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1 Controller Operation

1.1 Glossary of Terms

- **Application Software:** The part of the firmware that controls all of the Synergy controller functions and user interface.
- **Backwash:** The process of forcing water back up through a filter in order to clear it of obstructions. Also referred to as a "flush".
- **Bootloader:** The part of the firmware that runs momentarily when the Synergy Controller boots up. It can update the application software and/or start the application software.
- **DCS:** Dry Contact Switch outputs.
- **EoWF:** End-of-window flush. When enabled, a backwash will occur such that it ends at the end of a period window.
- **Firmware:** Software that resides inside the controller and defines how the hardware functions.
- **Flush:** Synonym for backwash; frequently used in the menus.
- **MV:** Master Valve. Only use in certain configurations, the MV must be activated before any of the 16 stations are activated.
- **Period Window:** A configurable time window in which backwashes will occur at a specified period. Period windows only apply to Periodic Flush Timing.
- **Periodic Flush Timing:** A backwash timing option that will initiate a backwash at a configured interval and only during configured Period Windows.
- **Root Directory:** The highest level directory on a given drive. For example, if when plugged in to a computer a USB drive is the F: drive, the root directory would be "F:\".
- **Scheduled Flush Timing:** A backwash timing option that allows the user to configure the time of each backwash individually.
- **Station:** Each of the 16 valve outputs of the Synergy controller are referred to as a station.

1.2 System Connections

Some of the connectors used to make electrical connections between the Synergy Controller and its peripherals are male, and some are female. There is also a variety as far as the number of contacts. These variations are used in an attempt to prevent user error. Plugging one device into a connector it shouldn't be plugged into can sometimes cause damage.

To remove a female receptacle from the board, simply press down on the orange tab on the top of the receptacle and slide it away from the board.

To remove a male connector, slide the small orange piece at the bottom of the connector toward the connector, then slide the entire connector away from the board. If the tab holding

the small orange piece has broken off, insert a removal tool in the same location to bend the lower tab down and unlock the connector.

1.2.1 Power

The Synergy controller can be powered via the AC INPUT or DC INPUT connectors. Either 115V or 230V AC can be connected to the AC INPUT, however the 115V-230V switch must be in the correct position before applying power. The DC INPUT accepts 12V and the position of the 115V-230V switch is irrelevant when using DC power. Polarity is not important for AC power, but must be correct DC power, as indicated by the '-' and '+' symbols. Do not connect both AC and DC power to the controller at the same time.

Supply Source Type	Minimum for Normal Operation	Typical	Absolute Maximum
AC INPUT*	90 VAC	115 VAC	140 VAC
	196 VAC	230 VAC	264 VAC
DC INPUT	11 VDC	12 VDC	14 VDC

*If using AC valves, ensure that the provided output is sufficient to drive them (nominally 24 VAC)

1.2.2 Differential Pressure Sensor

The PRESSURE SENSOR connector expects a connection to a normally open differential pressure (DP) sensor. When active, this sensor will trigger an unscheduled backwash in the event that a high differential pressure is detected. This sensor is optional; the connector can simply be left unpopulated and will not affect the operation of the system.

1.2.3 Dry Contact Switches

The DRY CONTACT SWITCHES connector provides 2 normally open relay connections that can be configured to close upon certain alarm conditions. No power is supplied through these connections; they are simply shorted together through a 10A relay upon activation.

1.2.4 Master Valve

The MV connector is the connection point for the master valve, if required. The polarity markings must be followed for valve types that require it.

1.2.5 Stations

Each station can be configured to be used or not in the menus. If a station is configured to be used, the positive contact of the associated valve (if polarity matters for the specific valve type) should be connected to one of the 8-pin connectors in the position of its station number. The negative contact should be connected to any one of the contacts in the COMMON connector. The COMMON connector can accept multiple connections on each contact for systems with more than 4 stations. Use the supplied wire nuts to gang multiple commons.

1.3 Interface

1.3.1 USB Connector

A USB drive can be used to save the Synergy's operating log, save or load the controller configuration settings, and to update software.

