

This instruction covers the use of the bench-top WS-650 Spin Coater system located in the cleanroom.

The Laurell WS-650-23 B spin coater is compact and packed with advanced features. This 650-series coater system will accommodate up to 150mm wafers and 5" x 5" (127mm x 127mm) substrates, and down to small pieces. It features a maximum rotational speed of 12,000 RPM (based on a 100mm silicon wafer).

These spinners are for [approved](#) acetone soluble resists only. Please contact jcwirth@purdue.edu with questions or new material requests.



Laurell WS-650-23 B System

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1. SAFETY REQUIREMENTS

- 1.1 Personal Protective Equipment must be worn when using the solvent hoods the spinner is located in. These include chemical safety goggles (which fully enclose the eyes) and latex solvent gloves.
- 1.2 Information regarding the hazardous materials used in the cleanroom can be found through MSDS documentation located in the gowning room.
- 1.3 Please contact the Process & Equipment Engineer for any maintenance, repairs, or problems of the WS-650 Spinner system.

2. EQUIPMENT

- 2.1 WS-650 Spinner
 - 2.1.1 Wafer Alignment Tool
 - 2.1.2 1/8" Allen Wrench

- 2.1.3 Photoresist (PR)
- 2.1.4 Substrate Wafer

3. FACILITY REQUIREMENTS

- 3.1 WS-650 Spinner
 - 3.1.1 Electrical: 110VAC / 3amp
 - 3.1.2 House Supplied Vacuum
 - 3.1.3 House Supplied Utility Nitrogen: 4.1-4.8 bar

4. CYCLE OF OPERATIONS – WS-650 Spinner

This procedure details how to operate the WS-650 Spinner system. Users must find the best parameters for their processes, starting points for common resists may be found on the [BNCWiki Photoresists page](#).

