Pergo System
OPERATION MANUAL

DATE: 2020.08

The contents of this manual are subject to change without prior notice due to improvements in the instruments' performance and functions. Display contents illustrated in this manual may vary slightly from current software version.

In no event shall JYF be liable for incidental or consequential damages arising from use of this document or the software and hardware described in this document.

Every effort has been made in the preparation of this manual to ensure the accuracy of the contents. However, should you have any questions or find any errors, please contact your sales representative.

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FIGURES

FUNDAMENTAL SAFETY WARNINGS

- **Caution:** High Voltage in the control cabinet.
- **Do not** start machine without properly maintaining and calibrating machine.
- **Never** operate the machine if it has a damaged gear or tool.
- **Always** turn off machine power by shutting off the power switch (disconnect) and unplugging the machine from the power outlet.
- **Do not** let anyone into the safety cover while machine is operating.
- **Do not** touch any transmission device after machine starts up.
- **Do not** operate and dismantle machine without professional training.
- **Do not** touch fan or pneumatic devices while machine is running.
- **Never** drop or insert foreign objects into any machine openings.
- **Do not** remove protective cover while operating.
- **Avoid** operating machine with long hanging material or loose hair.

IMPORTANT SAFETY WARNINGS

- Always unplug the equipment from an electrical outlet when not in use. Never use the cord to pull the plug from the outlet. Grasp plug and pull to disconnect.
- Before powering up, confirm whether power voltage and amperage are corresponding to tagged specifications.
- The machine should always be properly grounded before normal operations.

1. INTRODUCTION

Thank you for choosing this universal compression spring coiler. We hope you enjoy and gain more productivity with this new machine. This machine is equipped with our Pergo control system. Take a few minutes to read this Operation Manual. This will avoid all safety hazards and damages to the machine.

i. This machine is designed specifically for compression springs. It allows the user to translate the characteristics of the compression spring into a systematic program that can be easily duplicated.
ii. Compression Springs can be fully characterized by their Outer Diameter, Pitch, and the number of coils. This machine will translate those spring characteristics into a manufactured spring.
iii. The machine has a linear Outside Diameter Cam; the user can input the Spring OD directly to control the diameter of the spring after initializing the machine by calibrating the minimum OD and the reference OD.
iv. The machine has a linear pitch architecture; the user can input the spring pitch directly to control the pitch after calibrating the Pitch zero and the reference pitch.
v. The machine uses the spring OD, pitch, and the wire diameter to calculate the wire feeding length by the number of coils.

vi. Using our system, common compression springs can be produced immediately after defining the OD and Pitch.
vii. The machine has a Minimum OD protection feature to prevent technician missteps, which may cause damage to the machine or tools.
viii. The spring length detector (SLD) setup process is quick and simple. Together with the Product Sorter, it can adjust the spring height automatically and produce springs that are 100% within tolerance levels.
ix. The SLD can detect the spring length and auto-adjust the spring pitch. It uses the ratio method to adjust spring pitch in real-time to ensure the spring falls within the desired tolerance.
x. When making conical springs, the wire feed will adjust according to the change on the outer diameter, it will ensure the shape of the conical spring is well maintained.
xi. Built in sensor probes can be set up and enabled to guarantee spring angle and length.
xii. The built-in safety sensors (such as the door safety sensor, hydraulic-pressure sensor) will automatically stop the machine and generate an alarm.
xiii. Wire color detection sensor is an optional feature for the coiler to identify defective sections within the wire to improve product quality. This feature may not be utilized on all wire materials.

1.1. Description

In the Pergo control system, we provide a simplified interface for users to interact with the machine. The main interface utilizes a spring formation script that allows the machine to execute a single row, no matter the number of cells, all at once. To input the desired action, the user simply enters the information of each corresponding cell within the table.

The machine has a built-in spring length detector (SLD) and sorter. The produced spring can be sorted according to the tolerance requirement. An external camera input is available for customers who wish to add a vision system.

The control system offers WIFI connection capability which enables:
- Remote machinery monitoring (production quantity, yield, production speed, production rate) for production management analysis.
- Remote machinery control, such as run/ stop/ pause/ resume the machine.
- Multi-user spring formation script collaboration (multi-user access to the software).

2. MACHINE INTERFACE

This machine uses the following to execute commands:
- Standard PC Keyboard + Mouse
- External Control Panel
- Handwheel Device (RPG Dial)

The machine offers the following ports for external peripheral connections:
- I/O board

- Sorter Output
- Air Cylinder Output

2.1. External Control Panel

All hardware switches are placed on the control panel which is located under the monitor.

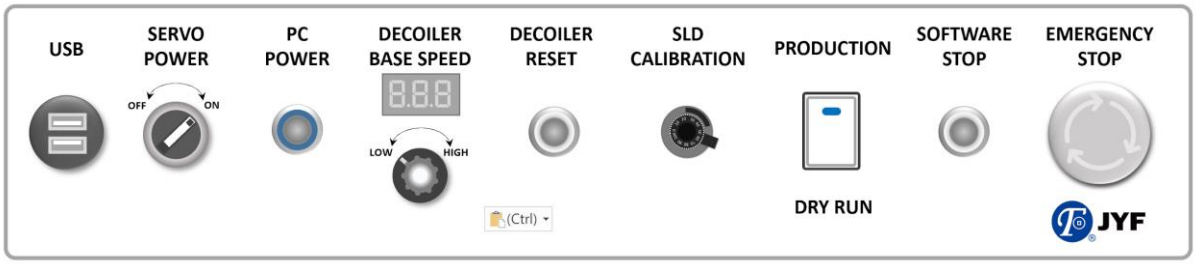


Figure 1. Control Panel

The control panel, from left to right, are comprised of the following:

- USB: 2 USB ports.
- Servo power switch: Control servo motor on/ off.
- PC power switch: Control PC on/ off; press once to power on and press and hold to shut down.
- Decoiler base speed knob: Control the base speed of the decoiler while the machine is running.
- Decoiler alarm reset button: Reset the decoiler alarm during the initial startup.
- Spring length detector voltage calibration knob: Adjust the SLD base voltage.
- Production / Dry Run switch: Switching between two execution modes.
- Software stop button: Stops machine at the software level.
- Emergency stop switch: Power cut to the entire machine.

2.2. Handwheel Device (RPG Dial)

The Handwheel is located next to the control panel. It is used to control the movement of the selected motor (axis) or to control the spring formation flow during a production run under the dry-run execution mode.

The Handwheel is made up of the following components:

- Emergency Stop – Press to cut machine power.
- Motor Select Knob – Use to select the axis.
- Speed Control Knob – Use to switch between different motor running speeds.
- Status LED – The LED will be lit when the RPG is active.
- Side button – Use to activate the RPG device.
- RPG – Clockwise/counter-clockwise RPG movements correspond to motor movements in the same direction.

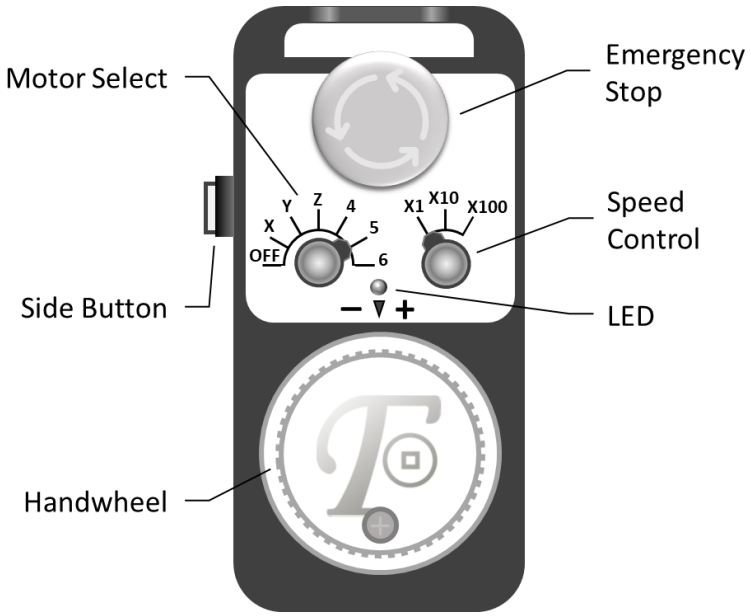


Figure 2. RPG Dial

The Handwheel can be used to control the movement of a single motor at any given moment when the spring formation script is not being executed (production mode). The user turns the RPG Dial to control the motor currently selected. The motor indicated by the “motor select” knob will move according to the direction of the “Handwheel” knob. The movement step of the motor will be based on the turning speed of the knob capped by the selected “speed control”. The Handwheel can be activated by either holding the side button or switch on the Hands Free toggle in the Handwheel setting located in the status panel. The “LED” will light up to indicate that the Handwheel is active.

The Handwheel device can also be used to control the flow of the spring formation process. It is automatically activated when a spring formation script is executed under the “dry-run” execution mode. The “Run” button on the execution panel will be replaced with “Waiting” button and the “LED” on the Handwheel device will light up to indicate that the script is ready to accept the Handwheel knob input. The user can simply turn the Handwheel knob to control the flow of the spring formation process. The speed at which the spring is produced is predetermined, which cannot be controlled by the Handwheel knob, but can be changed by changing the overall speed factor or the desired motor speed factor located in the status panel. For convenience, pressing the “side” button will change the overall speed factor to 5%/10%/100%, corresponding to the selected x1/x10/x100 setting of the “speed control” knob.

2.3. I/O Board

All I/O ports are integrated on one single I/O board. It can be found on either the left or right side of the machine. The making of a standard compression spring will not require any I/O connections. These I/O connectors are reserved for the making of special compression springs or users who wish to setup other external devices to interact with the machine.

