LEVEL 1 AUTOMATION GUIDE

PLC: Siemens 22x
HMI: Maple 520C

Manual date: 10/14/05
Manual version: M.L1.13
Software version: 1.1.25
Author: David Williams

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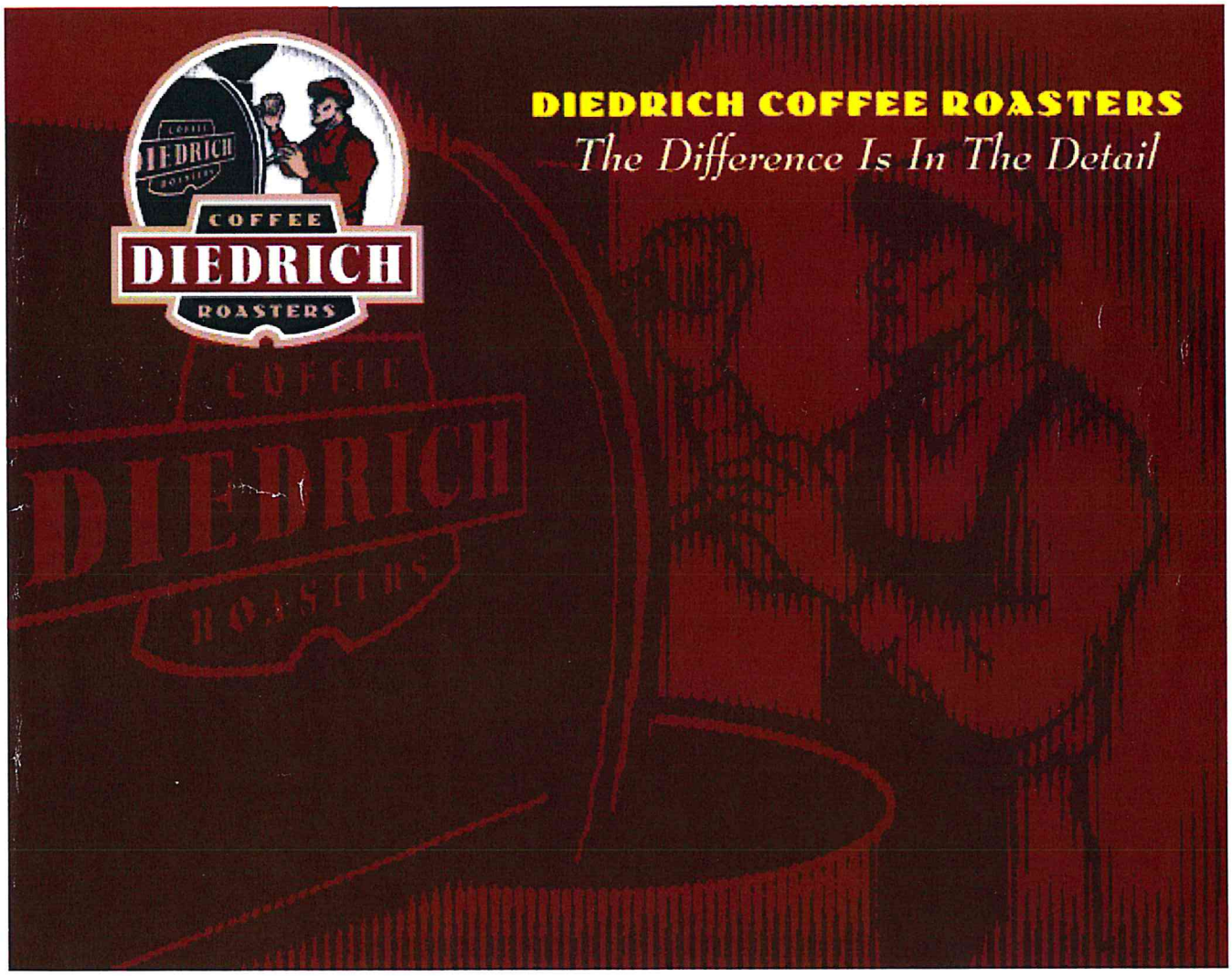
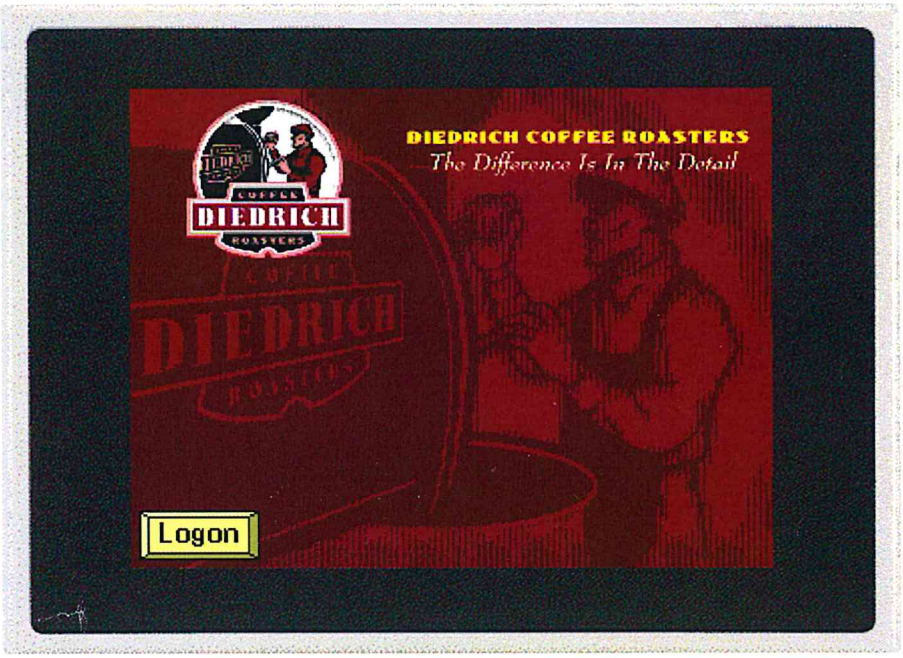


1.0 Introduction

Please read the entire manual before operating the equipment. **Be familiar with all of the safety instructions. Read these in section 7.**

Most operating controls on this automatic roaster are 'virtual buttons' located on the touch screen. These operate with a slight pressure (finger or plastic pointer, such as the kind used by hand-held computers) on the screen area.

After applying power to the roaster, the screen will light up, showing the *Splash* screen. If the screen is not touched (activated) for several minutes, it may blank itself; just touch it to turn on the display again.