When a USB drive is detected by the controller, the day of the week at the top-center of the display will change and display the text "USB Found". If this text does not appear, the USB device was not detected, or is of the wrong format.

1.3.1.1 Software Updates

If it becomes necessary to update the software running on the Synergy Controller, follow these steps to apply the update when provided with a new firmware file:

- 1) Copy the .s19 file to a USB drive.
- 2) Plug the USB drive into the controller and apply power or reset the device if it is already running.
- 3) The controller will enter bootloader mode. The bootloader will check the USB drive for an .s19 file. When it finds the file, it will make sure the contained image is valid then begin flash loading the image into memory. This process can take several minutes.
- 4) Upon successfully flashing the image to memory, the bootloader will automatically launch the new software, at which point the normal startup routine will take place. Do not remove the USB drive until the backlight of the LCD display turns on.

Updating the software does not erase the previous configuration settings. All settings will remain, although new configuration fields may be created with new software. Default values will be used until a user explicitly modifies them.

1.3.2 LCD Display

The LCD Display shows the time, menu title, and menu information on each screen. It has a backlight that turns off after 3 minutes of inactivity. All buttons except the DISPLAY button are ignored when the LCD backlight is off.

1.3.3 DISPLAY Button

The DISPLAY button turns on the LCD backlight when it is off. It has no other function.

1.3.4 SELECT or MODIFY Button

The rotary button at the center of the controller can be turned in either direction to navigate through menus or adjust values within a menu, or it can be pushed to make a selection or perform an action.

1.3.5 START Button

The START button can be pushed to initiate a manual backwash at the first configured step of the backwash sequence. If the START button is held down and the MODIFY dial is turned, the

user can start the backwash at a configured station of their choice. Releasing the START button starts the backwash. This operation works whether the system is enabled or not.

Pushing the START button while a backwash is active will skip to the next configured station.

1.3.6 STOP Button

The STOP button can be pushed to stop any active backwash, whether it was scheduled, started manually, or triggered via the DP.

1.3.7 Home Button

Pushing the Home button will navigate back to the Status menu. If this button is held for ~6 seconds, the controller will reboot.

1.4 Menu System

The menu system can be easily navigated using the SELECT or MODIFY dial in the center of the front panel. When “<” and “>” appear on either side of a value, this indicates the value can be modified. If this value happens to be the menu title, the user can navigate through menus. If the value appears within the menu, the user can adjust the value and make a selection by pressing SELECT.

1.4.1 Main Menus

Each of the main menus appear at the same level as the Status menu, which is the first menu displayed upon system boot, and the menu displayed when the Home button is pushed.

1.4.1.1 Status Menu

The status menu has several possible menus that can be displayed, depending on the state of the system. The table below describes the conditions for each menu.

Menu Conditions	Menu Description	Menu Image
System is disabled, no backwash active, no errors active	Simply stating that the system is off	
System enabled or disabled, backwash active, no errors active	Description of the current state and the associated station (flushing, delay, MV offset) and how much time is left in that state	
System enabled, no backwash active, no errors active	The backwash count since the count was reset, or since the controller power was cycled along with the time of the last backwash. January 1, 12:00 will appear when the count is 0	
System enabled or disabled, backwash active or inactive, errors active	Displays the number of active error codes	

When errors are active the user can press SELECT, which will display the error sub-menu. This menu allows the user to scroll through and view descriptions for each error code.



Pressing SELECT again while viewing any error code will clear all errors and generate an entry in the log.



1.4.1.2 Manual Menu

The manual menu is an alternative to the START and STOP buttons. It can be used to manually start and stop a backwash.

If a backwash is currently active, the menu will display which station is being backwashed or which station will be backwashed next if there is a delay between stations.



The user may press SELECT to stop the backwash, which will display a menu explaining that it is being stopped.



If a backwash is not currently active, the user may press SELECT to start one.



The next menu in the sequence allows the user to choose which station to start the backwash at.



Once SELECT is pressed again, the backwash is started as depicted in this menu.