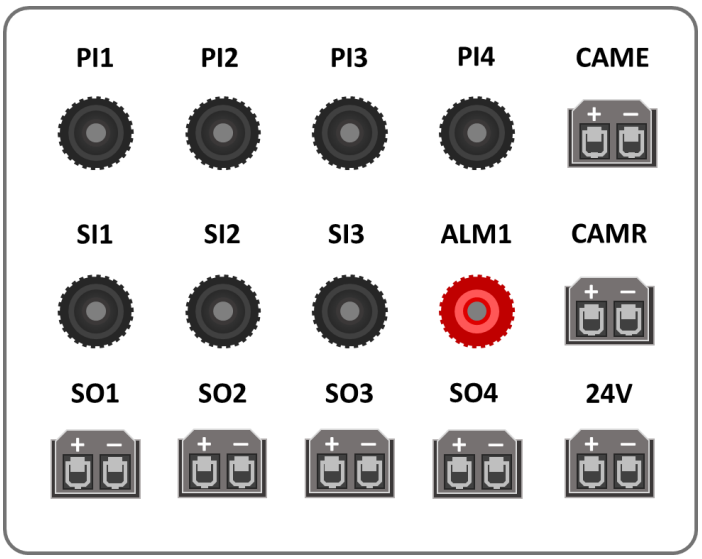


Figure 3. I/O panel

In general, all input ports are considered as active when grounded and all output ports are 24V when active. The I/O panel, from top to bottom, is comprised of the following:

- Probe Input (PI1 – PI4)
  - Provides 4 probe inputs. It is reserved for probe inputs (a grounding signal). When active it can be used for conditional jumps, alarms, time delays, etc.

- Camera Enable Output (CAME)
  - The output port is reserved for triggering the external camera system that is utilized by the spring length detection function.

- Signal Input (SI1 - SI3)
  - Provides 4 signal inputs. It is reserved for signal inputs (a grounding signal). When active it can be used for conditional jumps, alarms, time delays, etc. It can be used interchangeably with the probe inputs.

- External Alarm Input (ALM1)
  - When active (a grounding signal is received at this port), the machine alarm will be triggered.

- Camera Signal Analog Input (CAMR)
  - The port is reserved to receive an analog signal (-10v to +10V) from the camera system that is utilized by the spring length detection function.

- Signal Output (SO1 - SO4)
  - Provides 4 signal outputs that, when active, provides +24V to power an external device.

- POWER SUPPLY
  - This port provides 24V with a maximum 1A power output.

2.4. Sorter Output

The sorter output is located on the side of the machine. It has two guiding gates which are controlled through the activation of the SOR1 and SOR2 signal by the machine. The sorter should be used coupled with the built in/external SLD device. Once the SLD enabled flag is checked and the desired sorter delay is set, both of which are located on the side panel under the Handwheel control tab, the sorter will sort according to the quality of the spring. The sorter signal SOR1 and SOR2 can be manually triggered under the I.O. Status tab located on the side panel. It is not recommended to enable the sorter signal manually, but the control is provided for a user to disable sorter signals when required under rare circumstances.

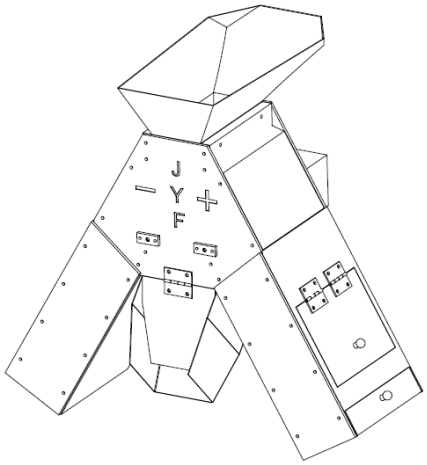


Figure 4. Sorter

2.5. Air Cylinder Output

The air cylinder output is located on the side of the machine. It is controlled through the activation of the corresponding ACO1, ACO2, ACO3 and ACO4 signals from the machine. The signal can be controlled under the I.O. Status tab located on the side panel.

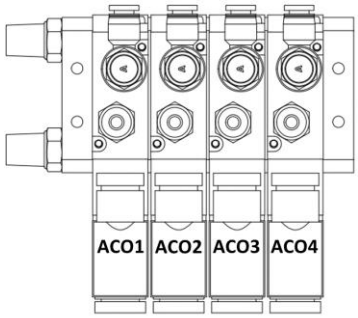


Figure 5. Air Cylinder

3. USER INTERFACE

The interface can be divided into seven screen components. In this section, the function of each component will be introduced.

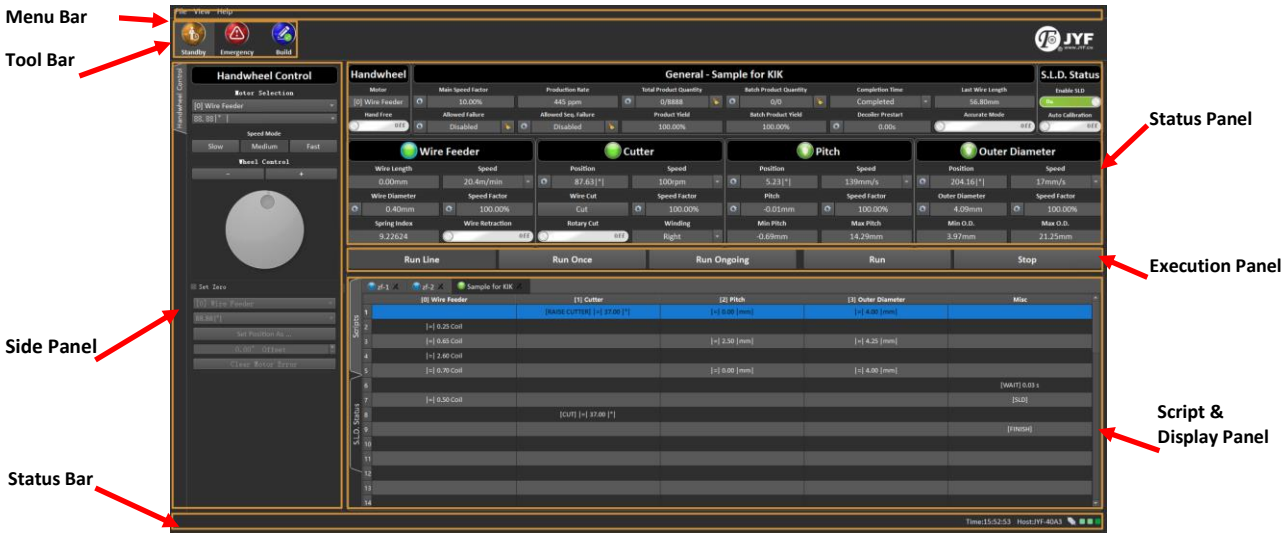


Figure 6 User Interface

4. Menu Bar

The menu bar contains the following menu and sub menu:

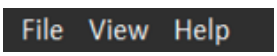
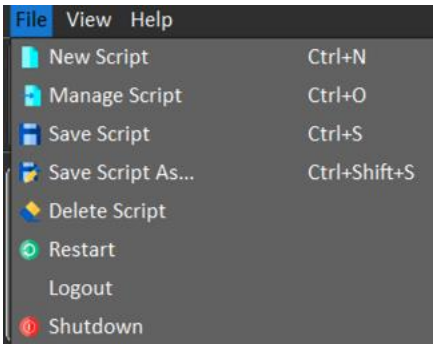


Figure 7. Menu Bar

4.1. File



– For the user to manage a script, restart the program or shutdown the machine.

- New Script – Create new script.
  - ***No programming knowledge is needed to use the software. All scripts are integrated into a data entry format.***
- Manage Script – To load the script and view currently opened script.
- Save Script – To save the script.
- Save Script As… – To save the script under a different name.
- Delete Script – Delete the current script
- Restart – To restart the program
- Logout – Exit the current script
- Shutdown – Shut down the machine

In the "Manage Script" sub menu, it allows the user to open the previously saved script from the "File System" tab and to view the script which is currently opened in the "Workspace" tab.

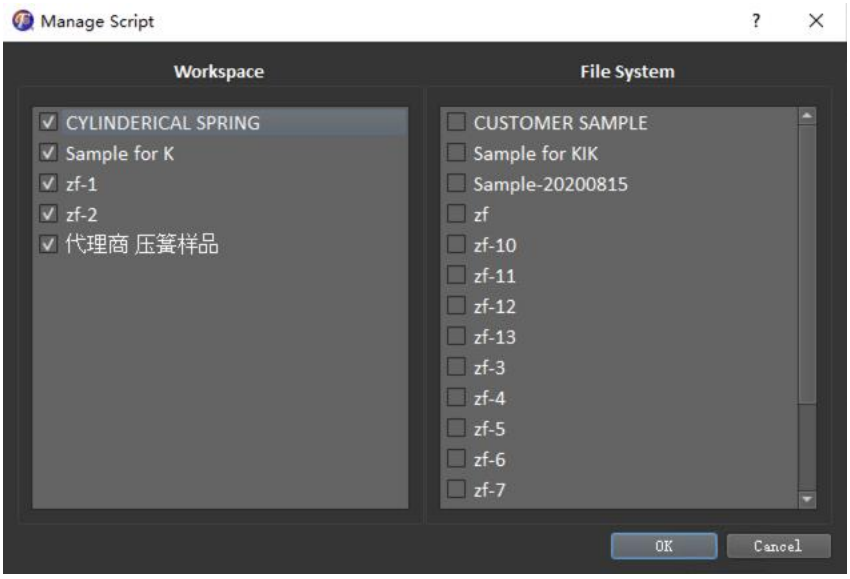


Figure SEQ Figure * ARABIC 8 Manage Script

4.2. View

– For user to manage the tabs present in the side panel. When the tab name is checked, the corresponding side panel tab will be displayed. It contains the following tab options:

- Handwheel Control
- S.L.D Setting

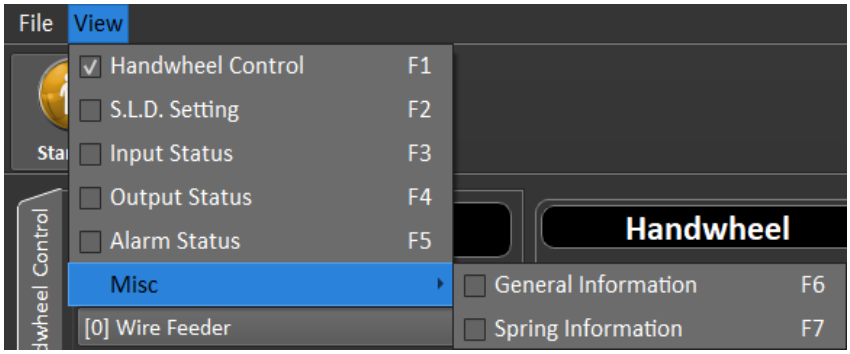


Figure SEQ Figure * ARABIC 9 View Menu

- I. O. Status
- Misc.
  - General Information
  - Spring Information

5. *Tool Bar*

The top tool bar is responsible for servo status displays, emergency stop and operation mode controls. The bottom tool bar, from left to right are: Standby, Emergency and Mode Button.