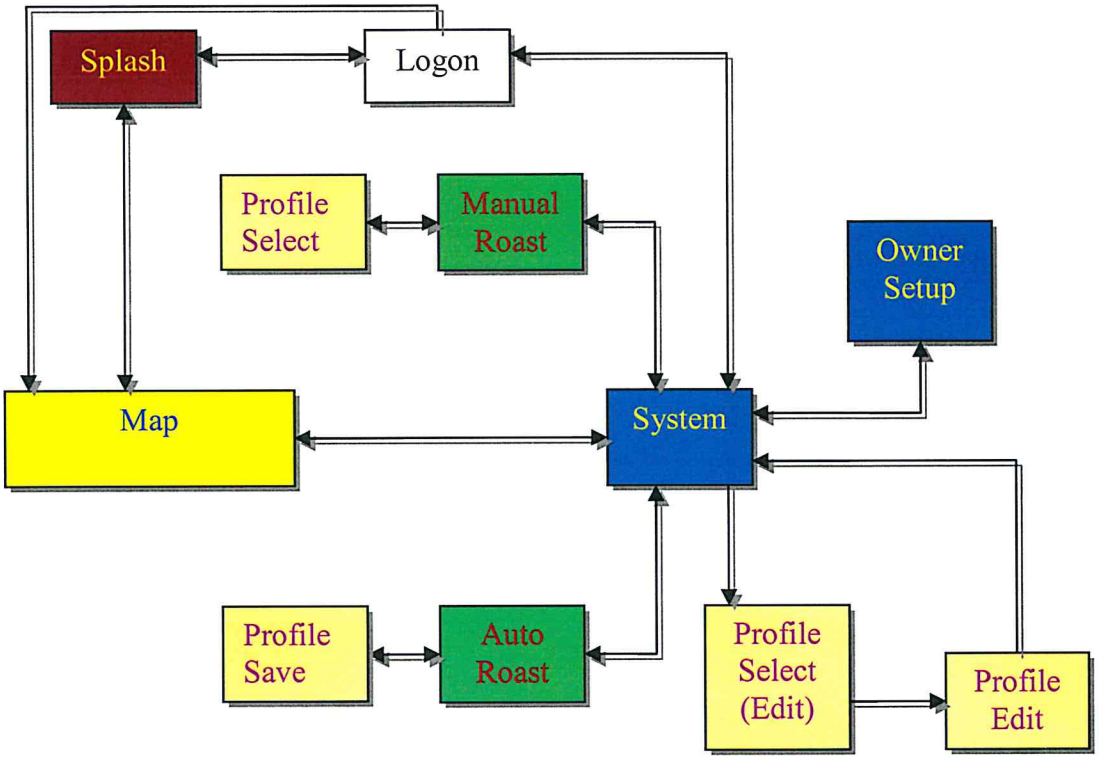
The only button that is initially available is the *Logon* button. You must enter a password to access the other operations screens. When this button is pressed, roaster warmup data is transferred from the touch screen computer (**HMI**) to the roaster control computer (**PLC**), and the *Logon* screen appears in a couple of seconds. This is described further in the *Quick Tour* section of this manual.

Note: There is a significant amount of synchronous and asynchronous communication between the HMI and the PLC. The PLC is used to change the screens on the HMI. Please allow sufficient time for the buttons to complete whatever functions are assigned. (For example, the *Access Level* (see section 2.1) is transferred every second, so pressing the *Map* button in the *Logon* screen will have no effect until a second or two after the *Access Level* has been changed.)

The password for Access Level 1 is **244**.

2.0 Quick Tour, Operating Screens

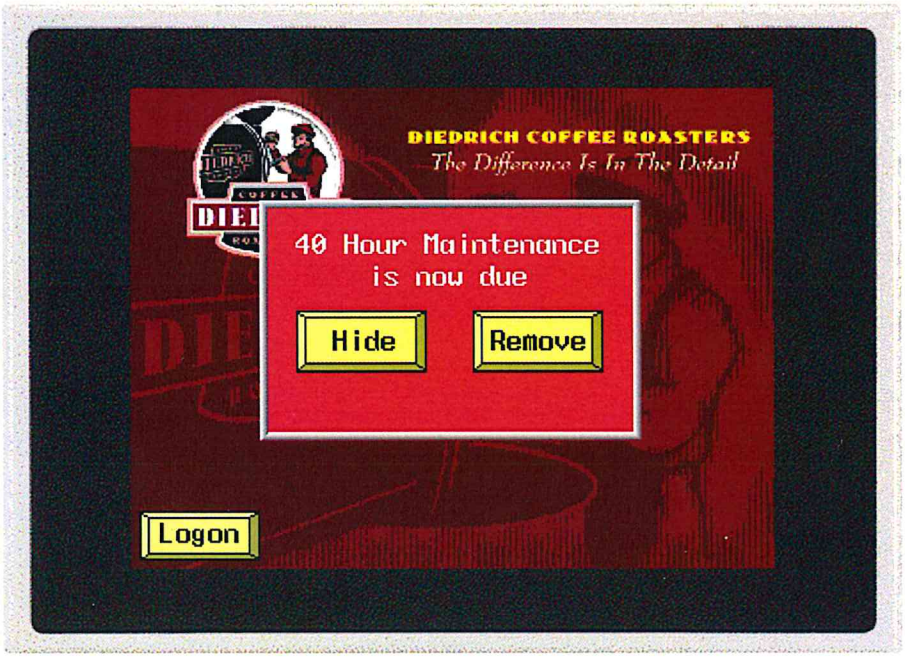
User flow diagram



2.1 Splash Screen

Press the *Logon* button to change from access level 0 (logged out) to access level 1 (user mode). This will display the *Logon* screen, where the password can be entered.

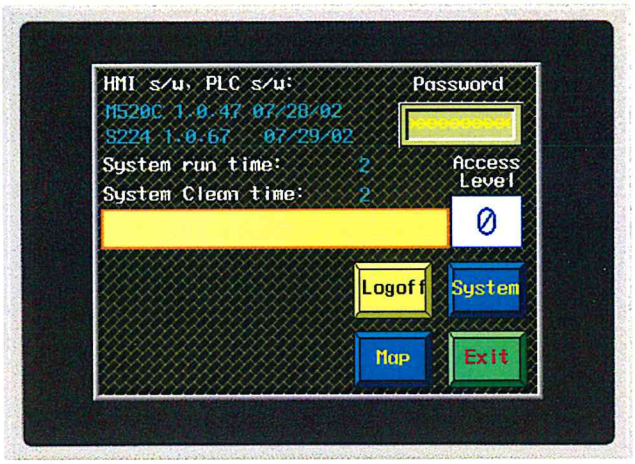
After a set time (usually about 40 hours) a *Maintenance Message* will be displayed indicating that the roaster is due for cleaning. Pressing *Hide* will remove the display for about 1 hour. Pressing *Remove* will reset the Clean Time hour counter; do this only if the roaster has been actually cleaned.



During the automatic roaster warmup process, a *Warmup Message* will also be displayed on this screen indicating that Warmup is in process.

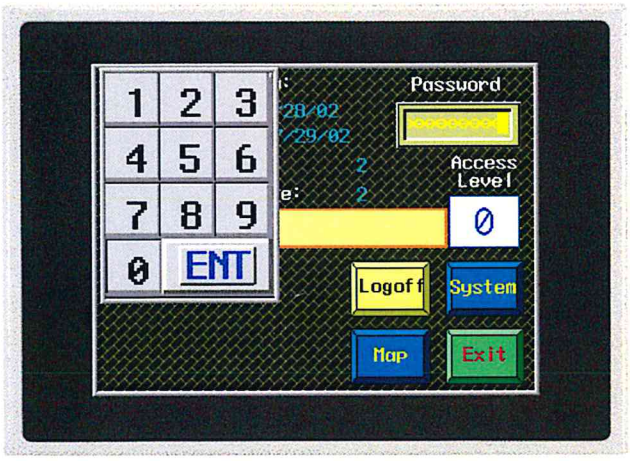
2.2 Logon Screen

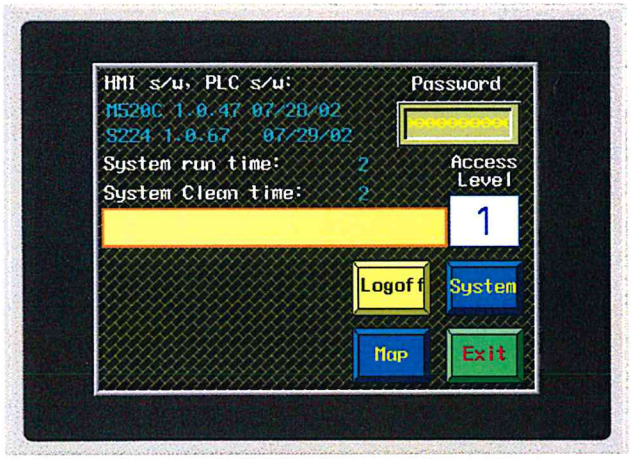
On the upper left is displayed software version information for the PLC and HMI, which may be requested if a call to technical support is initiated.



