recommended that someone is standing by the furnace while changes are made to guarantee safe operation.

You can also grab screen shots of the instrument for documentation.

If your computer has access to the web, it will be possible to setup a remote connection to the PROTHERM 455 instruments using TeamViewer and VNC. TeamViewer QuickSupport (https://www.teamviewer.com/en/download/windows/) runs on your computer. When you start

it, it will display a user number and password that you can give to the UPC service engineer. If this information does not display then the network connection has failed to negotiate an outside connection. You may have to contact your IT administrator for help.

If the user number and password are displayed, UPC technical support can access your computer and then run VNC to access the instrument. Obviously we have to do this with you and local operators in place since the instrument cannot be running any critical loads while configuration changes are made.

If you have any questions about any aspect of remote access please call United Process Controls.

12 USB MEMORY STICK

Each Protherm 455 is shipped with a USB memory Stick. This stick is preloaded with important resources and information. The instrument configuration sheet is included and documents the as-shipped configuration of the instrument. Additional folders are including:

Brochures and Manuals – contains the latest documents for the UPC product line and the FAQ files for the PROTHERM 455.

MMIUpdates - Contains of all files of the latest instrument system files that are loaded into the PROTHERM 455 using the Software Updates function in the instrument's Maintenance Menu. The contents of this folder can only be changed using the Update Tool. It is recommended that you contact the UPC technical support staff before changing any files in the MMIUpdates folder.

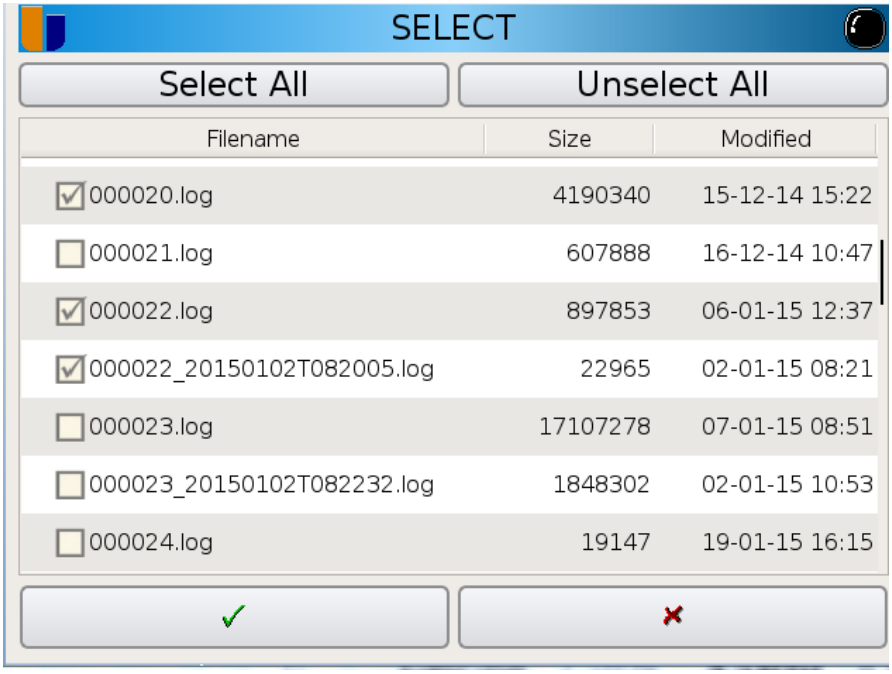
PROTHERM 455 Windows Utilities – Contains all of the Windows based applications used to configure the PROTHERM 455, create a MMIUpdates folder, or view the instrument log files.

MMIBackup – Contains the configuration files that define the operation of the instrument and I/O assignments. These files are managed with the Configuration Utility. It is recommended that you discuss any changes with the UPC technical support staff before changing the instrument setup.

13 PROTHERM 455 LOG/CHART VIEWER

The Protherm 455 can generate standby and job log files that can be viewed as either a chart or log on a Windows based computer. These files can be transferred to the computer using the USB stick and the Log Maintenance function on the PT455.

When the Log Maintenance Screen is opened a list of log files will be displayed.



The files that are numbered sequentially are log files that document individual jobs or recipes that were run. Each file shows the size and modified date. The files with the longer numbered names are log files that were created while the instrument was running in standby mode. Each standby file name is a combination of date and time when the standby mode was started.