Figure SEQ Figure * ARABIC 10 Tool Bar in different State

5.1. Standby Button

When the Standby button is pressed, it will release the servo alarm. The servo status indicator from the Status Panel will change from red to green to indicate the servo has reset its alarm status. The button itself changes between a Running or Standby icon to reflect the servo state of the motors when they are moving or idle.

5.2. Emergency Button

When the Emergency button is pressed, it will trigger the servo alarm. The servo status indicator from the Status Panel will change from green to red to indicate the servo has entered alarm status and stops running.

5.3. Mode Button

The Mode button allows the user to switch between Design Mode and Build Mode.

In general, the following actions are performed in the corresponding mode:

- DESIGN MODE: Edit the spring formation table in the script and display panel.
- BUILD MODE: Run the spring formation table in the script and display panel. When this mode is selected an execution panel will appear for a user to select an action to run the spring formation table.

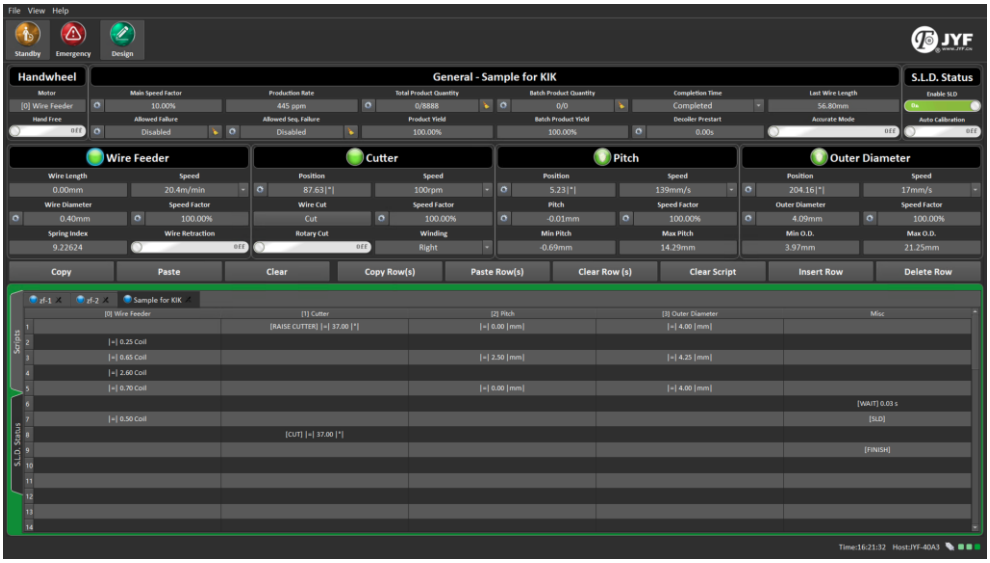


Figure 11. DESIGN MODE

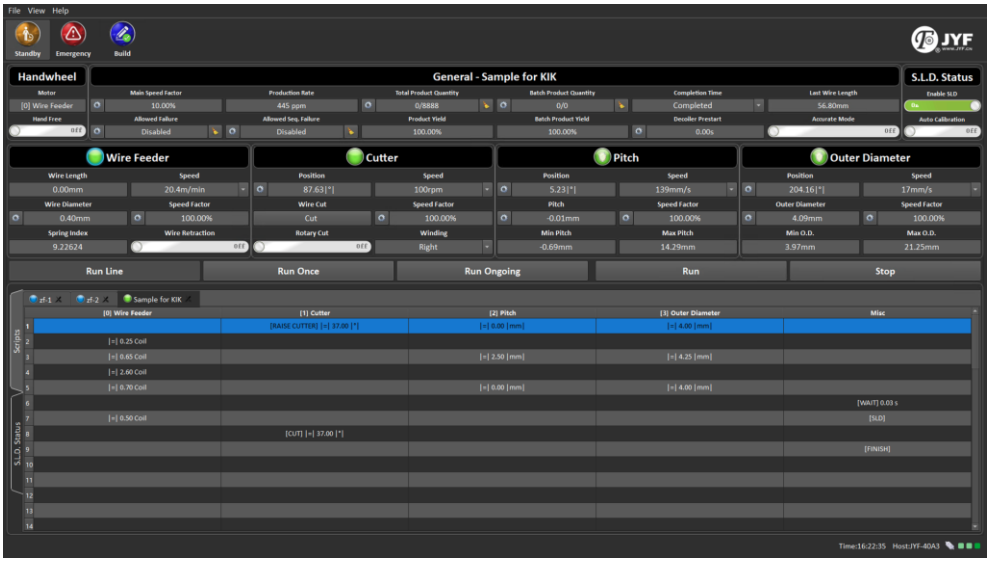


Figure 12. BUILD MODE

6. ***Side Panel***

The Side Panel contains the following tabs, which can be turned on/ off from Menu bar.

- Handwheel Control
- S.L.D Setting
- I. O. Status
- Misc
  - General Information
  - Spring Information

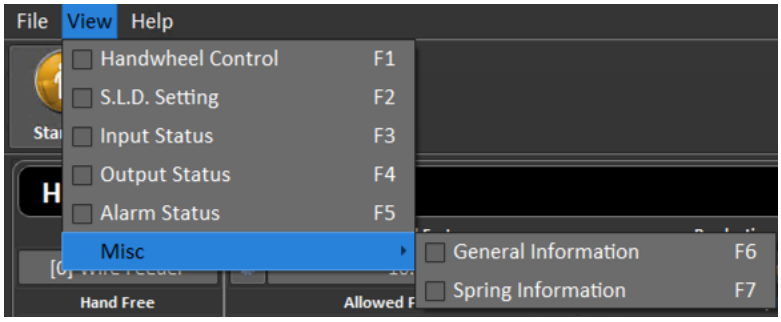


Figure SEQ Figure * ARABIC 13 Side Panel

6.1. Handwheel Control (RPG Dial)

The Handwheel control tab offers another software interface to control the machine. It serves the same purpose as the physical Handwheel control. Additionally, setting the motor zero position can be performed in this tab.

In the motor selection drop down, the user can select the desired motor to put in motion. The motor's current position is provided once a motor is selected. The speed mode allows the user to choose between three different speed presets, while the wheel control allows the user to run the motor using the "+" and "-" keys or turn the dial.

The set zero checkbox must be checked to set the motor zero position.

In the Set Zero menu, the user can select the motor and set the zero position by pressing the "Set Position As…" button; the default offset value is set to "0.00" and can be changed as needed.

Figure SEQ Figure * ARABIC 14.

6.2. S.L.D Setting

The Spring Length Detector (SLD) is controlled and setup in this tab. The user can enable the SLD auto calibration by checking both the "Enable Spring Length Detector" and "Enable Auto Length Calibration" checkboxes.

"Enable Spring Length Detector" – This option will enable the SLD to start sorting the produced spring based on the detected spring free length.

"Enable Auto Length Calibration" – This option will enable the SLD to start using the measured spring free lengths to auto calibrate the pitch. (Note: the option will have no effect if "Enable Spring Length Detector" is not enabled.)

Real time detected voltages can be found in the Spring Length Detector section. The user can set the reference voltage for positive and negative tolerance deviations as well as the normal voltage when the

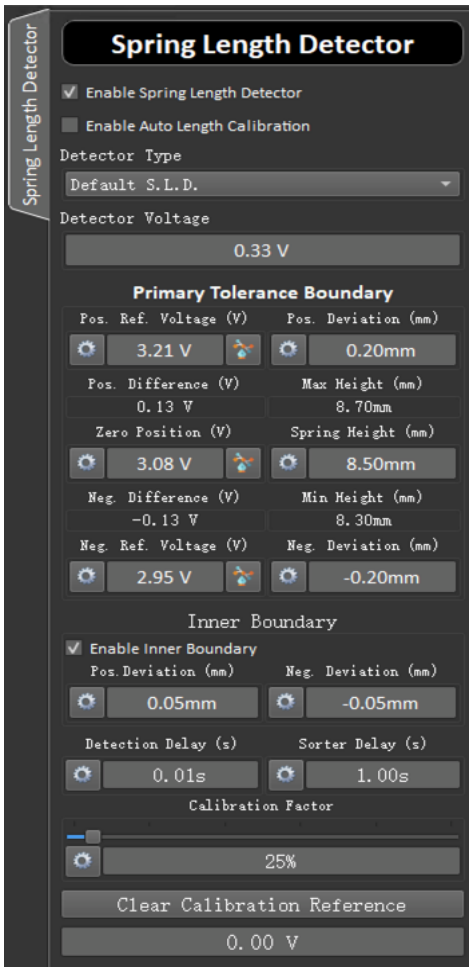


Figure SEQ Figure * ARABIC 15 SLD Setting

spring is at its required height. (Note: The SLD device needs to be mounted and setup first before filling in any field in the Primary Tolerance Boundary section.)