The System Run Time indicates the hours of roasting operation, and the Clean Time indicates the hours of roasting operation since the last time that the *Maintenance Message* was removed from the screen (see section 2.1). The light bar below this area is used to display system messages, which are also displayed on the *Manual* and *Automatic* Operations screens.

Pressing the password entry control (upper right) causes a keypad to appear; after entering the password, pressing 'ENT' on the keypad will cause the latter to disappear. The current access level is indicated in the white window. (Level 0 is equivalent to being logged out; Level 1 is normal use; Level 2 is for Service access. The level is determined by the password.) If you enter the wrong password, the access level will not change.



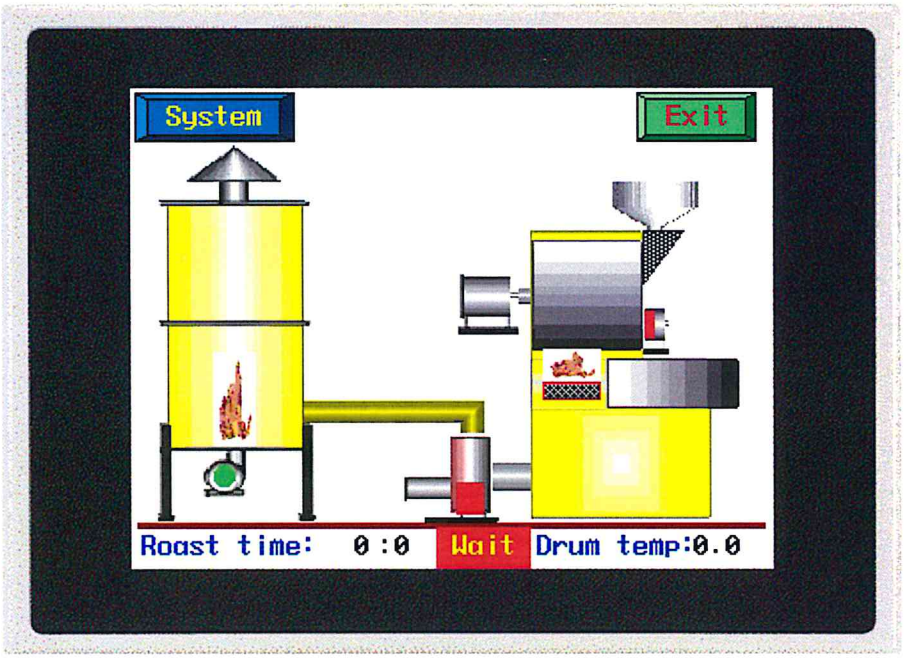


Pressing Logoff will initiate a roaster cooldown sequence, and ultimately shut off the roaster when the drum temperature is below 200°F.

The *System Map* and *System Setup* screens can be viewed when the access level is not 0. *Exit* will return to the *Splash* screen.

2.3 System Map Screen

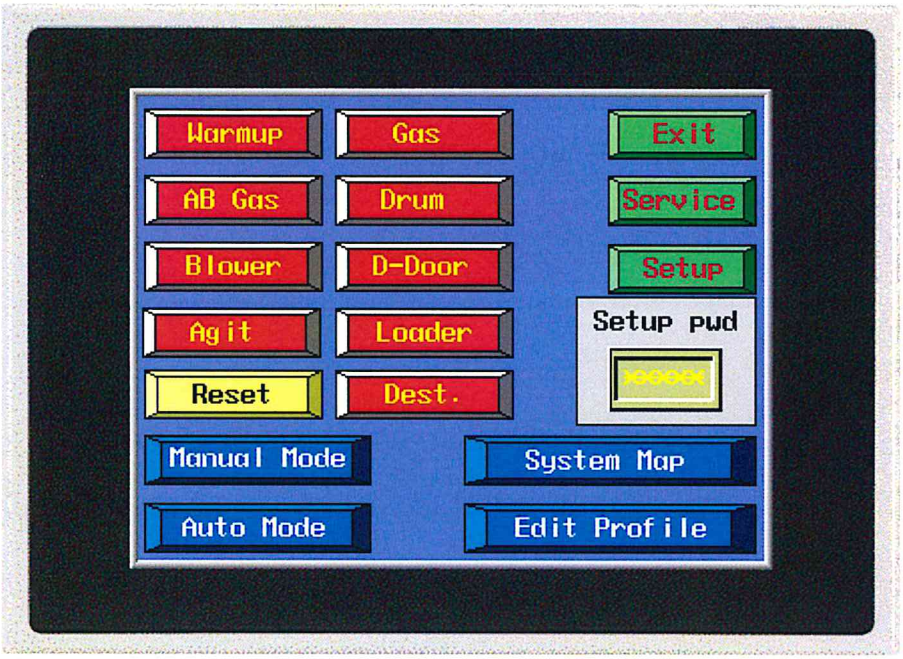
This screen presents an overview of roaster operations, giving visual feedback on motor and gas activation.



Exit returns to the *Splash* screen, and *System* returns to the *System* screen.

2.4 System Screen

The *Manual Roast* and *Automatic Roast* screens are selected on this page, as well as navigating to the *System Map* screen.



The gas and motors can be manually operated if necessary, or for manual roasting. Resetting the alarm (and high limit) can be done here, as well as in the *Manual* and *Auto Roast* screens.

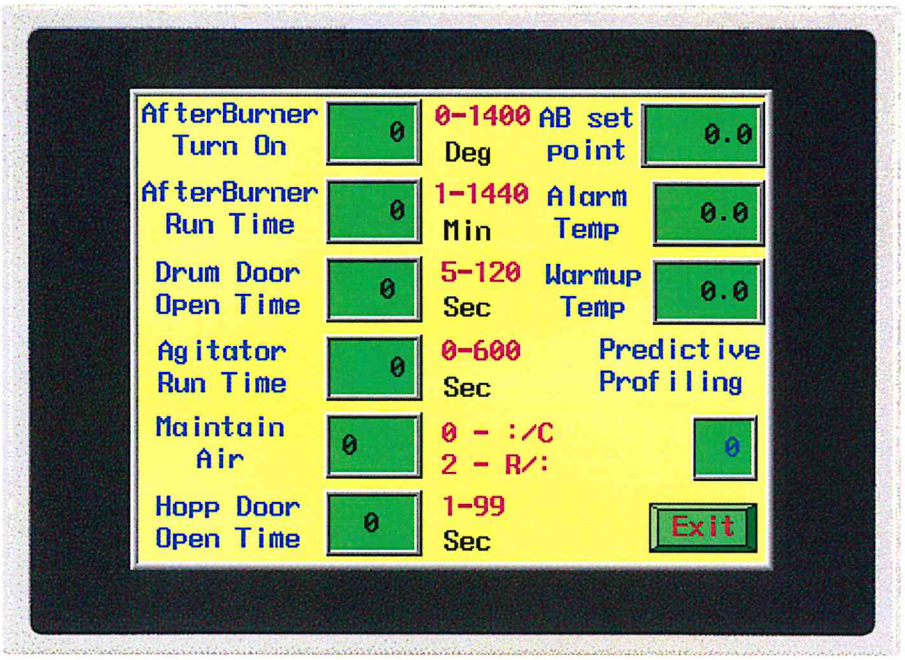
The *Service* button is used for service purposes only, when the access level is 2. (See section 2.2)

When *Warmup* is on (button is green), the roaster will initiate an automatic warmup process when cold. In between roasts, the temperature will be maintained at a set temperature (*Owner Setup* screen). This action will be cancelled when any one of the motor/gas buttons is pushed.

Press the *Setup Password* area to enter the Owner password data. This will enable the *Setup* button, which, when pushed, will cause the *Owner Setup* screen to display.

Some buttons will not be seen if the option is not set, or if the function is not allowed at the time. This applied to other screens as well.