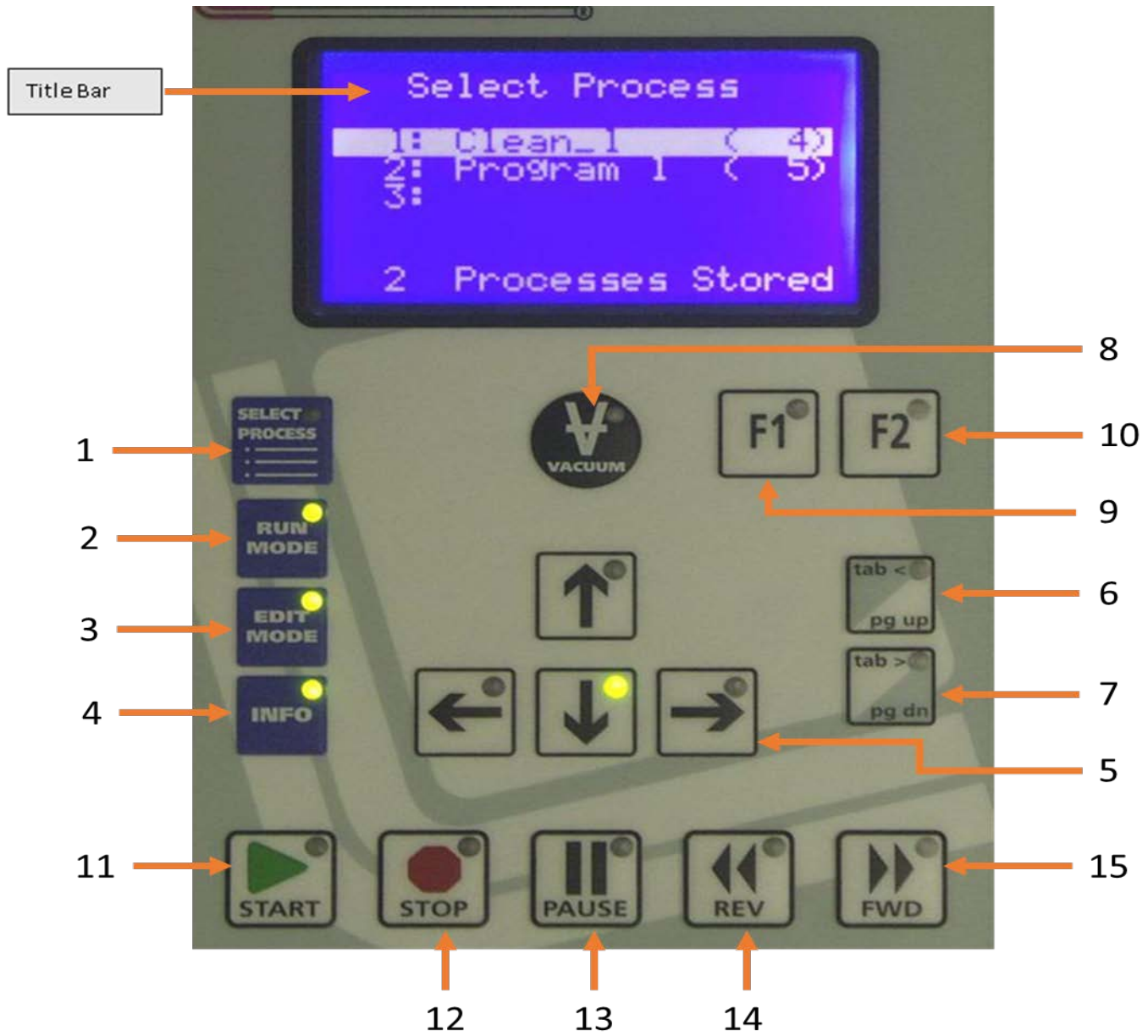
- 4.1 Enable the WS-650 Spinner in iLab.
- 4.2 Turn on the spin processor.
- 4.3 Locate the appropriate chuck for the sample. The sample should completely cover any vacuum lines on the chuck.
- 4.4 Mount the chuck on the spinner
 - 4.4.1 Do not force the chuck into position, or hit it with anything to seat it. Immediately stop and contact BNC staff for assistance.
- 4.5 Place and align a substrate onto the chuck. Press the “VACUUM” key to activate the vacuum valve.
- 4.6 Close lid and ensure the lid lock is secure.
- 4.7 Press “SELECT PROCESS” to view stored programs.
- 4.8 Highlight the desired program using the arrow keys.
- 4.9 Press the “EDIT MODE” button to create a new program or modify an existing one.
- 4.10 Use the navigation keys to move from line-to-line or the “tab<” or “tab>” key to move to field-to-field.
 - 4.10.1 The Tab key enables the field to be editable. Make changes to the field by using the ↑/↓ arrow keys.
- 4.11 Add or delete steps by highlighting the “Step” field with the “tab” key and increase or decrease the number.
- 4.12 Move from step-to-step by using the “FWD” or “REV” key. See section 5. PROGRAMMING THE 650 CONTROLLER for more information on creating/editing a spin program.
- 4.13 Press the “RUN MODE” key to run the program.
- 4.14 Dispense photoresist manually onto wafer.

- 4.15 Press the "START" key to start the program.
- 4.16 "Done" will be displayed when the process is completed and the lid has not yet been opened for wafer removal.
 - 4.16.1 Restarting the same sequence on the same wafer is not allowed until the lid is opened or the "EDIT MODE" key is pressed then the "RUN MODE" key.
- 4.17 Clean up.
 - 4.17.1 After you are done with all your wafers, load the "Cleaning" dummy wafer onto the chuck and turn on the vacuum.
 - 4.17.2 Spray acetone onto the wafer from a squirt bottle.
 - 4.17.3 Clean Program:
 - Step 1: Time 10 sec, Speed 1000 rpm
 - Step 2: Time 10 sec, Speed 3000 rpm
 - Step 3: Time 10 sec, Speed 5000 rpm
 - 4.17.4 Run the "clean" program and keep spraying acetone onto the wafer through the hole in the lid while the program runs. This should spray acetone all over the inside and clean out the resist residue.
 - 4.17.5 If any resist remains, do it again. If after a 2nd rinse, use a cleanroom wipe wetted with acetone to remove any remaining resist residue.
 - 4.17.6 After it is all cleaned, do the same thing with isopropanol.
 - 4.17.7 Wait for any solvent to drain into the waste reservoir, then remove it and dump it into the appropriate solvent waste container. Rinse out the waste cup with acetone and isopropanol and dump it into the appropriate solvent waste container.
- 4.18 Leave the lid fully open to allow any residual solvents to evaporate.
- 4.19 Disable the tool in iLab.