Press this icon to enter value.

Press this icon to obtain value from associated peripherals.

➢ **Setting the Detection Delay Time**

The user can set the detection delay time to keep the spring stable when the SLD detects the Spring Free Length.

➢ **Setting the Sorter Delay Time**

The user can set the sorter delay time to assist the sorter selection process when the sorting speed cannot keep up with the spring production speed. An appropriate added delay time will allow the sorter to move into position before the formed spring is cut, which will enable the sorter to effectively sort the spring based on its quality. (Note: The delay has been optimized to not wait when no sorting is required.)

6.3. Input Status

The Input Status ports can be viewed and controlled from this tab. It includes the Input Status of the following:

- Probe
  - PI1 – PI4
- Sensor
  - SI1 – SI4

6.4. Output Status

The Output Status ports

- Sorter
  - SOR1 - SOR2
- Air Cylinder
  - ACO1 – ACO2
- Signal
  - SO1 – SO4

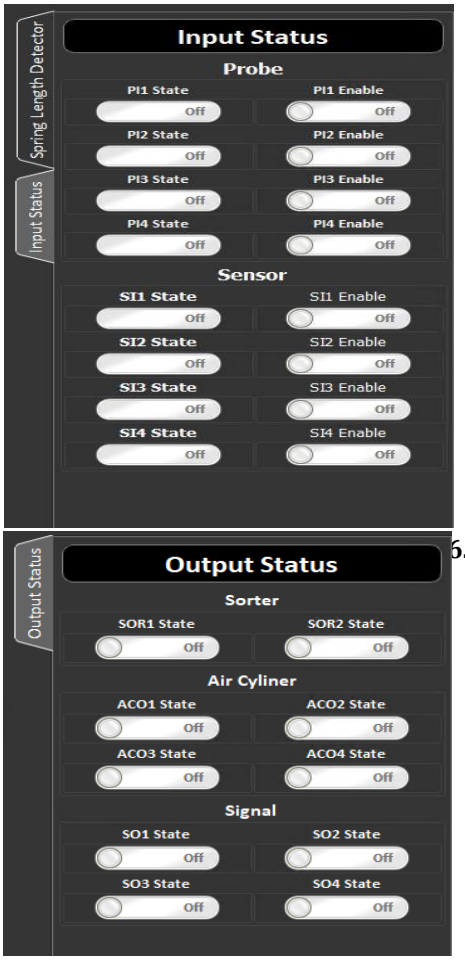


Figure SEQ Figure * ARABIC 17. Output Status

"Sorter", "Air Cylinder" and "Signal" outputs can be controlled by clicking on the on/off toggle switch.

6.5. Alarm Status

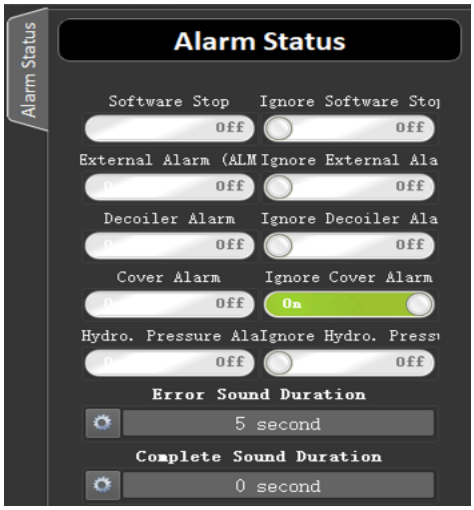


Figure SEQ Figure * ARABIC 18

- The left column indicates the alarm status of the machine
- The right column allows the user to disable the alarm

➢ Error Sound Duration
Alarm Sound duration time (in seconds)

➢ Complete Sound Duration
Production Complete Sound duration time (in seconds)

6.6. Customer Information

In general information, the user may store relevant customer information in this tab. The information will be stored with each spring formation script.

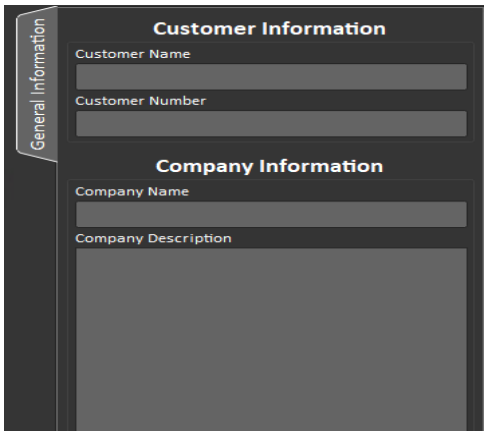


Figure SEQ Figure * ARABIC 19

6.7. Spring Information

In spring information, the user may store relevant spring information in this tab, such as spring name, tool to be used, etc. The information will be stored with each spring formation script.

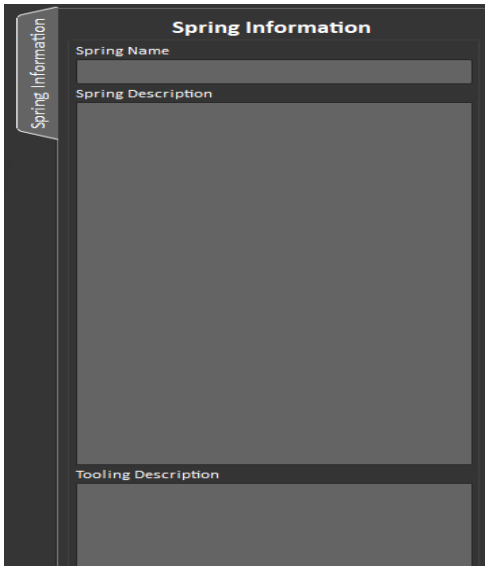


Figure SEQ Figure * ARABIC 20 Spring

7. Status Panel

The Status Panel contains motor status and control for auxiliary units. The functionality of each sub section is as follows:

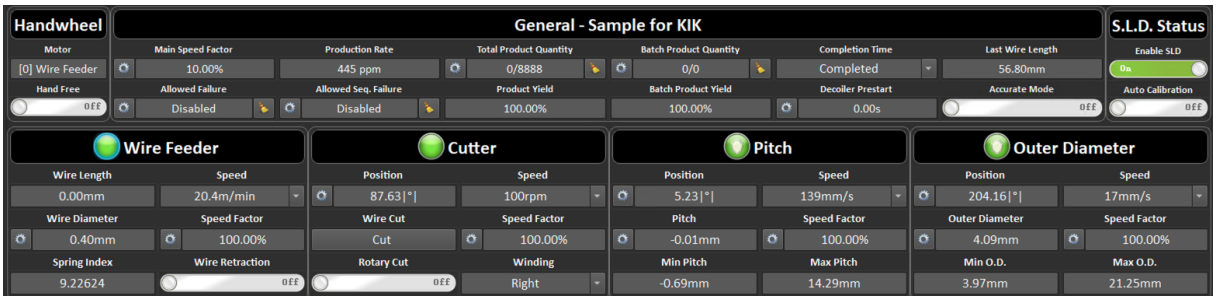


Figure 21 Status Panel

7.1. Handwheel

The Handwheel section indicates which motor is currently selected. Hands free toggle can activate the Handwheel device without needing to hold the side button.

Figure SEQ Figure * ARABIC

7.2. S.L.D. Status

The S.L.D Status section allows users to enable the SLD and start auto calibrating directly from the main interface as well as indicating if SLD is currently enabled or not.

Figure SEQ Figure *

7.3. General section

Contains general motor speed controls and production information.

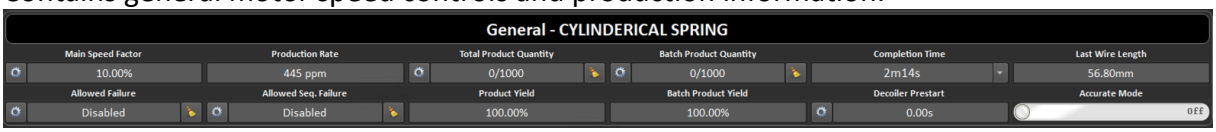


Figure 24 General Section Status

- **Main Speed Factor**
  - It shows a ratio that affects all motor speeds. It is used to speed up or slow down the overall production rate. For example, if 10% is set, all the motors will run at 10% of its current set speed in the motor section.
- **Production Rate**

- It refers to the number of springs that are produced per minute.

- **Total Product Quantity**
  - Sets the total number of springs to be produced.
- **Batch Product Quantity**
  - Sets the total number of springs to be produced in the batch.
- **Completion Time**
  - It refers to the amount of time required to complete the set product quantity.
- **Last Wire Length**
  - It refers to the wire length which is used on the last produced spring.
- **Allowed Failure**
  Number of parts that fail spring specifications.
- **Allowed Seq. Failure**
  Number of consecutive parts that fail spring specifications.
- **Product Yield**
  - The percentage of non-defective springs to total springs produced.
- **Batch Product Yield**
  - It refers to the percentage of non-defective springs to total springs in the batch.
- **Decoiler Prestart**
  Time lapse on Decoiler before machine starts production
- **Accurate Mode Switch (on/off)**
  Machine Runs with Accurate Mode (On/Off)
  This mode closes the gap between production mode and design/step mode variations. However, it will slow down the overall production rate of the part.

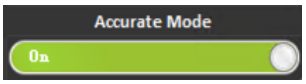


Figure SEQ Figure * ARABIC 25 Accurate Mode

7.4. Motor Section

This section allows the user to set up the motor and check its current status.
The color orb next to the motor indicates the following:

- A Red orb indicates the motor has not been initialized.