2.5 Owner Setup Screen



AfterBurner Turn On temperature is the roaster temperature at which the AfterBurner flame comes on, and *AfterBurner Run Time* is the length of time that the Afterburner flame will be on at the end of an automatic roast cycle. *AB set point* is the setpoint temperature for a controlled AfterBurner (optional).

Drum Door Open Time / *Agitator Run Time* is the length of time that the Drum Door / Agitator will remain open / run at the end of an automatic roast cycle. *Hopp Door Open Time* is the length of time the input hopper will open at the start of a roast (input hopper option).

Maintain Air is the air direction set during *Maintain* mode (**0**: Cooler; **1**: 50/50; **2**: Roaster). Default is **0**.

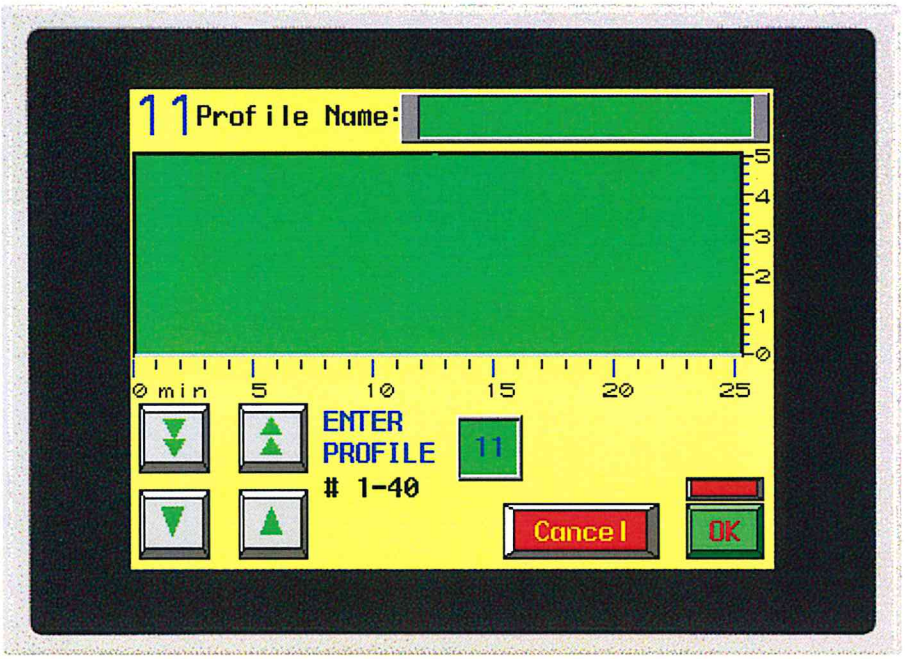
Alarm Temp is the roaster temperature at which the alarm will sound during a manual roast.

Warmup Temp is the temperature which the roaster will maintain between roasting cycles if the *Warmup* option (*User Setup* screen) is set.

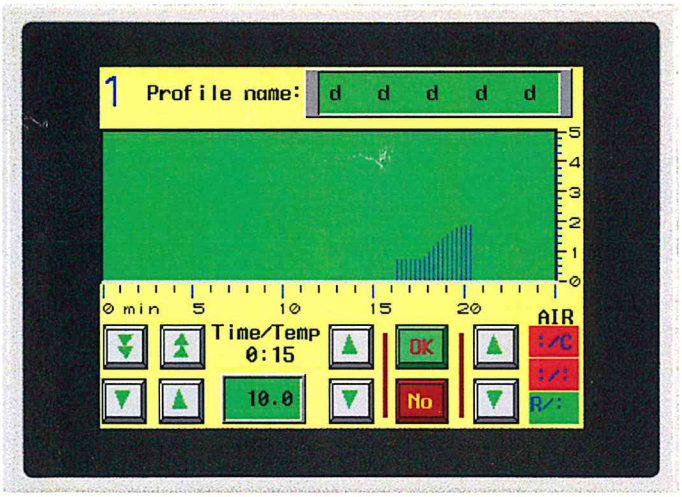
The number of cycles entered for *Predictive Profiling* determines the length of time, in 15 second increments, to advance into the profile, in order to calculate an adjusted setpoint for the current position (time). This setpoint may then differ from the actual profile setpoint, and allows the PID loop to compensate for a change in slope of the profile before that point is reached. Thus, a setting of 8 will allow the PID loop to react to a change in profile slope (derivative) 2 minutes ahead of time. The net effect of this feature is a smoothing of the profile, or an increase in the profile hysteresis. A setting between 0 (no prediction) and 12 (3 minutes) should be sufficient.

Editing the roasting profiles is started from the *System* screen, by pressing the *Edit Profile* button. This causes the *Profile Select* screen to be displayed. Pressing the up/down buttons allow the profiles to be viewed; *OK* will load the selected profile into the PLC, where it can be edited. Pressing *Cancel* will return to the *System* screen.

2.6 Profile Editing



If a profile has been selected, and *OK* has been pressed, the *Profile Edit* screen will appear. Pressing the name area will cause an alphanumeric keypad to appear, which can be used to change the name of the profile.



The buttons on the lower left of the *Edit* screen increment and decrement the pointer, which will be adjacent to the temperature/air setting that can be set. Use the up/down keys to set the air control (R/: indicates air flow to the *Roaster*; :/: indicates a 50/50 mix; :/C indicates air flow to the *Cooler*).

Press *No* to cancel changes (except for the name, which is changed immediately); press *OK* to save them.

Note on Profiles

A *Profile* is a data set, containing temperature and air control values for set times during a roast. For this software release, there are 100 set times: each 15 second interval for a maximum of 25 minutes. During a manual roast, this data set is placed into temporary memory.

When the roast is ended, the *Save Prof* button allows this data set to be saved in permanent memory, and a 20-character name assigned to it.

All such profiles are available for automatic roasting; once one is selected from the *Automatic Operations* screen, it is copied from permanent memory into temporary memory, where the data values are used to control the air flow and heating of the roaster. In this way, a particular style of roast can be repeated indefinitely.

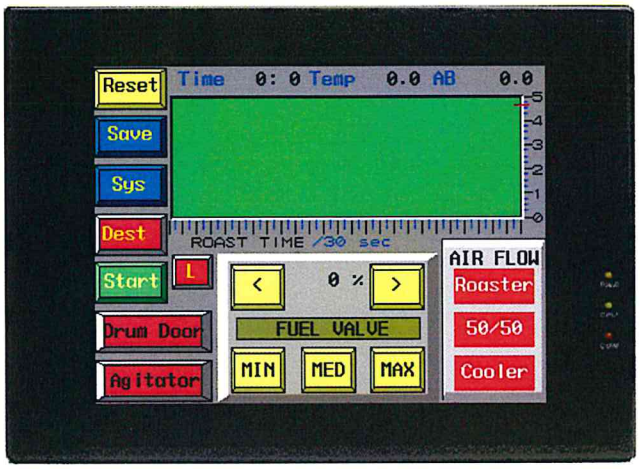
This software release provides for the saving of 40 *Profiles*.

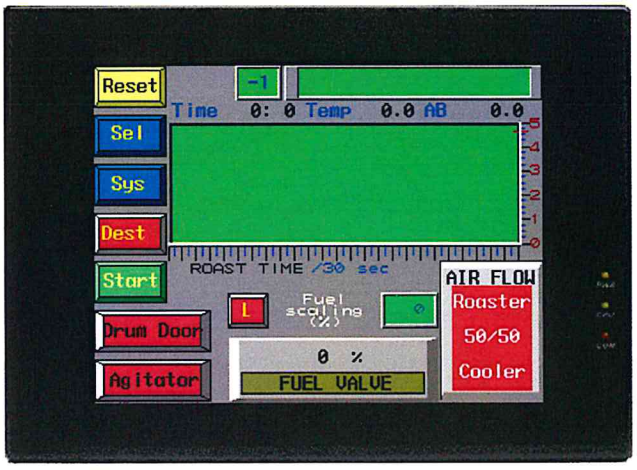
A "save as" feature, to move profiles, can be done as follows:

1. Select *System -> Auto Operations*
2. *Select Profile*
3. Return to *System* screen, select *Manual Operations*
4. *Save Profile* (in the new location). (Old data will be overwritten; specify the new name as well.)