5. PROGRAMMING THE 650 CONTROLLER

5.1 KEYPAD

All operator actions are initiated through the membrane switch keypad.



NEVER flood or spray solvent such as acetone or any other type of cleaner directly onto the keypad surface. Doing so may cause keypad failure. Always wet a wipe or cloth with the solvent and gently wipe the keypad surface.

5.1.1 OPERATIONAL KEYS

1 – SELECT PROCESS MODE – press this key to list all process programs stored within the 650 controller. This key is active when the green LED is illuminated. When the “select process” mode is selected a number of keys become active as indicated by illuminated green LEDs. These illuminated keys can be used to navigate the keyboard and display. Using the select process mode key the user can select the “RUN MODE” (2), “EDIT MODE” (3) or “INFO” (4). The “Up arrow (↑)” and “Down arrow (↓)” keys (5) can be used to move from line-to-line.

Each line displays the ten-character program name followed by how many steps the program has, in parentheses. See keypad figure.

Twenty (20), 51 step programs can be stored in the 650 controller. Many more can be stored in Spin 3000. The last line of the display shows the total number of resident programs within the 650 controller.

2 – RUN MODE – press this key to enter a selected program from the “Select Process” screen into the “RUN MODE”. This key is active when the green LED is illuminated. The start key (**11**) is active; pressing this key will begin processing. When the “RUN MODE” is selected a number of keys become active as indicated by illuminated green LEDs. From the “RUN MODE” the user can enter the “Select Process Mode”, Edit Mode” or “INFO”. The “Up Arrow (↑)” and “Down Arrow (↓)” keys can be used to move between “Valv”, “Sens” and “Type” line. The F1 key (**9**) becomes active when the “Valv” or “Sens” line is highlighted. The F1 key will send the user to the valve or sensor submenu. Vacuum (**8**) can be turned on or off.

Displayed fields are the operation mode/program name, step-of-steps, vacuum status, set point time, agitation rate, actual wafer RPM, set point RPM and spin rotation direction, valve, sensor and type status for each step of a program. The last line of the display will show the processor status and error messages.

3 – EDIT MODE – press this key to create a new program or to select an existing program for modification. This key is active when the green LED is illuminated. Figure 3-8 shows the “EDIT” mode screen. From the “EDIT MODE” the user can enter the “Select Process Mode”, Run Mode” or “INFO”. The “Up Arrow (↑)” and “Down Arrow (↓)” keys can be used to move from line-to-line. The “Tab <” (**6**) or “Tab >” (**7**) keys can be used to switch the highlighted field into an “*editable*” field. The “FWD” (**15**) or “REV” (**14**) keys are used to move from step-to step with in a program. Vacuum can be turned on or off.

Editable fields are: the step number, number of steps, step duration, spin speed, acceleration, motor direction, vacuum requirement, agitation rate, valves’ state, and sensors’ state. Each field is highlighted when it is selected. Use the “Up Arrow (↑)” and “Down Arrow (↓)” navigational keys to move from line to line. The “tab<” and the “tab>” key when pressed enables the highlighted field to be *editable*. When a “tab<” or “tab>” key is pressed the highlighted field will blink, this is an indicator that the field is now changeable. When a “tab<” or “tab>” key is pressed the blinking cursor will move from field to field within a program. The “Up Arrow (↑)” and “Down Arrow (↓)” keys will change the value or state of an *editable* field. The ←(Left) & →(Right) keys are used to move within fields with many digits such as speed. When the valve or sensor field is highlighted the F1 key becomes active to allow access to their respective submenus.