You can select all or individually select any file by tapping the box to the left of each file name. Insure that the USB memory stick is plugged into the front port of the instrument. Once the required files have been selected click the green check mark at the bottom of the display.

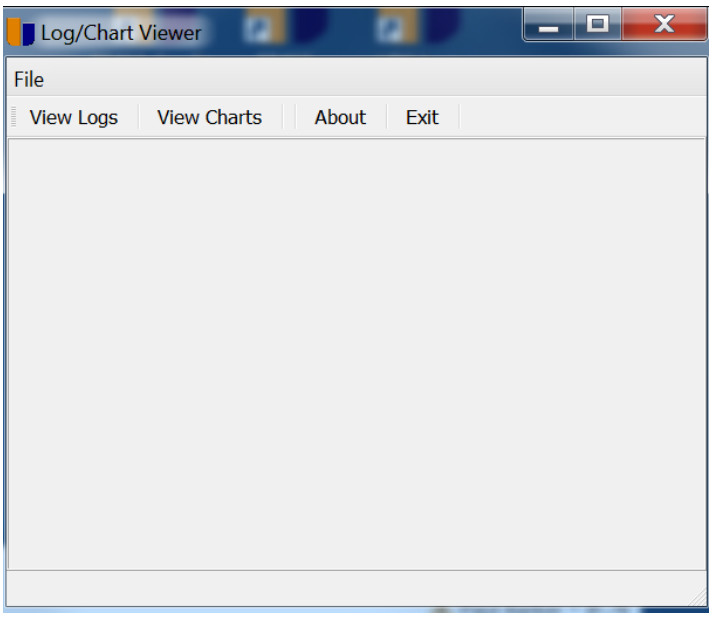
The selected log files will be copied to a directory created from the Equipment Code name setup in the Configuration \ System page of the instrument.

To view the chart or log on a Windows computer it is necessary to install the PT455 Log Viewer software.

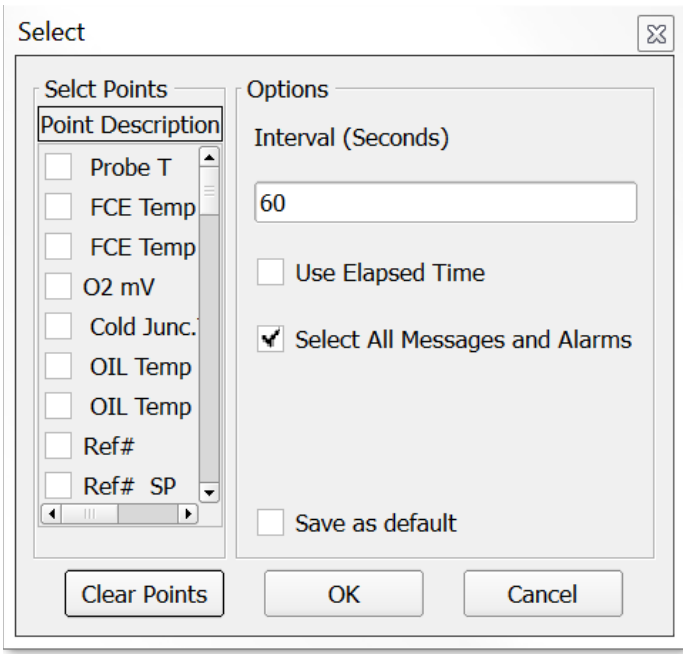
Installation Procedure

1. Plug the PT455 USB stick into an available USB port on the computer
2. Open the USB drive explorer and locate the PT455LogViewerInstaller folder
3. Click on this folder
4. Double click on the Setup Application file to start the installer.
5. Follow the instructions during the installation procedure.
6. Click the Finish button when the installation is complete.

To start the view, double click on the Desktop UPC Log Chart Viewer icon. The following screen will open:



At this point you have the option of viewing the job or standby data by clicking on the File tab and selecting either View Logs or View Charts. The results come from the same log file, they are just displayed differently as either a chart or as tabulated data. Select either option and open the log file on the stick. Select any log file and click OK.



For either the chart or log option a list of available process values will appear. The require values can be selected. Other options are available on this screen as well. For the chart function, there is an option in the select screen to plot different values on the right or left Y axis.

If the tabulated log is displayed it is possible to export this data to a spreadsheet as an HTML file by pressing the HTML button in the upper right corner of the display.

If a chart is displayed, it is possible to save this display as a PDF by pressing the Save PDF tab in the upper display tool bar.