Manual and Auto Roast (Operations) Screens

This describes the *Manual Roast* screen primarily. The *Auto Roast* screen differs in the following ways: (1) No manual fuel control, (2) No manual Air direction control and (3) Batch Scaling selection.





If the *Input Hopper* option is installed, the screens have a *Start* button, which takes the place of the hopper lever. Also, the *AB* (AfterBurner) temperature is visible for the *Controlled AB* option, as is the *L* (Loader) for the *Loader* option.

Opening the hopper door (or pressing the *Start* button) will initiate a roast cycle. (If the drum temperature is below the Cycle Temperature (set in the first *Service* screen), an automatic roast will be inaccurate, so in this case the roaster will switch to *Manual* mode and display a warning on the screen.) The Roast Time will reset and count up, and the current Drum Temperature will always be displayed below it.

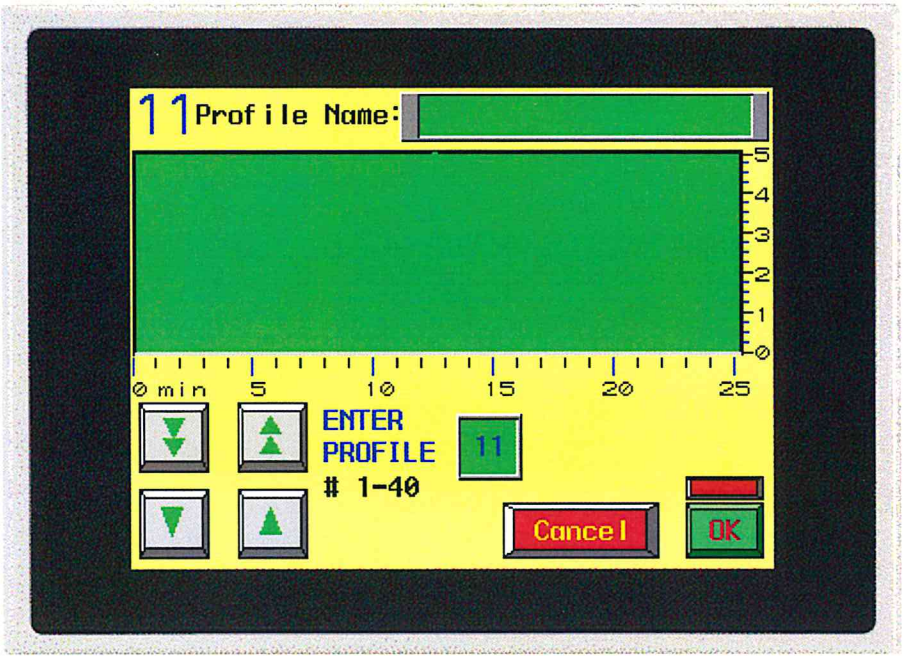
The trend graph displays (1) the current air flow direction [blue], (2) the current drum (bean) temperature [brown], and (3) the current profile set point [red] (which is set to zero in a manual roast). (Note the lines in the above trend graphs). The temperature scale goes from 0°F to 500°F. The air graph has 3 positions – on the screens above, the lowest position is shown, indicating that air is going to the *Roaster* (highlighted in green on the lower right AIR FLOW box).

The *Drum Door* and *Agitator* buttons are for emergency use in the *Auto Roast* screen, since they are operated programmatically. **Note that operating the Drum Door is the method of ending a roast cycle.**

Reset turns off the alarm temporarily, as well as resetting the temperature high limit device,and the *Map* and *Setup* screens are accessed by the corresponding buttons.

Save Prof will display the *Profile Selection* screen, and is used to save a profile to the HMI after a *Manual Roast*. After selecting one of the available profiles, and pressing *OK*, the data in the PLC will overwrite any data in the selected profile, saving Set Temperature and Set Air Direction information for the 100 points in a profile (each 15 sec for a max of 25 minutes). See section 2.6 for details on the profiles.

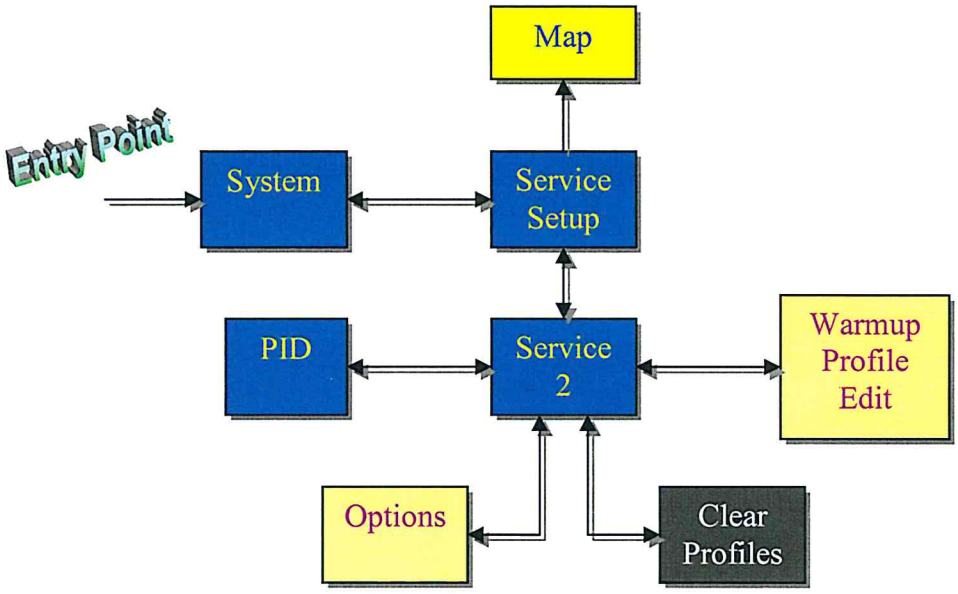
The *Save Profile* screen allows the name of the profile to be edited. This is not cancellable using the *Cancel* button. If you make a mistake, just reenter the name.



Note: Profiles do not need to take the full 25 minutes; most will be less than 20 minutes.

3.0 Quick Tour, Service Screens

3.1 Service flow diagram



Alarm bits:

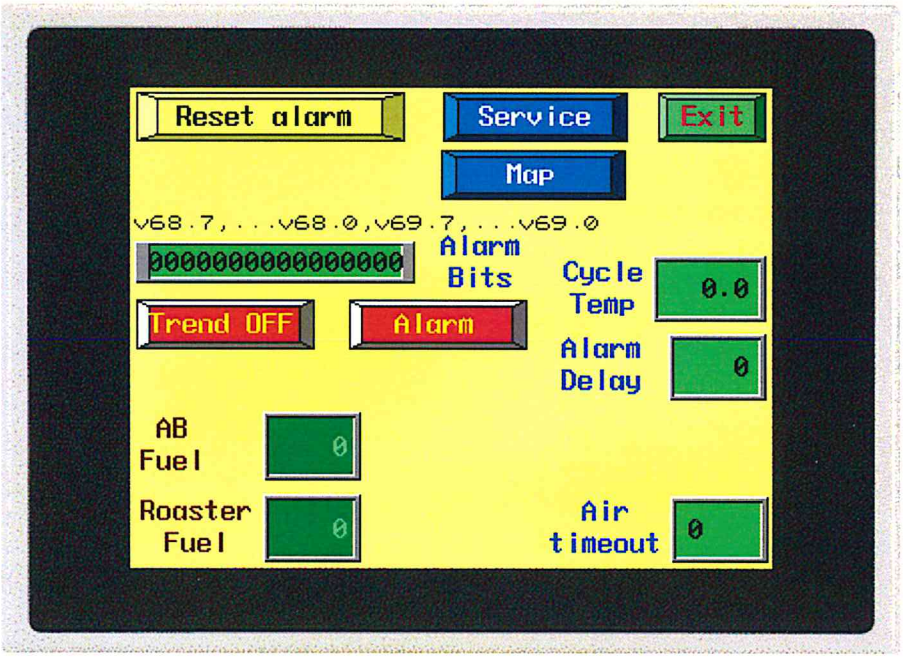
68.0 Drum motor error
68.1 Blower motor error
68.2 Agitator motor error
68.3 Gas not on after 20 sec
69.0 Beans @ Finish temp
69.1 Bean temp >= alarm setting
69.2 Bean temp >= 465 F
69.7 Alarm test button

3.2 Service Setup Screen

Accessed from the *User Setup* screen, this requires an access level of 2.