4 – INFO – press this key to view “Statistical”, “Configuration” and “About” information. This key is active when the green LED is illuminated. Highlight the desired field and press the F1 key to enter each submenu. From the info mode the user can enter the “Select Process Mode”, Run Mode” or “EDIT MODE”. The “Up Arrow (↑)” and “Down Arrow (↓)” keys can be used to move from line-to-line. The F1 key when pressed shows the information associated with each line.

These menus are for informational purposes only. All system configurations are done through Spin 3000.

5 – NAVIGATION KEYS - ←(Left) & →(Right) and ↑(Up) & ↓(Down) – these directional keys have multiple functions within each menu. The “Up Arrow (↑)” and “Down Arrow (↓)” keys can be used to scroll up or down a list of items such as the program list in the “Select Process” menu. They can be used in the “RUN” or “EDIT” mode to move from line to line within a menu. The ↑(Up) & ↓(Down) keys are used to change values when editing a field within a program. The ←(Left) & →(Right) keys are used to scroll left or right when there is additional information off to the left or right of the display. They are used in the edit mode to move within a field. These keys are active when the green LED is illuminated.

6 – TAB< / PG UP – this is a dual function key. The “tab<” key is used to move from field to field in the “EDIT MODE”. When pressed this key changes a highlighted field to an *editable* blinking field. The “Pg Up” key is used to scroll up a list of items when there are 4 lines or more of information. This key is active when the green LED is illuminated.

7 – TAB> / PG DN – this is a dual function key. The “tab>” key is used to move from field to field in the “EDIT MODE”. When pressed this key changes a highlighted field to an *editable* blinking field. The “Pg Dn” key is used to scroll down a list of items when there are 4 lines or more of information. This key is active when the green LED is illuminated.

8 - VACUUM - this key toggles the vacuum valve on and off. This key is interlocked such that the vacuum cannot be turned off while a program is running or the chuck is in motion. The value is displayed in inches of Hg when the vacuum valve is turned on. The normal requirement to operate safely is ≥ 15 ” of Hg. The vacuum requirement of “vacuum required” or “vacuum not required” is programmable within a program. This key is active when the green LED is illuminated.

9 - F1 - this key is used to enter a submenu when available. Submenus can be accessed in the “RUN” and “EDIT MODE” when the valve or sensor line is highlighted. This key is active when the green LED is illuminated.

10 – F2 - this key is used to exit the submenu. When in a submenu pressing the F2 key will exit the user back to the “RUN”, “EDIT” or “INFO” mode. This key is active when the green LED is illuminated.

11 - START - this key is used to initiate a programmed sequence. While a program is running the mode display will indicate “**RUNNING**”. “**DONE**” indicate that a program has run and will persist until the lid is opened or another program selection is made. This key is disabled until the vacuum, seal purge, exhaust and lid interlocks are satisfied. This key is active when the green LED is illuminated.

12 - STOP – this key will “Stop” the current program from completing the process program. When running a program in “RUN” or “EDIT” mode, the stop key will, when pressed, stop the process from completing the step, the motor will stop spinning and any active valves will close. The step and time is retained and if start is pressed again, the processing will resume where the process stopped. This key is active when the green LED is illuminated.

13 - PAUSE – this key will “Pause” the current program from completing the process program. When running a program in the run mode, the “pause” key will, when pressed, pause the process program time from proceeding. The motor will continue to spin and any active valve will remain on but the remaining time is ignored. The step and time is retained and if “pause” is pressed again, the processing will resume. This key is active when the green LED is illuminated.