1.4.1.3 Duration Menu

This menu shows the currently configured setting for the duration of a backwash at each station.



If SELECT is pressed, the user may change the setting.

Pressing SELECT again updates the system to the new setting.



1.4.1.4 Delay Menu

The delay is the amount of time to wait between the end of a backwash at one station and the beginning of a backwash at the next station. The configured delay does not affect the amount of time between when a station is active/inactive and when the MV is active/inactive.

Pressing SELECT allows the user to update the current setting.

Pressing SELECT again updates the system to the new setting.



1.4.1.5 Count Menu

The count is the number of backwashes that have run since the count was last reset, or since the power was cycled on the controller. The counter rolls over at 9999.

Pressing SELECT will reset the count.



1.4.1.6 Period Menu

This menu is only visible if periodic flush timing is selected. The period defines how often a backwash will occur within a configured period window.

Pressing SELECT allows the user to change the configured setting.

Pressing SELECT again updates the system to operate with the new setting.



1.4.1.7 Period Windows Menu

This menu is only visible if periodic flush timing is selected. The number of period windows defines how many spans of time exist on a daily basis in which periodic backwashes can occur.

By pressing SELECT, the user can change the number of windows.

Pressing SELECT again causes the system to use the new setting.



1.4.1.8 Window Times Menu

This menu is only visible if periodic flush timing is selected. This menu allows a user to change the configured times in which periodic timing is valid.



Pressing SELECT allows the user to choose which window to edit, or to exit to the previous menu.

Pressing SELECT again begins the process of changing the period window's start hour, start minutes, end hour, and end minutes. The user may adjust the value of each, pressing SELECT to advance to each new menu. Setting values of 0 for each entry will cause the window to be ignored. Setting a time of 00:00-23:59 indicates that the window is valid all day, and that an end-of-window flush should not be executed at 23:59 if backwashing is enabled on the following day. Overlapping windows will cause an error code to be activated. If a window end time is later than its start time, the window will begin during an enabled day and will end on the next day, whether that day is enabled or not. The window will only start on an enabled day. Pressing the Home button at any time in these 4 menus will discard any changes made.

Pressing SELECT from the end minutes menu will set the configured time.



1.4.1.9 End of Window Flush Menu

This menu is only visible if periodic flush timing is selected. This menu shows if the EoWF is enabled or disabled. When enabled, a backwash will occur near the end of a period window such that the backwash finishes at the end of the period window.

Pressing SELECT toggles the setting which takes effect immediately.



1.4.1.10 Daily Flushes Menu

This menu is only visible if scheduled flush timing is selected. This menu displays how many scheduled backwashes occur on any given day that is enabled.

Pressing SELECT allows the user to change the number of backwashes on each day. Decreasing the number deletes the last one(s) in the list. Increasing the number will create new entries at 00:00, unless those entries were previously calibrated in which case the old time will persist.

Pressing SELECT again updates the system to the new value.



1.4.1.11 Flush Times Menu

This menu is only visible if scheduled flush timing is selected. This menu allows the user to change the times that scheduled backwashes start at.



Pressing SELECT brings the user to a menu where they may choose which scheduled backwash they would like to edit, or exit to the previous menu.



Pressing SELECT again begins the process of changing the hour and minutes for the associated backwash. Pressing the Home button at any time in these 2 menus will discard any changes made.



Pressing SELECT updates the system to the new time.

1.4.1.12 Flush Days Menu

This menu shows which days are enabled for either periodic or scheduled flush timing. For scheduled flush timing, no backwashes will occur on days that are disabled. For periodic flush timing, backwashes will only occur on a disabled day if a window extends past midnight of an enabled day.



Pressing SELECT brings the user to a set of 2 sub-menus. The first allows the user to enable all days, which takes effect immediately and returns the user to the upper Flush Days Menu. The second sub-menu allows the user to enable custom days.



Pressing SELECT on the custom days menu brings up a menu which allows the user to scroll through the days of the week, displaying if that day is enabled or not.