Exit returns to the *User Setup* screen, *Map* to the *System Map*, and *Service* to the *Service 2* screen. *Reset Alarm* has the same function as the similar button on the *System* screen. The time delay for the resetting of the alarm is set here as *Alarm Delay*, expressed in 10ms increments (700 is equivalent to 7 seconds).

Trend ON will turn on the trending in the *Manual* and *Auto* operations screens; this can be used to conveniently view roaster temperatures. *Trend OFF* is active when a roasting cycle is not in process.



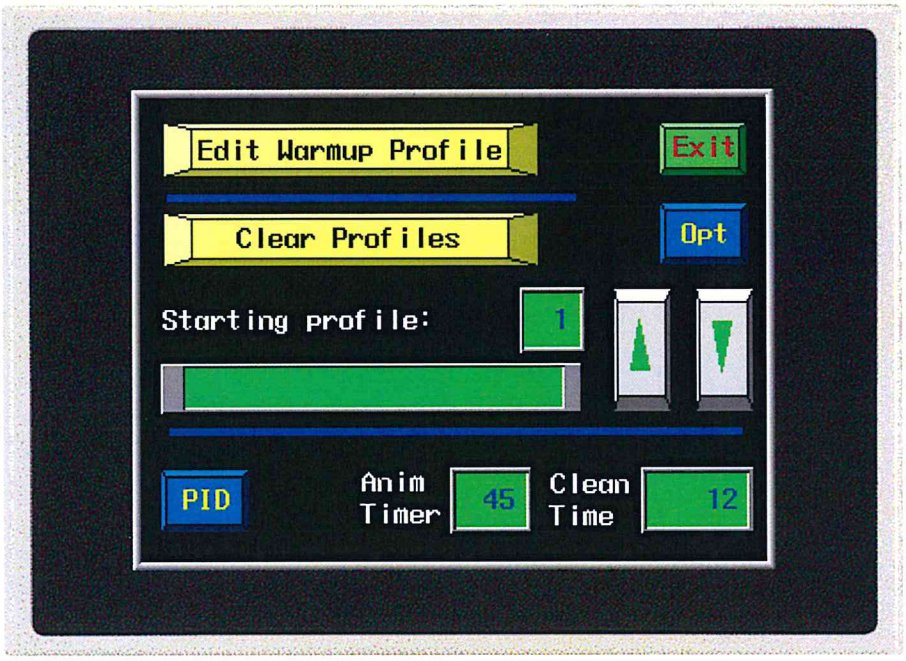
The *Alarm Bits*, noted in section 3.1, are in the order v68.7,v68.6,…,v68.0,v69.7,…,v69.0. This allows the source of an alarm to be identified. The *Alarm* button will test the sound.

AB Fuel / Roaster Fuel indicate the actual value sent to the gas valves (6400 – 32000).

Cycle Temp is the minimum temperature at which an automatic roast may start. Unless disabled in the *Options* screen, an automatic roast will switch over to manual mode if the roaster drum temperature is below this value when the roast is started. If this feature is not wanted, set the value low (such as 50).

Air Timeout is the maximum length of time for air actuator travel to/from the 50/50 position. This should not normally be changed.

3.3 Service 2 Screen

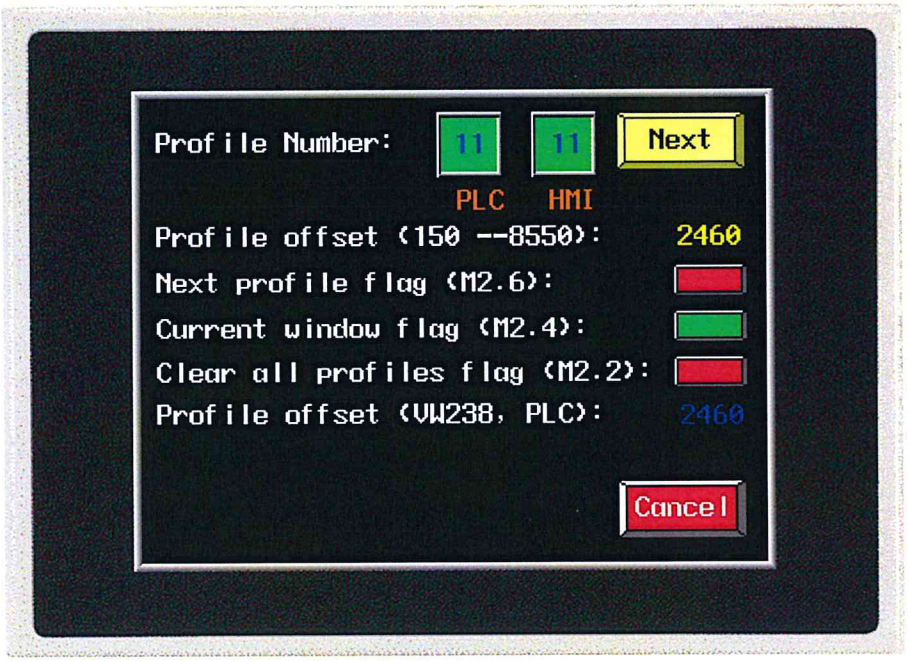


Edit Warmup Profile allows the editing of profile 0 (user profiles are 1-40). Edit functions are the same as the user edit screen, detailed in section 2.3.

Anim Timer is used to optimize the *Map* screen animations. *Clean Time* can be changed here, to reduce the time until the next 40–hour cleaning requirement. *PID* will display the *PID Setup* screen, and *Opt* will display the *Options* screen.

After selecting a starting number, press *Clear Profiles* to null the profile area selected. A warning will appear prior to the appearance of the *Clear Profiles* screen:

Subsequent profiles can be nulled by repeatedly pressing *Next* in the *Clear Profiles* screen.