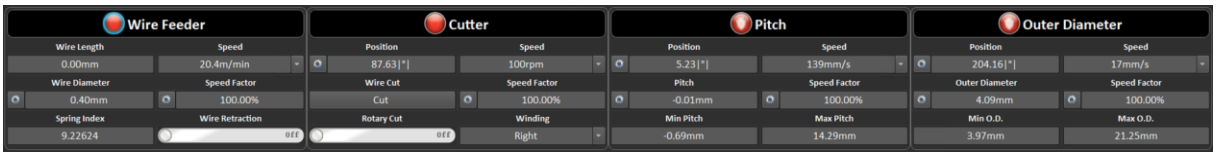


Figure 26 Motors are not ready

- Green orb means the motor is ready.

Figure 27 Motors are ready

- A blue glow means this motor is currently selected by the Handwheel.

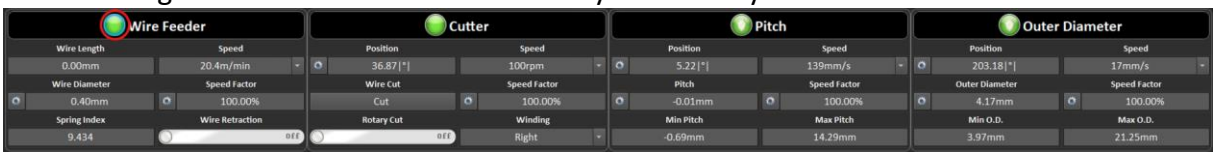


Figure 28 The wire feeder motor is currently selected by the Handwheel

- A shield on the orb means the limit protection is enabled in the associated motor.

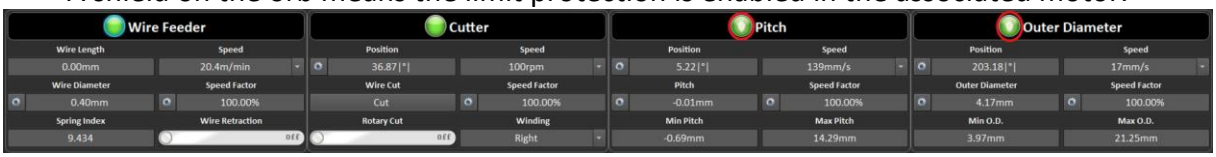


Figure 29 The limit protection is enabled in the associated motor

Press this icon to enter value.

Press this icon to obtain values from associated peripherals.

Note: Limit protection is automatically switched on and the hands free toggle is automatically switched off as soon as the spring formation script is executed.

7.4.1. Wire Feeder

The Wire Feeder motor contains the following information and setting:

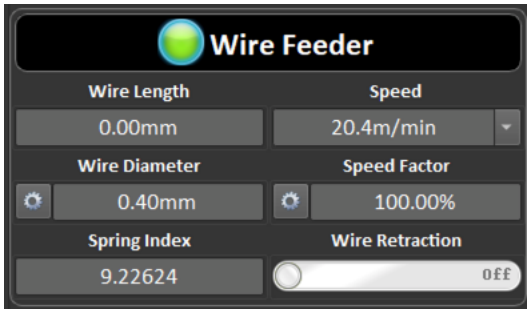


Figure SEQ Figure * ARABIC 30 Wire

- **Wire Length**
  - It refers to the sum of the current feed wire lengths.
- **Speed**
  - It shows the current motor speed in rpm or m/min.
- **Wire Diameter**
  - It refers to the wire diameter that is used to produce the current spring. The user sets the current wire diameter in this field.
- **Speed Factor**
  - It refers to the ratio of the motor's maximum speed that can be used when motor is running. The user sets the maximum speed of the wire feeder motor in this field.
- **Spring Index**
  - It refers to the spring index in respect to the spring's current OD. Spring index is the correlation between the mean diameter of a spring and the wire diameter of a spring.
- **Wire retraction**
  - To enable the Wire Retraction function.

7.4.2. Cutter

The Cutter motor contains the following information and setting:

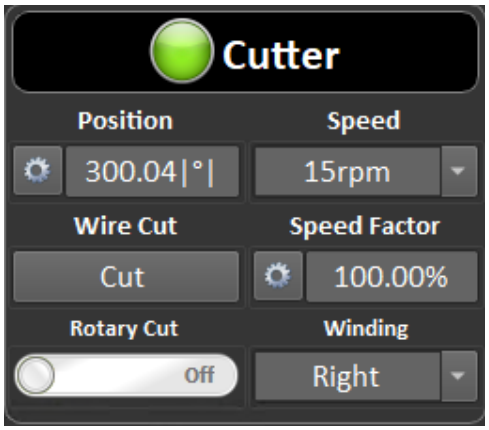


Figure SEQ Figure * ARABIC 31 Cutter

- **Position**
  - It refers to the current motor position, it also allows the user to set the current position such as set the motor zero position.
- **Speed**
  - It shows the current motor speed in rpm.
- **Wire Cut**
  - Press to cut wire using current settings.
- **Speed Factor**
  - It refers to the ratio of the motor's maximum speed that can be used when motor is running. Users can use this field to set the maximum speed of the cutter motor.
- **Rotary Cut**
  - It allows the user to execute the script in rotary cut mode. By default, the system performs a straight cut. By executing the cutting command, the cutter will swing like a pendulum towards the predefined positions. When the mode is switched on (Rotary Cut), the motor will instead rotate in a positive direction only to execute cutting command. It will also rotate during the formation of the spring so it is in position for the final cut. (Note: the motor in rotary mode is optimized to move in the positive direction by default)
- **Winding**
  - It allows the user to change the current winding direction. (Note: A software restart is required when the winding direction is changed as the current cutter/pitch related configuration will be lost and will required a new setup.)

CUTTER MOTOR SETTING:

For the cutter to function normally, the following set up procedure must be followed:
Please use the Handwheel and select the cutter motor to reach the desired motor position. For safety, the user should start moving the motor using the Handwheel device in slow speed mode.

I. Set the cutter 0° position.
   - The Ideal 0° cutter position is when the distance between the cutter and mandrel is at its minimum.

7.4.3. Pitch

The Pitch motor contains the following information and setting:

Figure SEQ Figure * ARABIC 32 Pitch Status

- **Position**
  - It shows the current motor position and allows user to set the current position such as the motor zero or reference positions.
- **Speed**
  - It shows the current motor speed

in rpm or millimeter per second.

- **Pitch**
  - Shows the current pitch and allows the user to set the current pitch in respect to the current position.
- **Speed Factor**
  - It refers to the ratio of the motor's maximum speed that can be used when motor is running. The user can set the maximum speed of the pitch motor in this field.
- **Min Pitch**
  - It refers to the set minimum pitch
- **Max Pitch**
  - It refers to the set maximum pitch

Under normal circumstances, users do not need to change the pitch boundaries. If required, the user can change the pitch boundary in the associated min and max fields. To release the boundary protection, please uncheck the Enable Limit Protection check box.

PITCH MOTOR SETTING:

For the pitch to function normally, the following set up procedure must be followed:
Please use the Handwheel and select the pitch motor to reach the desired motor position. For safety, the user should start moving the motor using the Handwheel device in slow speed mode.

I. Set the Pitch 0° position.
   - The Ideal 0° pitch position is when the motor is closest to the mandrel. (Note: this only applies for the pitch that uses the cutter mirroring motor as pitch. By default, the motor ID will either be 2 in "Right Winding" or 1 in "Left Winding".)

II. Change the Pitch boundary (Required when pre-defined boundaries has been reset due to left/right winding changes).
   - The 0mm pitch can be used as the min degree boundary.
   - The max degree boundary is found by slowly moving the motor in the positive position from the min pitch boundary up to the position before the pitch tool starts retracting.

III. Set the 0 mm Pitch.
   - The Ideal 0 mm Pitch is when the pitch tool is just touching the feed wire and does not give out any pitch while feeding and coiling the wire. When the position is obtained, the user can enter the 0 mm into the Pitch field.

IV. Set the reference Pitch.
   - The user can push the pitch tool out and apply pressure to the wire in order to measure the pitch obtained then enter into the Pitch field.

7.4.4. Outer Diameter

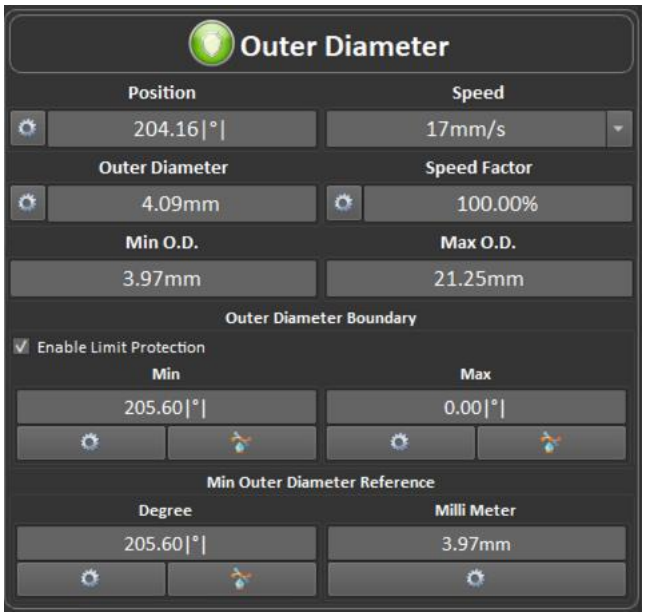


Figure SEQ Figure * ARABIC 33 Outer Diameter

The Outer Diameter motor contains the following information and setting:

- **Position**
  - It shows the current motor position and allows the user to set the current position such as the motor zero and reference positions.
- **Speed**
  - It shows the current motor speed in rpm and millimeter per second.
- **Outer Diameter**
  - Shows the current outer diameter and allows the user to set the current OD in respect to the current position.
- **Speed Factor**
  - It refers to the ratio of the motor's maximum speed that can be used when motor is running. The user can set the maximum speed of the O.D. motor in this field.
- **Min O.D.**
  - It refers to the set minimum outer diameter.
- **Max O.D.**
  - It refers to the set maximum outer diameter.