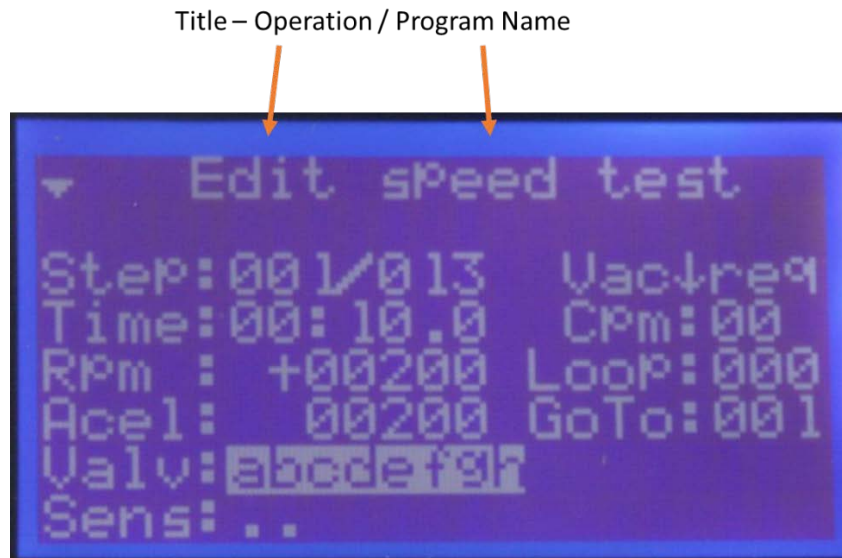
14 - REV – Reverse back to the previous step in a program. This key is active in the “EDIT MODE” to help while programming. Each time the key is pressed the user will go back to the previous step within a program. This function allows the wrapping of the first step to the last within a program. This function in the “RUN MODE” is disabled at the factory. This key is active when the green LED is illuminated.

15 - FWD – Advance forward to the next step in a program. This key is active in the “EDIT MODE” to help while programming. Each time the key is pressed the user will go to the next step within a program. This function allows the wrapping of the last step to the first within a program. This function in the run mode is disabled at the factory. This key is active when the green LED is illuminated.

5.2 “EDIT MODE” SCREENS

Press the “EDIT MODE” key to enter a selected program into the “EDIT MODE”. The screen shot below shows the Edit screen.

Displayed fields are the operation mode/program name, step-of-steps, vacuum status, time, agitation rate, spin rotation direction and wafer rpm, acceleration rate, valve, and sensor status and off screen the sensor type line.



5.2.1 EDIT MODE – DISPLAYED FIELDS – see figure above

- **Title** – Operation Mode / Program Name – shows the operational mode that the user is in and the program name
- **Step** – shows steps-of-steps; the 1st field is the current step and the 2nd field is the total number of steps in the program. When editing a program the “FWD” or “REV” keys, can move from step-to-step, by pressing the “FWD” or “REV” keys. This feature in the “EDIT MODE” is always enabled.
- **Vac** – this field sets the vacuum requirement i.e. if vacuum is required or not required for a program. If vacuum is required the field will show “req”; if vacuum is not required the field will show “non”. This setting is a global setting for the entire program. The ↑ shows that the vacuum key was pressed and the ↓ shows that the vacuum key was not pressed. If a program requires vacuum the process will not run until vacuum is present and in the correct amount. The amount of vacuum present is displayed next to the arrow. The factory set point is 15” of Hg.
- **Time** - Following the “Time” label are the step duration fields which are in the form of mm:ss.t where mm is minutes, ss is seconds, and t is tenths of seconds. A step must have at least one second duration. The minimum time possible is 1 second. When running the time will count down to 00:00.00 before moving to the next step.
- **Cpm (650H/HPD2 motor only)** – Not used on the BRK spinners.