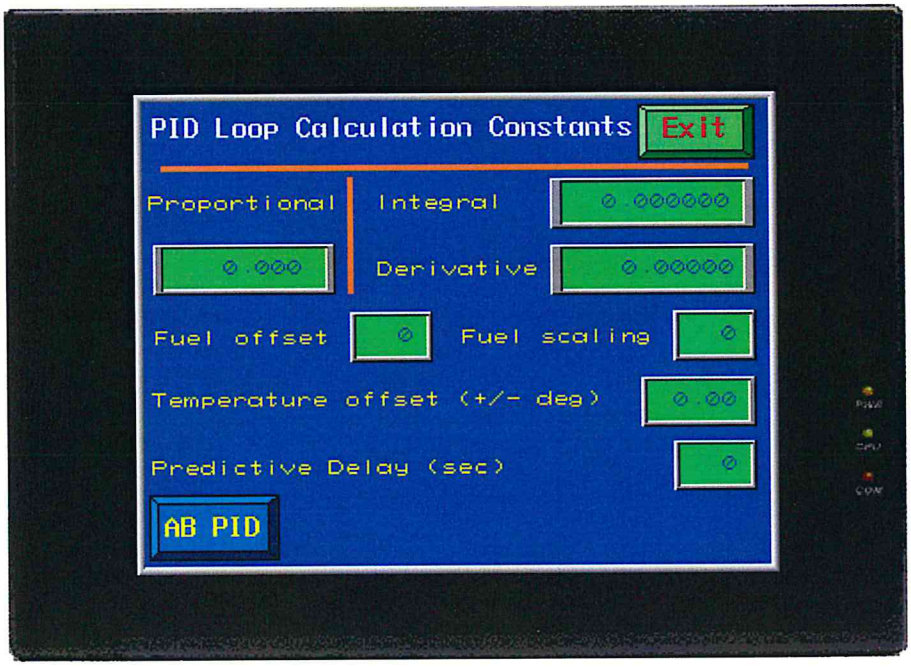
Each profile clearing, initiated by pressing the *Next* button, is accomplished by the transfer of null data from the PLC to the HMI. Since this takes several CPU cycles, there is an associated delay; wait until the flag colors change back to the initial setting before pressing the next button again. (If you press too quickly, a profile may not be deleted, and you will need to repeat the operation.)

Press *Cancel* when you do not wish to clear any more profiles. The current number displayed will not have been cleared.

Note that there is no need to delete profiles; a new one can be saved over an existing one.

PID Setup Screen

This screen allows the setting of the calculation constants for the standard PID loop, and some additional features.



Proportional Gain affects the *Proportional*, *Integral* and *Derivative* factors of the loop. **The higher the number, the greater the sensitivity** of the control in driving the actual value to the (calculated) setpoint.

The *Integral time* is concerned with the area above/below the actual temperature graph, between the latter and the set temperature graph. **The higher the number, the lesser the integral action** in driving the area to zero.

The *Derivative time* is concerned with the slope of the actual temperature graph, when compared with the profile graph. **The higher the number, the greater the derivative action** in driving the slope difference to zero.

Fuel offset / scaling scales the PID output (0.0-1.0 scaled to the gas valve) in order to compensate for nonlinearities in the gas valve which cause maximum flame at values less than 100% fuel setting in the roasting screens. Normally, this should not be changed.

Temperature offset increases the PID output value. Normally, this should not be changed.

Predictive Delay disables *Predictive Profiling* (if turned on in the *Owner Setup* screen) for the set number of seconds into the auto roast. It is better to use prediction after the roast has "bottomed out" and the temperature has begun to rise again.

AB PID allows changing of the PID variables if a controlled AfterBurner is present.

3.5 Options Screen

Roasters without agitators require the *No Agitator* option set to prevent alarms.

CO2 Discharge option recognizes the removal of a pin on an optional CO2 cylinder.

Simplified Control removes the *Manual Operations*, *Edit Profiles*, *Setup* and *Service* buttons from the *System* screen.

Disable Manual Cycle will remove the *Manual Mode* button on the *System* screen, restricting Level 1 operators to the *Auto Mode* screen. The roaster will not switch into *Manual Mode* if the drum temperature is below the set minimum (*Cycle Temp*), or if a null profile is loaded.

10" screen changes certain screen display variables.

Loader and *Destoner* enable the corresponding buttons in the *System* screen.

Neg logic ... is factory set according to the type of sensor hardware used in the roaster.

Input hopper gate puts the Start button on the operations screens, and *Controlled AB* puts the AfterBurner temperature on the same screens.

4.0 Start Up and Shutdown

After logging on (see section 2.2), press *System* to access the motor control page. The roaster should be warmed up next.

Pressing *Warmup* will initiate an automatic roaster warmup; the *Wait* indicator at the lower middle section of the *Map* screen will turn to *Ready* when the temperature is sufficiently high.

If you would prefer to warmup the machine manually, turn on the *Drum*, *Blower* and *Gas*. When the gas has lit, the button will turn green. (Prior to that, a green area in the right side of the button indicates that the gas system is attempting to come on.) The current drum temperature may be viewed in the *Operations* or *Map* screens.

To shutdown, and automatically cool the roaster, press *Logoff* in the *Logon* screen. (*System->Exit*.) See section 2.2.

System Checks

Do this before roasting.

User checks:

- Logon.
- Press *System*.
- Press *Drum*, *Blower*, *Agitator*, *Drum Door*. Verify that the button changes from red to green, and that the roaster operates the corresponding device. Press *Drum Door* & *Agitator* again.
- Press *Gas*, and verify that the button turns green and that the gas is lit.
- Press *AB Gas* and verify that the flame ignites (heat should come out the top). Leave it on for at least a minute before turning it off (**don't do this** for the *Controlled AfterBurner*).
- Press *Warmup*. The button should turn green, and the roaster should begin to track the warmup profile (visible in the *Operations* screens).
- Turn off *Warmup* (button should be red), *Gas*, *Drum* & *Blower*. The roaster should stop operations.

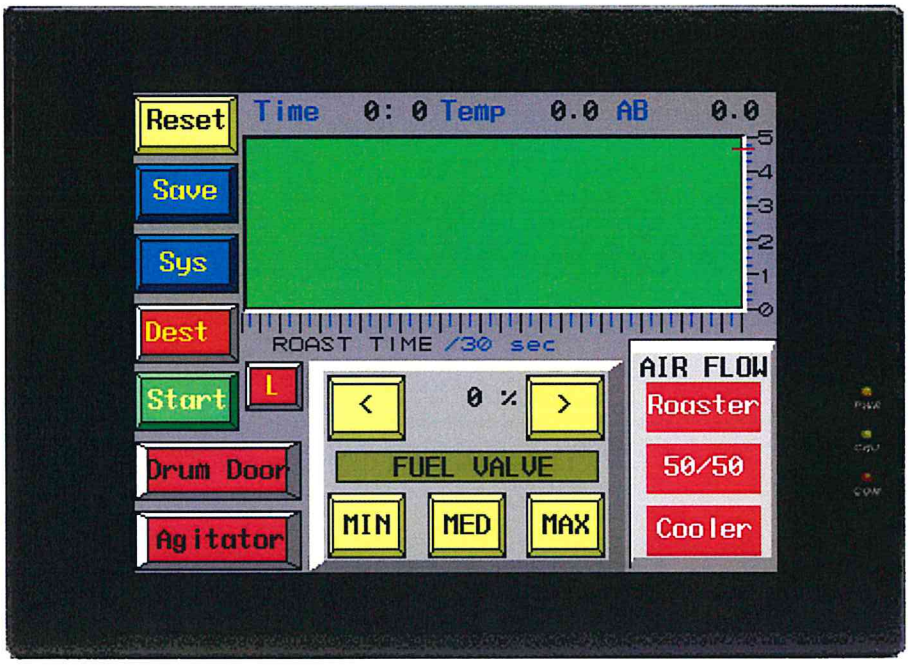
Owner checks:

- Enter the Setup Password on the *System* screen, and press *Setup*. Verify that the values on the screen are correct. Press *Exit*.

Service checks:

- Press *Service* in the *System* screen. Verify that Cycle Temp and Alarm Delay are set appropriately, and that Analog Fuel value is 6400 at 0% fuel (view % on *Manual* screen).
- Press *Alarm*. The alarm should sound, and a bit should set in the window. Press *Alarm* again. The bit should clear, and the alarm be silenced. Press *Alarm* again, and then *Reset Alarm*. The sound should be silenced for the period set in Alarm Delay (seconds). Press *Alarm* to end the test.
- Press *Service*, and then *PID* on the next screen. Verify that the settings are appropriate, then exit the screens.
- Logon with Level 1 access.