Pressing SELECT again toggles the selected day and returns the user to the day of the week selection menu.



1.4.1.13 System Menu

Pressing SELECT on this menu brings the user to the second set of menus used to further configure and maintain the Synergy Controller.

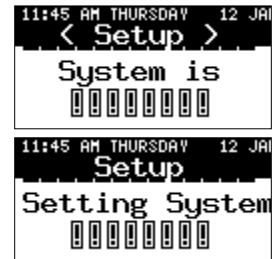


1.4.2 System Configuration Menus

1.4.2.1 System Enable Menu

This menu displays whether the system is enabled or disabled. No backwashes will run while the system is disabled unless a manual backwash is initiated.

Pressing the SELECT button will toggle the state of the system. If the system is enabled, periodic flush timing is selected, and the current time is within a configured period window, periodic timing will begin.

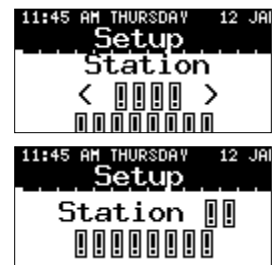


1.4.2.2 Active Stations Menu

This menu shows which stations are currently configured to be included as part of the backwash sequence. If a station is enabled, the station number will appear in the menu; otherwise a hyphen will appear in its place. If there is an error associated with the station, an "E" will appear in its place and the station will be disabled. To re-enable the station, clear the error from the status menu (Section 1.4.1.1) then enable the station in this menu.

Pressing SELECT allows the user to scroll through individual menus which display if the station is enabled or disabled. The user can also exit to the previous menu.

Pressing SELECT again toggles the state of the displayed station.



1.4.2.3 Differential Pressure Sensor Delay Menu

The DP Delay menu displays the amount of time the sensor must be active for before triggering a backwash.

Pressing SELECT allows the user to choose a new delay.

Pressing SELECT again updates the system to use the new setting.



1.4.2.4 Flush Timing Menu

This menu displays whether Periodic or Scheduled flush timing is currently selected. The configured setting here affects which menus are visible in the main menus regarding how backwashes are configured.

Pressing SELECT allows the user to choose a new setting.

Pressing SELECT again updates the system to use the new setting.



1.4.2.5 Master Valve Offset Menu

This menu displays the amount of time between when the MV is activated and when the first station is activated. The same amount of time applies between when the last station is shut off and when the MV is shut off. If 'Disabled' is selected, the MV is not used during backwashes.



Pressing SELECT allows the user to choose a new setting.

Pressing SELECT again updates the system to use the new setting.



1.4.2.6 Valve Configuration Menu

This menu displays the type of power supply that is used to control the station valves during a backwash. Continuous solenoid valves can be of mixed voltage (12VDC & 24VAC). The table below shows the valve types that are supported and the conditions under which they can be used.



Pressing SELECT allows the user to choose a new valve type.

Pressing SELECT again allows the user to choose a new power supply. Please note that this setting only affect how the valves are supplied, not how the controller is supplied.



Pressing SELECT once more updates the system to the new settings.

Valve Type	Valve Supply	Controller Supply Compatibility	
		DC	AC
Continuous	12 VDC	X	X
Continuous	24 VAC		X
Latching	12 VDC	X	

1.4.2.7 Dry Contact Switch Alarm Outputs Menu

This menu displays if the left and right DCS outputs are enabled or disabled. When enabled, the DCS normally open outputs will close in the event that a configured error occurs. The menu to configure these errors is described in Section 1.4.2.8.



Pressing SELECT allows the user to change the setting for the left DCS output.



Pressing SELECT again allows the user to change the setting for the right DCS output.

Pressing SELECT once more updates the system to the new settings.



1.4.2.8 Error Outputs Menu

This menu displays which errors will trigger enabled DCS outputs. If an error is enabled in this menu and a DCS outputs is enabled (Section 1.4.2.7), then that DCS will become active when the enabled error becomes active.

Pressing SELECT allows the user to choose the settings for the displayed errors.