- **Loop** – Enter the number of loops to be performed. The “GoTo” line specifies where in the program to loop back to, to begin another loop cycle.
- **Rpm** - Following the “Rpm” label is the desired target speed in revolutions per minute. The field shows the set point value. (HPD2 only - Negative speeds may be entered which causes the motor to rotate in the opposite direction).
- **Acel – (650M - Standard Motor Drive Only)** - Following the “Acel” label is the motor acceleration rate in rpm/second. For the standard motor drive the maximum acceleration rate is very dependent on the mass of the chuck and substrate. A proper acceleration value will prevent spin speed overshoot when spinning a substrate.
Calculate the acceleration rate value by taking the spin speed difference between steps and using that difference for the acceleration rate for the current step. For example:

Step	Time	RPM	Acel
1	5.0	500	500
2	5.0	1500	1000

The speed difference between step 1 and 2 is 1000rpm. Use this difference as the acceleration rate in step 2. Continue this calculation throughout the program. This calculation is a guide for finding the proper maximum acceleration rate.
- **Valv** - Following the “Valv” label is a field indicating desired valve condition. A lower case letter, “a” for example, indicates the valve is off. From left-to-right the valves are labeled “a, b, c...” up to 16 possible valves. If a valve is enabled an upper case letter, “A” for example, appears. This field has a sub-menu where the valve names are displayed and whether or not they are mutually exclusive. A dash “-” indicates the valve is off and is mutually exclusive (MXL) with some subset of the valves (also indicated by “-” if off). Valves that are mutually exclusive to each other means that only one valve of a MXL group can be turned on. If another valve in that group is activated, the previous valve will automatically turn off. This is a safety feature to prevent incompatible chemicals from dispensing at the same time. The MXL feature can only be assign in Spin 3000. Pressing the “F1” key enters the valve sub-menu. Use the navigation or the “pg up” or “pg dn” keys to scroll through the list of valves and sensors. If valves are designated as MXL, the submenu will show “MXL” beside the associated valves. Press the F2 key to exit a submenu. **(Note: in the Run mode only upper case letters or dot “.” will appear.)**
- **Sens** - Following the “Sens” label is a field indicating enabled sensors. A dot “.” Indicates the sensor is inactive. From left-to-right the sensors are labeled “A, B, C...” up to 16 possible Sensors. If enabled, a letter appears. This field has a sub-menu where the sensor names are displayed and what will happen if they are triggered. Pressing the “F1” key enters the sub-menu. Use the navigation or the “pg up” or “pg dn” keys to scroll through the list of valves and sensors. Press the F2 key to exit a submenu.
- **Type** – Following the “Type” label is a field indicating sensors action. This line is directly linked to the “Sens” line. Different sensor actions states can be assigned to the operation of a sensor. For example, a sensor may be assigned to “abort the process” if a certain condition is sensed. The “Type” field will show, in abbreviated form, the action assign to the sensor. Below is the list of possible sensor actions and its’ abbreviation.
 - “Abort” = A
 - “Next Step” = N
 - “Start” = S
 - “Warning” = W

5.3 “EDIT MODE” – OPERATION

As can be seen in the figure below, the 650 controller is in the “EDIT MODE”. The title shows “EDIT” as the operation mode. The “Start” key is active. Pressing the “Start” key will initiate running of program “speed test”. A program will run in the “EDIT MODE” but the time is ignored. The processor will run indefinitely until the “stop” key is pressed. To move from step-to-step within a program while running, press the “FWD” or the “REV” key. All fields are changeable while running.