13.1 System Alarms

Alarm Name	*Alarm*	*Cause*	*Possible Solution*
Turns off 81	80		
Temperature Deviation Band Alarm	81		• Check temperature SCR/Burner is working • Verify no faulty Thermocouples
Turns off 83	82		
%C (DPT or mV) Deviation Alarm	83	Actual %C deviated from SP	• Check atmosphere control is working properly • Wait for %C to return to reach SP • Modify deviation in recipe
OFF: Probe/Controller Temperature Deviation	84		
Probe T/C and Furnace T/C Deviation Alarm	85		
Probe Impedance Too High	86	Probe impedance exceeded max amount	• Replace Probe
Impedance Recovery Time Exceeded	87	Recovery time for impedance test has exceeded max amount	• Increase recovery time
Burn Off Recovery Time Exceeded	88	Recovery time for burn off has exceeded max amount	• Increase recovery time

Burn Off Temperature Exceeded	89	Probe temperature has exceeded max amount	• Decrease burn off time • Decrease furnace temperature
Verification Exceeded Tolerance	90		
LIMIT Statement Time-Out	93		
Illegal RAMP	95		
Auto Start After Power Failure	96	PROTHERM 455 has lost power	Warning to let operator know PROTHERM 455 has lost power.
Illegal Subroutine Call	97		
Illegal JUMP Attempted	98		
Error In Subroutine	110		
Go Sub Too Deep	112		
Bad Load Returning From Subroutine	118		

14 TECHNICAL SPECIFICATIONS

14.1 General Specification

Base:	
CPU	Intel® Atom™ processor N2600, 2x1.6 GHz
RAM memory	1 GB
Flash memory	SSD 512 MB + SSD 2 GB
Operating system	Tiny Core Linux
Internal UPS	Optional
Front panel:	
Display	5.7" VGA (640x480) LCD, LED backlight
User interface	Touch screen, resistive
	Diagnostic LED (power supply)
	1-port USB 1.1/2.0, max. 0.5 A
Communcation interfaces:	
Standard	2-port USB 1.1/2.0, max. 0.5 A / port
	1-port LAN 10/100/1000 Mbit
	2-port RS-422/485
Optional (Note 1)	1-port CAN
	1-port Profibus DP Master/Slave
	1-port (2nd) LAN 10/100/1000 Mbit
I/O system:	
Internal I/O space	4 slots
Environment:	
Power supply	24 V DC (-25 % ... +25 %)
Power consumption	25W typ., 80W max.
Temperature (operation)	0° ... 65°C (without internal UPS)
Temperature (storage)	-10 ... +85 °C
Humidity	10-90 %, non condensing at 50 °C
Mechanical:	
Housing material	Aluminum
Degree of protection	IP20 acc. to DIN 40050
Cabinet mounting	1/2 DIN
Dimensions (W x H x L)	150 x 150 x 240 mm
Weight	3 kg (Note 2)

Note 1

1-port Profibus DP Master/Slave and 1-port (2nd) LAN 10/100/1000 Mbit options are possible.

Note 2

Typical Protherm 455 configuration:

- Without internal UPS
- Standard communication interfaces
- I/O slot 1 - 8x Digital I/O, 120/230 V AC
- I/O slot 2 - 8x Digital I/O, 120/230 V AC
- I/O slot 3 - 16x Digital I/O, 24 V DC
- I/O slot 4 - 4x Analog In, 4x Analog Out

14.2 Digital 8 Point I/O 120/230VAC

Number of configurable I/O	8
Input frequency	50 Hz ± 5 % (at 230 V AC)
	60 Hz ± 5 % (at 120 V AC)
Isolation (field/system)	1.5 kV
Isolation (field/chasis)	630 V
Isolation (channel/channel)	630 V
Wire connection	Spring Cage
Cross sections	0.2 mm² ... 2.5 mm² / AWG 26 ... 12
Digital inputs:	
Signal voltage (0)	0 V ... 40 V AC
Signal voltage (1)	80 V ... 260 V AC
Input current (typ.)	4 mA (at 120 V AC, 50Hz)
	6.5mA (at 230 V AC, 50Hz)
Digital outputs:	
Type of switch	SCR, high-side, zero-crossing
Type of load	Resistive, inductive
Voltage supply	20 V ... 260 V AC
Rated output current	0.5 A
On-state voltage drop (max.)	1.6 V AC
Leakage current when turned off	< 3 mA
Overcurrent protection	1A fast-acting fuse
Overvoltage protection	Varistor, breakdown voltage 275 V AC
Snubber circuit RC	100 Ω, 22 nF