Pressing SELECT again updates the system to use the new settings.



1.4.2.9 Save Log to USB Menu

This menu begins a sequence which allows the user to save the operational log from the Synergy Controller to a USB device.

Pressing SELECT will display a menu that allows the user to choose how much history to dump to the log file. If no USB device is detected, the user will be notified and returned to the previous menu.

Pressing SELECT again will cause the controller to begin writing the log file. This may take several minutes depending on how much history is contained in the selected time frame.



1.4.2.10 Load Synergy Configuration Menu

This menu allows the user to load a saved configuration from a USB device. This operation does not require the configuration to be saved to memory, as it is done automatically upon a successful load.

Press SELECT to choose which file to load a configuration from.

Pressing SELECT again begins loading the configuration from the selected file.



1.4.2.11 Save Synergy Configuration Menu

This menu allows the user to save the controller's configuration either to local memory or to a USB device. Any time a change is made in any menu other than setting the time, the configuration must be saved to local



memory. Otherwise the changes will be undone if power is lost or the controller is reset.

Press SELECT to choose where to save the configuration.

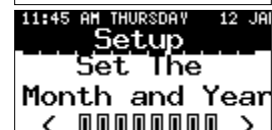
Press SELECT again to begin the save operation.



1.4.2.12 Set Time Menu

This menu allows the user to set the Synergy clock. The clock will continue to run for at least 3 days without power being applied to the board. If power is lost for longer than 3 days, the clock should be checked. If the controller detects that the time is invalid, it will change the time to when the current software revision was compiled and set an error.

Press SELECT to begin the sequence of changing the time. The hours, minutes, day, and month/year are each set in their own menus. Changes in these menus take effect as soon as the SELECT button is pressed to advance to the next menu. Pressing the Home button will not undo any changes already made.



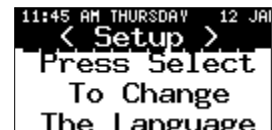
Pressing SELECT on the month and year menu will set the month and year, displaying this menu momentarily before returning to the upper time menu.



1.4.2.13 Language Menu

This menu allows the user to change the system language.

Pressing SELECT allows the user to scroll between the available languages.



Pressing SELECT again will cause all menus to be displayed in the new language.



1.4.2.14 Device Information Menu

This menu displays various properties of the Synergy Controller.

Press SELECT to be presented with a series of menus. Each menu displays the name of the property it represents as well as the value for that property. Pressing SELECT on any of these menu returns the user to the upper device info menu.



1.4.3 Error Codes

During operation, the Synergy Controller looks for certain error conditions. If these conditions are ever met, an error code is activated. The table below describes the causes and effects of each of these error codes.

Error Code	Possible Causes	Controller Actions Upon Activation
Fuse (0)	-A valve malfunctioned and pulled too much current from the controller -A relay malfunctioned and created a short to ground -The DP was mistakenly connected to the MV connector	-If a station valve/relay caused the fuse, that station will be disabled and the backwash will continue -If the MV caused the fuse, set the MV error -Set the Flush Failed error
Flush Failed (1)	-Fuse, Relay On/Off, Valve On/Off	-None
Time (2)	-The system time is set to a time earlier than when the current software version was compiled	-Set the system time to the same time as when the current software version was compiled
DP Switch (3)	-The differential pressure switch remained active during 3 consecutive flushes in an attempt to reset the DP switch	-None
Relay On (4)	-A relay on the controller did not turn on when it was expected to	-None
Relay Off (5)	-A relay on the controller did not turn off when it was expected to	-None
Valve On (6)	-A station valve or the master valve did not turn on when it was expected to	-If the MV caused the error, set the MV error
Valve Off (7)	-A station valve or the master valve did not turn off when it was expected to	-If the MV caused the error, set the MV error
MV (8)	-Fuse, Relay On/Off, or Valve On/Off related to the master valve	-Disable the system, stop active backwash
Log Fault (9)	-Inability to communicate with the log memory	-None
Window Overlap (10)	-Two or more period windows are overlapping	-None