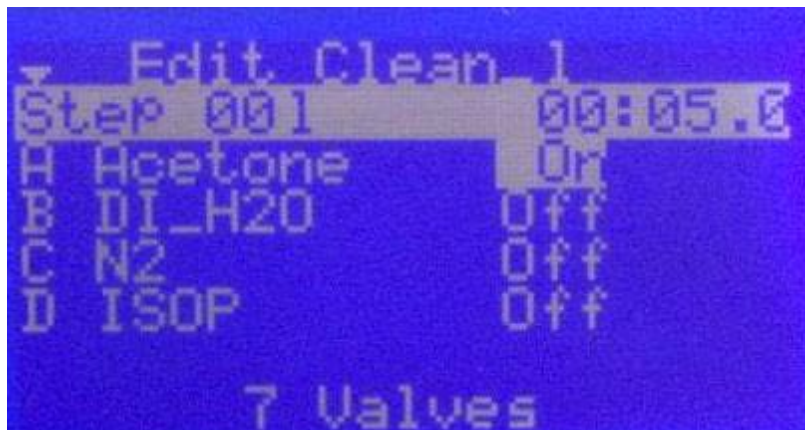


Each field is highlighted when it is selected. The figure above shows the “Valv” field highlighted. Use the “Up Arrow (↑)” and “Down Arrow (↓)” navigational keys to move from line to line. The “tab<” and the “tab>” key when pressed enables the highlighted field to be editable. When a “tab<” or “tab>” key is pressed the highlighted field will blink, this is an indicator that the field is now changeable. When a “tab<” or “tab>” key is pressed the blinking cursor will move from field to field within a program. The “Up Arrow (↑)” and “Down Arrow (↓)” keys will change the value or state of an *editable* field. The ←(Left) & →(Right) keys are used to move within a field with many digits such as speed and acceleration. When the valve or sensor field is highlighted the F1 key is becomes active to allow access to their respective submenus.

The screen shot below shows the “Valv” field highlighted. Valve A and B of step 1 are activated within the program. There are 8 possible valves. All the other valves are off in step 1 as indicated by “lower case” letters. When the F1 key is pressed the user will enter the valve submenu. See figure 3-18.



When the F1 key is pressed the user will enter the valve submenu. It shows 4 of the 7 possible valves. The last 3 valves are on the next page as indicated by the “off screen line indicator” in the upper left hand corner of the display. Valve A, “Acetone” is set to “ON”.



5.4 – PROGRAMMING THE 650 CONTROLLER

1. Turn on the spin processor. The 650 will initialize and default to the “Select Process” screen.
2. If editing an existing program, highlight the desired program. If creating a new program, highlight the empty line. Press the “EDIT MODE” key. If this is a new program a program name will be assigned. The program name will appear on the title line.
3. Use the navigation keys to move from line-to-line or the “tab<” or “tab>” key to move to field-to-field. The “Tab” key enables the field to be editable. Make changes to the field by using the ↑(UP) or ↓(DOWN) arrow keys.
4. Add or delete steps by highlighting the “steps” field with the “Tab” key and increase or decrease the number.
5. Move from step-to-step by using the “FWD” or “REV” key.
6. To change valve condition highlight the valve field, press the F1 key and edit the submenu using the “Tab” keys and the ↑(UP) or ↓(DOWN) arrow keys. Exit the submenu by pressing the F2 key. Valve configuration is done at the factory at time of order.
7. To change sensor action highlight the sensor field, press the F1 key and edit the submenu using the “Tab” keys and the ↑(UP) or ↓(DOWN) arrow keys.

Exit the submenu by pressing the F2 key. Sensor configuration is done at the factory at time of order.
 8. When finished press the "RUN MODE" key to run the program.

- ◇ **Example of a coat program.** This is for example only; the user must find the best parameters for their process.

PROGRAMMING EXAMPLE

Program: Coat_1

Valve Identification

Step	Time		Speed 0-6000	Valves X = ON								Accel	Comment
	99 Min	59.9 Sec		A	B	C	D	E	F	G	H		
1		5	500									500	This step is to get the chuck rotating at step 2 spin speed.
2		1.5	500	X								500	Spin speed same as step 1. Dispense for 1.5 sec.
3		1.5	2000									1500	Spin off excess material
4	1	30	4000									2000	Dry film
5													

REVISION RECORD

Reason for Revision	Date of Revision	Person Responsible
Initial Release.	December 8, 2017	William Arnett
Added programming section	June 7, 2019	Matthew Hayes