Under normal circumstances, the user may need to change outer diameter boundaries when the OD coiling pin is installed or adjusted. When necessary, the user can change the outer diameter boundaries in the associated min and max field. To release the boundary protection, please uncheck the Enable Limit Protection check box.

OUTER DIAMETER MOTOR SETTING:

For the outer diameter motor to function normally, the following set up procedure must be followed:

Please use the Handwheel and select the OD motor to control the motor position. For safety, the user should start moving the motor using the Handwheel device in slow speed mode.

I. Set the 0° for the outer diameter motor.
   - The ideal 0° for the outer diameter is when the O.D. coiling pin is at its widest open state. When the position is obtained, the user can enter the 0 mm in the Max field under the Outer Diameter Boundary section.

II. Change the O.D. boundary (Required when pre-defined boundaries are incorrect due to left/right winding changes).
   - Keep the min default degree boundary as 0°.
   - The max degree boundary is found by slowly moving the motor in the direction where the coiling pin is narrowing till the minimum O.D. position is reached. Use the minimum O.D. position as the max degree boundary.

III. Set the minimum O.D.
   - When the minimum O.D. position is reached, please make a coil by feeding wire and measuring the O.D. of the produced coil. Once the value is obtained, enter the value in the Outer Diameter field.

IV. Set the reference O.D
   - The user can move the O.D. coiling pin a little out (recommended to be > 0.5 mm of the minimum OD) and feed some wire to measure the new O.D. obtained then enter the value in the Outer Diameter field.

8. ***Execution Panel***

This panel is located between the status panel and the Script & display panel. It will only appear when Build Mode is selected. It contains the follow actions:

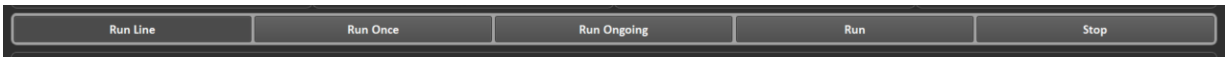


Figure 34. Execution Panel

- **Run Line**
  - The machine will only execute the current selected row in the spring formation table.
  - Once this is selected, the user must then press the run button to execute.
- **Run Once**
  - The machine will only execute from the current select row until the end of the program once.
  - Once this is selected, the user must then press the run button to execute.
- **Run Ongoing**
  - The machine will only execute from the current select row until the end of the program and then start from the beginning until the production quantity is reached.
  - Once this is selected, the user must then press the run button to execute.
- **Run/ Pause/ Resume**
  - The Run button is used to execute the spring formation table.
  - When Run is pressed the Pause button will appear for pausing the current action.
  - When the Pause button is pressed, the resume button will appear for the user to resume the current action.
- **Stop**
  - The Stop button allows the user to stop the motors when the machine is running.

The Spring formation script can be executed by first selecting an operation mode (Run Line/Run Once/Run Ongoing) and then press “Run”. The “Run” button will then be replaced by the “Pause” button for pausing the script during execution and “Resume” will appear if “Pause” is pressed before the script execution is completed. Row selection in the spring formation script is disabled during execution and re-enabled while paused or when the script execution is completed. While paused, the user can select any desired row as the new execution entry point to continue executing the script or select the last executed row to resume the script execution.

9. Script & Display Panel

This section reviews the spring formation script and SLD status. Under the spring formation script tab, the user can edit the script table to modify the steps in creating the desired spring. As for the SLD status tab, the user can view the current measured SLD status in real time while the spring formation process is taking place.

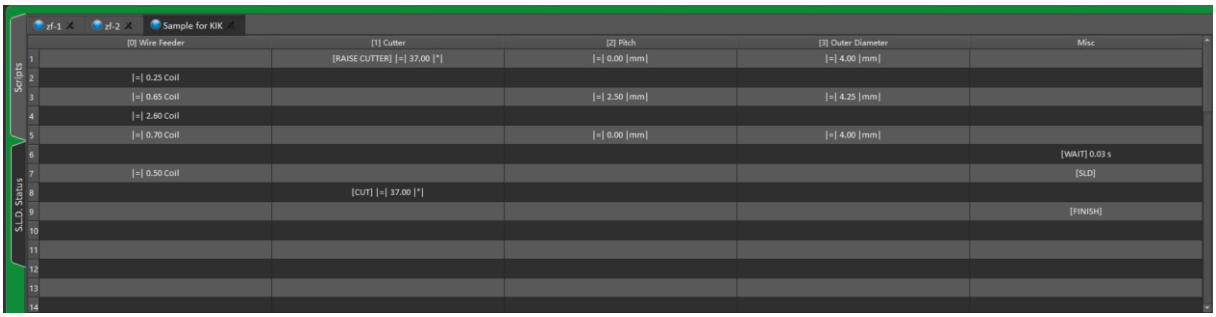


Figure 35. Script & Display Panel

Spring Formation Script

The Spring formation script contains 2 sections; the spring formation table and the current script tab. The user can input the command in the spring formation table and insert break points for spring testing. Start editing the script formation table by entering the design mode from the tool bar. The user can input the value and the value compensation in the cell of the spring formation table.

Spring Formation table

In general, the user can select between three direction flags next to the “Value” input.

- The “|+|” tag moves the selected motor clockwise according to the adjacent value.
- The “|-|” tag moves the selected motor counter-clockwise according to the adjacent value.
- The “|=|” tag moves the selected motor if no direction needs to be specified or the machine will auto select the direction to move.

The user can use the “Value Compensation” input to adjust the overall value. The overall value will consider the sum of the “Value” and “Value Compensation”.

9.1. Wire Feeder

Figure SEQ Figure * ARABIC 36 Wire

- **Speed (%)**
  - It refers to the wire feeder speed factor. It is used to set the wire feeder motor speed.
- **Turns (Coil)**
  - It refers to the number of turns the user wishes to make on this single step.
- **Length rel. (mm)**
  - It refers to the Length Relative value. It is used to set the wire length in mm in this single step.
- **Degree rel. (°)**
  - It refers to the Degree Relative value. It is used to set the wire length in degree in this single step.

9.2. Cutter

Figure SEQ Figure * ARABIC 37 Cutter

- **Speed (%)**
  - It refers to the cutter speed factor. It is used to set the cutter motor speed.
- **Degree abs. (|°|)**
  - It refers to the Degree Absolute value. It is used to set the cutter position in degree in this single step.
  - There are three directions that can be set by selecting “|+|”, “|-|” and “|=|”. When the “|+|” tag is selected, the cutter will move clockwise according to the adjacent value and vice versa. When “|=|” is selected, the cutter will automatically move in a direction to avoid cutting action and this is the recommended option.
- **Degree rel. (°)**
  - It refers to the Degree Relative value. It is used to set the cutter movement in degree in this single step.
- **CUT**
  - It refers to the straight cut action. The cutter will move in a direction to cut. When the position value in degrees is specified, the cutter will complete the cut action and move to the specified position.
- **RAISE CUTTER**
  - It refers to the action of raising the cutter. The cutter will raise to the height of the specified position in degrees and avoids passing the 180° mark.

9.3. Pitch

Figure SEQ Figure * ARABIC 38 Pitch

- **Speed (%)**
  - It refers to the pitch speed factor. It is used to set the pitch motor speed.
- **Length abs. (|mm|)**
  - It refers to the Length Absolute value. It is used to set the pitch position in mm in this single step.
- **Length rel. (mm)**
  - It refers to the Length Relative value. It is used to set the pitch movement in mm in this single step.
- **Degree abs. (|°|)**
  - It refers to the Degree Absolute value. It is used to set the pitch position in degree in this single step.
  - There are three direction that can be set by selecting "|+|", "|-|" and "|=|". When the "|+|" tag is selected, the pitch motor will move clockwise according to the adjacent value and vice versa. The "|=|" is used for factory set up purposes only.
- **Degree rel. (°)**
  - It refers to the Degree Relative value. It is used to set the pitch movement in degrees in this single step.

9.4. Outer Diameter

Figure SEQ Figure * ARABIC 39 Outer

- **Speed (%)**
  - It refers to the pitch speed factor. It is used to set the outer diameter motor speed.
- **Length abs. (|mm|)**
  - It refers to the Length Absolute value. It is used to set the outer diameter position in mm in this single step.
- **Length rel. (mm)**
  - It refers to the Length Relative value. It is used to set the outer diameter movement in mm in this single step.
- **Degree abs. (|°|)**
  - It refers to the Degree Absolute value. It is used to set the outer diameter position in degree in this single step.
  - There are three direction that can be set by selecting "|+|", "|-|" and "|=|". When the "|+|" tag is selected the pitch motor will move clockwise according to the adjacent value and vice versa. The "|=|" is used for factory setup purposes only.
- **Degree rel. (°)**
  - It refers to the Degree Relative value. It is used to set the outer diameter movement in degrees in this single step.

9.5. Misc

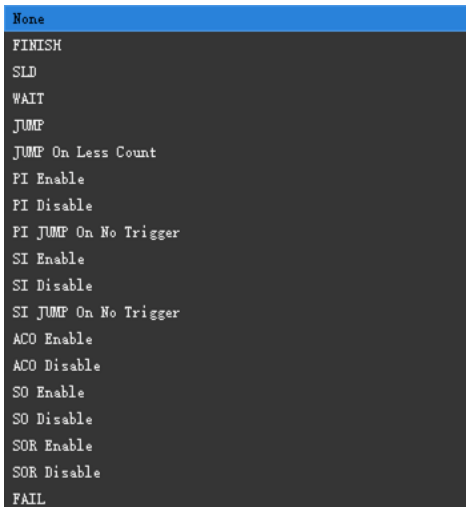


Figure SEQ Figure * ARABIC 40 Misc.