14.3 Digital 16 Point I/O , 24VDC

Number of configurable I/O	16
Dielectric strength (channel/channel)	500 V DC
Dielectric strength (channel/system)	500 V DC
Dielectric strength (channel/chasis)	500 V DC
Wire connection	Spring Cage
Cross sections	0.2 mm² ... 1.5 mm² / AWG 24 ... 16
Digital inputs:	
Signal voltage (0)	0 V ... 2 V DC
Signal voltage (1)	15 V ... 30 V DC
Input current	2.8 mA (typ. at 24 V DC)
Digital outputs:	
Type of switch	MOSFET, high-side
Type of load	Resistive, inductive, lamps
Voltage supply	18 .. 30 V DC
Rated output current	0.5 A
On-state resistance (typ.)	0.8 Ω (at 25 °C)
Overcurrent protection	0.9 A (at 25 °C), recoverable
Overvoltage protection	Varistor, breakdown voltage 39 V DC
Thermal protection	150 °C
Inductive load switch-off energy dissipation (max.)	1 J (at 150 °C, I=0.15 A)

14.4 4 Point Analog Inputs / 4 Point Analog Outputs

Number of configurable inputs	4
Number of configurable outputs	4
Dielectric strength (channel/channel)	400 V DC
Dielectric strength (channel/system)	400 V DC
Dielectric strength (channel/chasis)	400 V DC
Wire connection	Spring Cage
Cross sections	0.2 mm² .. 1.5 mm² / AWG 24 ... 16
Analog inputs:	
Voltage range	0 .. 2 V DC, 0 .. 5 V DC
Input resistance	19 MΩ (typ.)
Accuracy	± 0.1 % of the full scale value (25 °C)
Current range	0 .. 20 mA, 4 .. 20 mA
Loop power	24 V DC + 10 % (max.)
Input resistance	200 Ω (typ.)
Accuracy	± 0.1 % of the full scale value (25 °C)
Resistance range	100 .. 390.48 Ω
Sensor connection	3-wire
Measuring current	0.5 mA
Accuracy	± 0.1 % of the full scale value (25 °C)
Thermocouple range	-96 .. 96 mV
Sensor type	J, K, N, S, R, T, E, B, C, M
Input resistance	> 300 MΩ
Accuracy	± 0.1 % of the full scale value (25 °C)
Cold junction accuracy	1 °C
Analog outputs:	
Voltage range	0 .. 5 V DC, 0 .. 10V DC
Load impedance	≥ 5 kΩ
Output resistance	3 Ω (typ.)
Short circuit current	20 mA
Accuracy	< ± 0.2 % of the full scale value (25 °C)
Current range	0 .. 20 mA, 4 .. 20 mA
Load impedance	≤ 600 Ω
Loop power	24 V DC ± 10 %
Output resistance	50 MΩ (typ.)
Accuracy	< ± 0.3 % of the full scale value (25 °C)

15 RECIPE OP CODES

Op Code	Description
-	No Operation
A	Set ALARM number
B	BRANCH, true step 0 – 19 and false step 0 - 19
C	Set Carbon or dew point set point, implied decimal place xx.xx for carbon and xxx.x for dew point
c	Check carbon or dew point, implied decimal place xx.xx for carbon and xxx.x for dew point
d	Add to reference number
E	Event, event number 0 to 63, OFF or ON
F	Flag set, flag number 0 to 47, OFF or ON
G	Gosub to another recipe and return
H	Set temperature set point
h	Check actual temperature
i	Insert delay, time in seconds
J	Jump to another recipe
L	LIMIT, time in hours and minutes, implied decimal place xx.xx
m	Test Input A
n	Set reference number
o	Test input B (typically sensor mV)
P	Set process factor
q	Test reference number
r	TIME TO RAMP, time in hours and minutes, implied decimal place xx.xx
S	SOAK, time in hours and minutes, implied decimal place xx.xx
T	Set master timer, time in hours and minutes, implied decimal place xx.xx
t	Test master timer, time in hours and minutes, implied decimal place xx.xx
U	Test temperature control % output
u	Test carbon control % output
W	Wait for FLAG, flag number 0 to 47, OFF or ON
Y	Test INPUT C (Typically furnace temperature)
Z	Data Z1 for ‘F’ op code

16 CUSTOMER SUPPORT

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		Poland: +48 32 296 66 00

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