5.0 Manual Roasting



After putting beans in the hopper (optionally using a Loader via the *L* button), open the hopper door fully to empty the beans into the roaster. If a hopper gate is present, use the *Start* button to open the hopper. This will initiate a *Manual* roast cycle. The time will reset and then increment; Temp indicates the current roaster temperature.

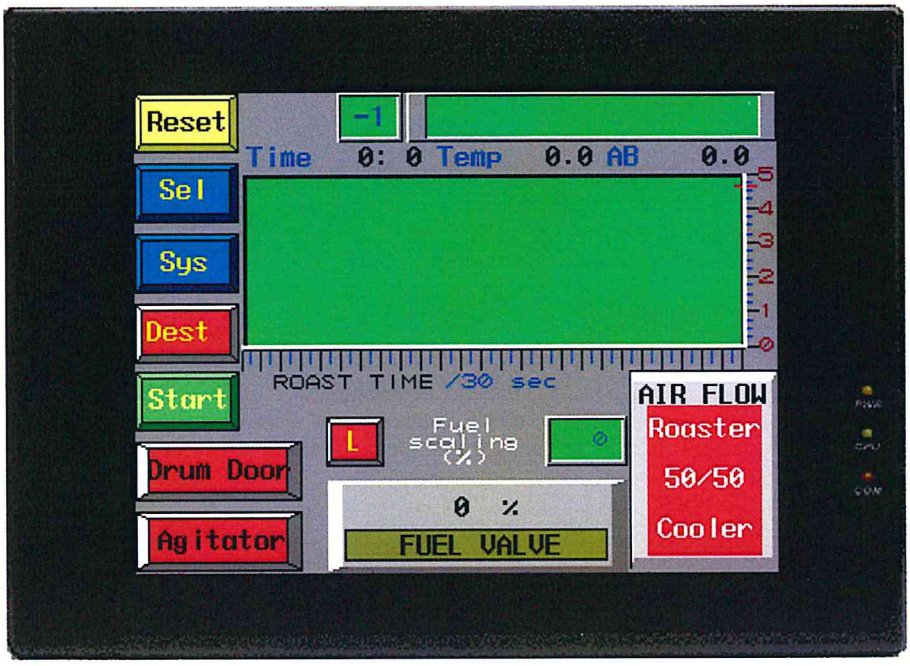
Push the appropriate AIR FLOW buttons to change the air direction as you wish. Set the fuel valve from 0 to 100% as you wish. The profile will be saved for 25 minutes maximum, so please complete the roast before that time for a uniform profile. Most roasts should be in the 15-20 minute range. Manual roasts can be run longer than 25 minutes, but the data won't be saved beyond that time for auto roasting.

Reset will reset the alarm, and the high limit (if it trips). *Sys* returns to the *System* page, for full motor control. *Drum Door* and *Agitator* directly control the corresponding motors; operating *Drum Door* will end the roast cycle. **Opening the drum door by using the drum door lever will not stop the timing; only the Drum Door button will do that.**

Save allows the saving of the profile, when the manual roast cycle is not in process.

The *Agitator* is normally turned on just before pressing the *Drum Door* button.

6.0 Automatic Roasting



First, select a profile using *Sel*, which allows the selection of a profile when an automatic cycle is not in process. This will clear the profile memory area of any unwanted data that can occur during profile editing.

The loader (*L*) and *Start* buttons are present if a loader and/or input hopper gate are optionally present.

Next, set the *Batch scaling* to a value less than the fuel % used during the initial part of the manual roast which was used to create the profile. This value can be changed during the first 90 seconds of the roast, and directly controls the fuel during this time. The purpose of this control is to maintain the correct amount of latent heat in the roasting drum. Ideally, the actual temperature curve (brown) will dip just below the profile temperature curve at the low point, approximately at 90 seconds. This will prevent the PID controller from cutting off the gas until the profile 'catches up' to the actual temperature, which can allow sufficient thermal mass loss from the drum to prevent good profile tracking.

For example, if a manual roast is done with the fuel at 70% initially, set the Batch Scaling at 45%. If the actual curve is too high, which can occur because of changes in mass or humidity (among other things), reduce the value more on the next roast.

Also, be aware that this percentage is not in linear relationship to the bean weight, since the roaster's thermal mass will be dependent on the stable temperature, and smaller batch sizes pull less heat from the drum. **The goal in the first 90 seconds of the roast is to "bottom out" the actual temperature just below the profile curve.** This requires a suitable *Batch Scaling* value, which will likely not be the same as the actual weight / profile weight ratio.

After putting beans in the hopper, open the hopper door fully to empty the beans into the roaster (or pust *Start*). This will initiate an *Automatic* roast cycle. The time will reset and then increment; Temp indicates the current roaster temperature. When the roast cycle is complete, the drum door will automatically open, and the agitator will turn, helping to cool the beans.

Drum Door and *Agitator* are generally not used. Pressing *Drum Door* will terminate the automatic cycle, dumping the contents of the drum into the cooler, and turning on the *Agitator*. Note that *Drum Door* should always be used to stop a roast prematurely, rather than opening the drum door manually.

Note: Changing the size of the roast may affect the ability of the system to track the selected profile. For example, the drum will be hot at the end of a roasting cycle. If a small quantity of beans, such as 3 lbs, is placed into a 7 lb roaster, there is insufficient mass in the beans to cool the drum to the low point of a 7 lb profile. So the roast will be hotter than desired until enough time has elapsed to let the profile "catch up" to the actual bean temperature. If a small roast quantity is desired, then be sure to cool the roaster before starting the cycle. (*Warmup* should be turned off or set to a lower value in this case.)

Ideally, create different profiles for different size roasts, and make sure that the starting temperature is the same for a given profile.

7.0 Safety Instructions

Operators should be familiar with this manual before using the equipment.

This roaster uses gas for heating, and reaches high internal temperatures. Fire extinguishing equipment should always be available in the event of an emergency, whether at the roaster or in the external gas system. Consult with your local fire marshal for recommendations.

Operators must understand how to start and stop the motors using the touch panel, and, in particular, should be aware of the **emergency stop button** on the control panel. This button disconnects the outputs of the PLC.

Never leave the roaster unattended while logged on; empty the chaff before leaving.

Never permit an unqualified individual to operate this roaster. A qualified operator will have read and understood this manual.

Never, under any circumstances, put a hand or any body part into the roasting drum, or any other roaster access port, until the roaster has cooled down, and power has been removed at the electrical source.

Keep clear of all moving parts such as the drum chain at the rear of the roaster and the agitator parts in the cooling bin. **Keep clothing away from these areas.**

Always keep the drum rotating if it is hot, or if the gas is on. This will normally happen automatically, but the *System* screen allows for override. This will prevent warping of the drum.

7.1 Surge suppression

Electrical surges can damage the roaster electronics. Use a good quality surge suppressor on the input power line to protect the system.

If a modem is used, it should also be protected or disconnected while not in use.

If a UPS (battery backup) system is used, be sure that it is capable of delivering the required power for the length of time that is desired in the event of a power loss.

Revisions

08/08/02	dw	Trend ON/OFF description removed from System screen description (now in service screen)
08/09/02	dw	Caution for drum operation Auto mode profile selection Note on buttons (Introduction)
08/13/02	dw	Note on Auto mode System check procedure (Startup)
08/27/02	dw	Change from 10 characters to 20 characters (Note on Profiles)
02/14/03	dw	Several changes to screens
03/04/03	dw	Owner Setup screen change
06/16/03	dw	Loader, destoner options, PID explanation
09/29/03	dw	manual title change, Batch size selection
10/16/03	dw	note on surge suppression
12/02/03	dw	IH, controlled AB options
12/04/03	dw	Simplified Control option
01/15/04	dw	note on batch size, profiling
06/30/04	dw	noted user password
07/20/04	dw	updated for v23 software
07/22/04	dw	added note on 'save as' for profiles
10/13/05	dw	safety emphasis