- **FINISH**
  - It refers to the completion of a spring. It is used to keep track of the product count related parameters. Adding the command at the end of the script is recommended.
- **SLD**
  - It refers to the time when the SLD will start to detect the spring's free length.
- **WAIT**
  - It refers to the time in seconds to wait before the next command execution.
- **JUMP**
  - It refers to jumping to a specified spring formation table row.
- **JUMP On Less Count**
  - If the Count is not zero, it refers to jumping to a specified spring formation table row.
- **PI Enable**
  - Enables the probe with the number that is provided in the value field. There are four probes that are currently available with the machine. Probes are used in the spring formation process when a section of the spring's length or rotation angle is unknown. The probe triggers a signal that can then be used to define the unknown length or rotation angle. When the PI probe is enabled, wire touching the probe (completes the circuit) will trigger the next command row and disable the probe simultaneously.
  - "PROBE Disable" and "PROBE JUMP On Trigger" commands should only be used after "PROBE Enable".
- **PI Disable**
  - Disables the probe with the number that is provided in the value field. Probes will be disabled regardless if it has been activated or not.
  - "PROBE Disable" should only be used after "PROBE Enable" with the same probe number.
- **PI JUMP On No Trigger**
  - Jump if the probe with the number that is provided in the value field has not been activated.
  - Jump to specified script table row based on value provided in the reserved field.
  - "PI JUMP On No Trigger" should only be used after "PI Enable".
- **SI Enable**
  - Enable SI with the number that is provided in the value field. There are four SI that are currently available with the machine. Probes are used in the spring formation process when a section of the spring's length or rotation angle is unknown. The SI triggering signal can then be used to define the unknown length or rotation angle. When the SI probe is enabled, wire touching the probe (completes the circuit) will trigger the next

command row and disable the probe simultaneously.
    - "SI Disable" and "SI JUMP On No Trigger" commands should only be used after "SI Enable".
- **SI Disable**
    - Disables SI with the number that is provided in the value field. Probe will be disabled regardless if it has been activated or not.
    - "SI Disable" should only be used after "SI Enable" with the same probe number.
- **SI JUMP On No Trigger**
    - Jump if the probe with the number that is provided in the value field has not been activated.
    - Jump to specified script table row base on value provided in the reserved field.
    - "SI JUMP On No Trigger" should only be used after "SI Enable".
- **ACO Enable**
    - Air cylinder Output Enable with the number that is provided in the value field.
- **ACO Disable**
    - Air cylinder Output Disable with the number that is provided in the value field.
- **SO Enable**
    - Signal Output Enable with the number that is provided in the value field.
- **SO Disable**
    - Signal Output disable with the number that is provided in the value field.
- **SOR Enable**
    - Sorter Enable.
- **SOR Disable**
    - Sorter Disable.
- **FAIL**
    - Bad product count increased by 1.

9.6. RUN TO BREAK POINT

- IN BUILD MODE
- Use the cursor to select the Script Step to Set the Break Point as below:

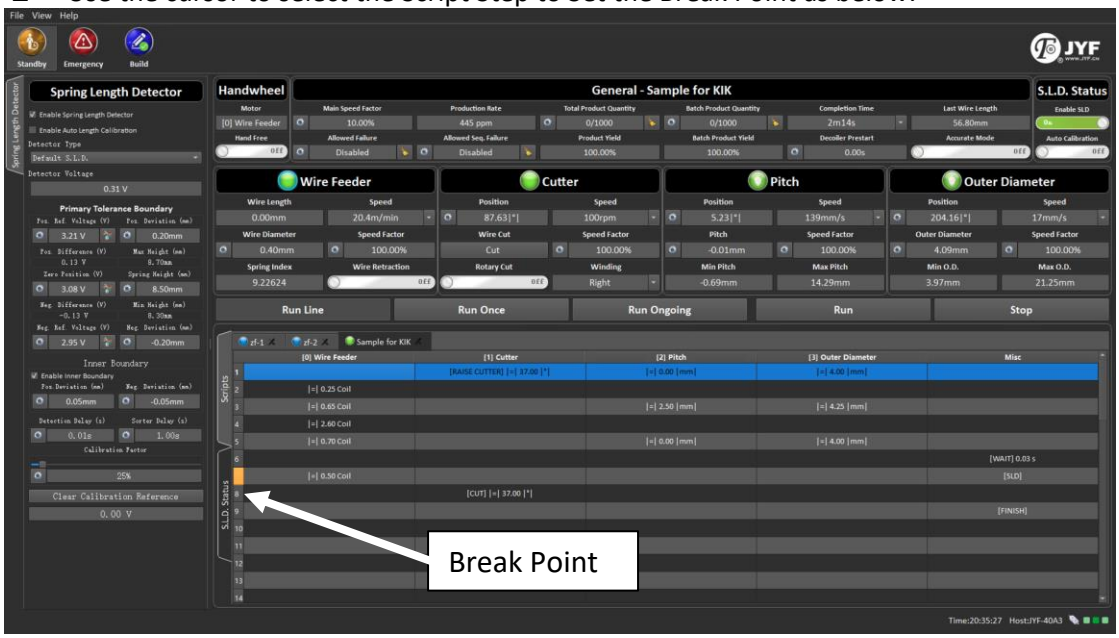


Figure 41. SET BREAK POINT FOR SLD CALIBRATION

Breakpoints are used to pause the script execution right after the specified row. This is useful for when specific spring formation steps need to be inspected or during SLD configuration setups to pause the script before the cutting action. Multiple breakpoints can be activated or de-activated by clicking on the vertical (numeric) header of the script table. The vertical header row with breakpoints activated will be orange.

9.7. S.L.D. Status

The S.L.D. status tab provides a graphical view of the current spring free length; it also shows the following information for reference.

- **Script Name**
  - It refers to the spring script which the spring is made according to.
- **Ideal spring Height**
  - It refers to the set ideal spring height.
- **Last Spring Height**
  - If refers to the last spring height.
- **Last Deviation**
  - It refers to the last spring deviation from ideal spring height.
- **Sequential Failure**
  - It refers to number of continuous times that a spring produced can be out of tolerance levels before an alarm is triggered.

Figure 42. S.L.D. Status

10. Status Bar

The status bar contains the status information. The status information will only appear when there is system feedback or alarms.

On the right of the status bar there is a connection icon with three flashing lights.

- A green light means the motors are connected.
- A red light means the motors are disconnected.

The Host name and current time can also be found next to the connection icon.

11. MACHINE PREPARATION

Before any compression spring can be created, the machine needs to go through three setup phases. These phases are essential to ensuring that the software and hardware of the machine are in sync, the tooling are protected and limited by the given working range and the tooling can accurately produce the spring following the given specifications.

11.1. Zero Origin Setting

Each motor has its specific designed 0° position; the user should ensure that the 0° position is as accurate as possible for an optimal spring formation process. The setting control can be found at the bottom section of the handwheel tab in the side panel. The Handwheel device is recommended to move the motor selected into position before setting the 0° position. The position is described as follows:

- **Motor 0 (Wire Feeder)**
  - It has no 0° position.

- **Motor 1** (Typically the cutter in right hand wounds or vertical pitch in left hand wounds)
  - The 0° position is the lowest point of the motor and the cutter tooling is closest to the mandrel, regardless of cutting style. Knowing the 0° position, the user can

consequently move the motor to its highest position, which is 180°. Should there be any obstructions around the 0° position, then the user can set the 180° first and the 0° position is set simultaneously as well.

- **Motor 2** (Typically vertical pitch in right hand wounds or the cutter in left hand wounds)
  - Mirroring motor 1, the 0° position is the highest point of the motor and the cutter tooling is closest to the mandrel, regardless of cutting style. Knowing the 0° position, the user can consequently move the motor to its lowest position, which is 180°. Should there be any obstructions around the 0° position, then the user can set the 180° first and the 0° position is set simultaneously as well.

- **Motor 3** (Outer Diameter)
  - The 0° position is the point is when the cam releases the coiling pin. (Maximum outer diameter)

- **Motor 4** (Mandrel)
  - The 0° position is not as crucial as some of the other motors, but it is still necessary to set an appropriate limit range. The 0° position can be set by simply setting it to the current position if the current position is a valid position in the working range.

- **Motor 5** (Horizontal pitch)
  - The 0° position is not as crucial as some of the other motors just like the mandrel but is still necessary to set an appropriate limit range. The 0° position can be set by simply setting it to the current position if the current position is a valid position in the working range.
  -

11.2. Limit Setting

The limit setting allows the user to set the working range of a motor and is typically dependent on the type of motor. (Range is measured and displayed in degrees.) When the min/max range is set, the motor will not be able to move below/above the range value while the limit protection is enabled. The limit setting is available under the additional setting section in the status panel. The additional setting can be shown by clicking on the name of the motor. The recommended limit setting is described as follows:

- **Wire Feeder or Cutter**
  - Limit setting is not required
- **Vertical Pitch**
  - The recommended range is between the 0° position to the 180° position. This is chosen such that when the user turns the pitch in the clockwise direction, the pitch will increase and will stop before it starts decreasing due to physical tooling design limitations. Any value that falls within the recommended range is viable. (Note: the

chosen range will affect the displayed min/max pitch range in millimeters.)

- **Horizontal Pitch**
  - The range should be the min/max pitch range (in millimeter) or typically 0 mm pitch to the max pitch value. These points can be found and set by moving the pitch using the Handwheel. Any value inside the actual physical limit is viable if 0mm pitch is included and the chosen max pitch is greater than the spring's requirement. (Generally, 0mm pitch is required for cutting action)

- **Outer Diameter**
  - The range should be the min/max outer diameter range (in millimeter). These points can be found and set by moving the outer diameter motor using the Handwheel. Any value inside the actual physical limit is viable if the min outer diameter is set as the cutting position and the max outer diameter is greater than the spring's requirement. (Note: The user should move the motor with caution as there is a chance for the tooling to collide with the mandrel without the limit protection.)

- **Mandrel**
  - The range should be the min/max mandrel range that is within the cam's physical limit. The limit is not as crucial as some of the other types of motors, but it is recommended to set the working range to avoid any unforeseen safety risks.

11.3. Reference Setting

Reference setting is required on certain motors, so the interpreted software length can match the actual physical length. The more accurate the provided measurements, the more exact the spring will be made. The reference setting can be found in the motor status panel and the requirements are as follows:

- Pitch
  - Two reference points are required. The pitch at 0 mm and any other reference point.
  - The 0 mm pitch setting can be found under additional setting in the pitch motor status panel.
  - Move the motor pitch to 0mm pitch and click on the  icon to copy the current degree at 0 mm pitch to set the zero-pitch reference.
  - Create a sample spring using the Handwheel. This involves moving both the motor wire and motor pitch. Feed some wire by turning the Handwheel clockwise when the Feed Axis is selected while the pitch is at the 0 mm position. Once there are about two or more coils, increase the pitch (as the second point of reference) using the Handwheel, then feed two or more coils and estimate the produced spring's pitch. Insert the measured pitch by clicking on the  icon in the pitch field in the motor status pitch panel. Move the pitch back to 0mm and feed another two or more coils

before cutting the wire.

- Outer Diameter
  - Two reference points are required. The minimum outer diameter (the point of contact for the cutter) and any other reference point.
  - The minimum outer diameter setting can be found under additional settings in the outer diameter motor status panel.
  - Move the motor outer diameter to its minimum value and click on the icon to copy the current degree to set the minimum outer diameter reference. The outer diameter can be set by clicking on the icon in the millimeter field of the minimum outer diameter reference.
  - Create a sample spring using the Handwheel. This involves moving both the Feed Axis and the OD Axis. Feed some wire by turning the Handwheel clockwise when the Feed Axis is selected while the pitch is at the 0 mm position and the OD is at the minimum position. Once there are about two or more coils, increase the OD by using the Handwheel, then feed two or more coils and estimate the produced spring's outer diameter. Insert the measured outer diameter by clicking on the icon in the OD field within the OD panel. Move the OD back to its minimum position and feed another two or more coils before cutting the wire.

- Mandrel
  - Single reference is required. The mandrel height that matches the minimum outer diameter, the point of contact for the cutter.

11.4. Change spring direction of wind

The spring's direction of winding can be found in the cutter motor status. It will display the current software direction of winding and can be changed by simply clicking on the combo box and select the desired winding. (Note: The software will need to be restarted when the direction of winding changes and configurations related to the pitch and cutter, such as limit settings and reference settings will need to be setup again.)

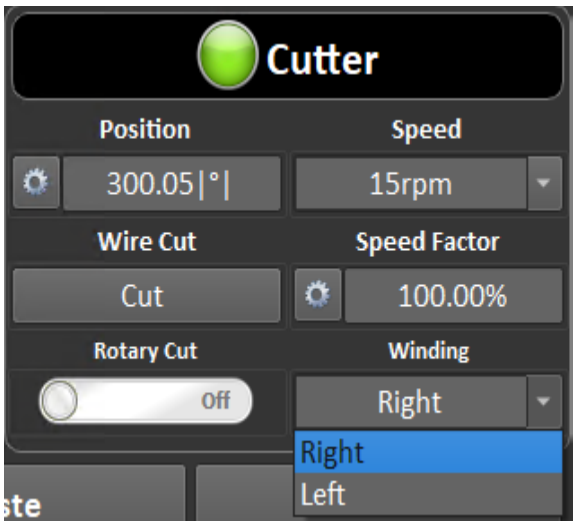


Figure SEQ Figure * ARABIC 43 Change Winding

12. HOW TO MAKE A SIMPLE SPRING

Once all machine preparations are done, the machine is ready to produce compression springs. The spring formation process utilizes the spring formation script. The procedure is sectioned into rows and columns. Each column represents a motor control with the last column to the right as the exception. This last column is used for special input commands so the total number of columns will be the number of physical motor axes plus the misc. column. The spring commands are executed in a row-by-row top-down sequential fashion and every command within a row will be executed synchronously with the misc. column command as the exception. The misc. column will be executed right after the current row's execution. Commands can be added/modified by double clicking on the script table cell in design mode and can be run/executed in build mode.

12.1. CYLINDRICAL SPRING WITH SLD

The spring formation script will be explained by the following example in a row-by-row fashion describing the written commands from left to right:

- Row 1: Raise the cutter to 30° (Depending on the current cutter position, the motor will move to either 30° or 330°); Move the pitch to 0mm; Move the OD to 4mm. (This is generally the minimum OD)
- Row 2: Feed 1 coil of wire (Actual wire length will be automatically determined based on the current pitch and OD value).
- Row 3: Feed 1 coil; Move the pitch to 1.5mm. (Synchronized)
- Row 4: Feed 5 coils of wire.
- Row 5: Feed 1 coil of wire; Move the pitch back to 0mm (Synchronized)
- Row 6: Feed 1 coil of wire; SLD detects current wire deviation. (This command will be ignored if the SLD is not enabled.)
- Row 7: Cut the wire; Increment the production count.

zf-1 | zf-2 | CYLINDERICAL SPRING | 代理商 压簧样品 | Sample for K

	[0] Wire Feeder	[1] Cutter	[2] Pitch	[3] Outer Diameter	Misc
1		[RAISE CUTTER] |=| 30.00 |°|	|=| 0.00 |mm|	|=| 4.00 |mm|	
2	|=| 1.00 Coil				
3	|=| 1.00 Coil		|=| 1.50 |mm|		
4	|=| 5.00 Coil				
5	|=| 1.00 Coil		|=| 0.00 |mm|		
6	|=| 1.00 Coil				[SLD]
7		[CUT] |=| 30.00 |°|			[FINISH]

Figure 44. Script example for simple compression spring.

12.2. CONICAL SPRING

The spring formation script will be explained by the following example in a row-by-row fashion describing the written commands from left to right:

1		[RAISE CUTTER] |=| 80.00 |°|	|=| 0.00 |mm|	|=| 4.00 |mm|	
2	|=| 0.30 Coil			|+| 0.10 mm	
3	|=| 0.80 Coil		|=| 1.50 |mm|	|+| 0.20 mm	
4	|=| 20.00 Coil			|=| 10.00 |mm|	
5	|=| 0.80 Coil		|=| 0.00 |mm|	|+| 0.20 mm	
6	|=| 0.10 Coil			|=| 4.00 |mm|	
7	|=| 0.20 Coil				
8		[CUT] |=| 80.00 |°|			[FINISH]

Figure 45. Script example for conical spring.

- Row 1: Raise the cutter to 80°; Move the pitch to 0mm; Move the OD to 4mm.
- Row 2: Feed 0.3mm of wire; Increase current OD by 0.1mm.
- Row 3: Feed 0.8 coil of wire; Move the pitch to 1.5mm; Increase current OD by 0.2mm.
- Row 4: Feed 20 coils of wire; Move the OD to 10mm.
- Row 5: Feed 0.8 coil of wire; Move the pitch to 0mm; Increase current OD by 0.2mm.
- Row 6: Feed 0.1 coil of wire; Move O.D. to 4mm.
- Row 7: Feed 0.2 coil of wire.
- Row 8: Cut the wire; Increase the production count.

12.3. HOW TO ADD S.L.D.

S.L.D. Setup

1. Align the caliper marker to the 0 position.

2. Fix the SLD and keep a suitable distance between the SLD and the formed uncut spring as shown in Figure 47.

3. Ensure the detector voltage shown in the side panel of the Spring Length Detector tab is within the range of -9V ~ 9V. If it is not within the voltage range, the user can turn the SLD calibration knob on the external control panel.

4. Set up the primary tolerance boundary parameters. First set the positive and negative deviation value as well as the spring height value (i.e. “Pos. Deviation”, “Spring Height”, “Neg. Deviation” value).

5. Insert the normal voltage by pressing the  icon.

6. Adjust the caliper according to the set tolerance deviation value to insert the Pos. Ref. voltage and Neg. Ref. Voltage value.

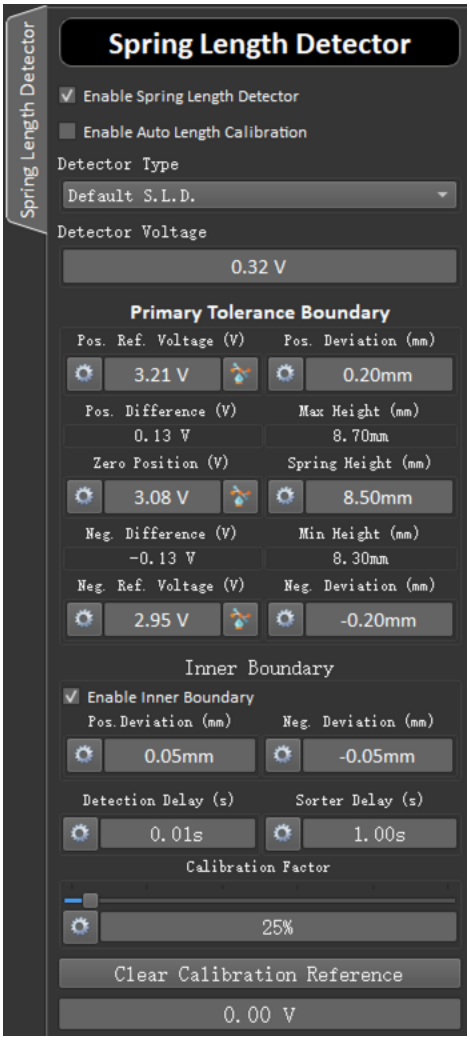


Figure SEQ Figure * ARABIC 46 SLD Setting

7. Set the Detection Delay time.

8. Set the Sorter Delay Time.

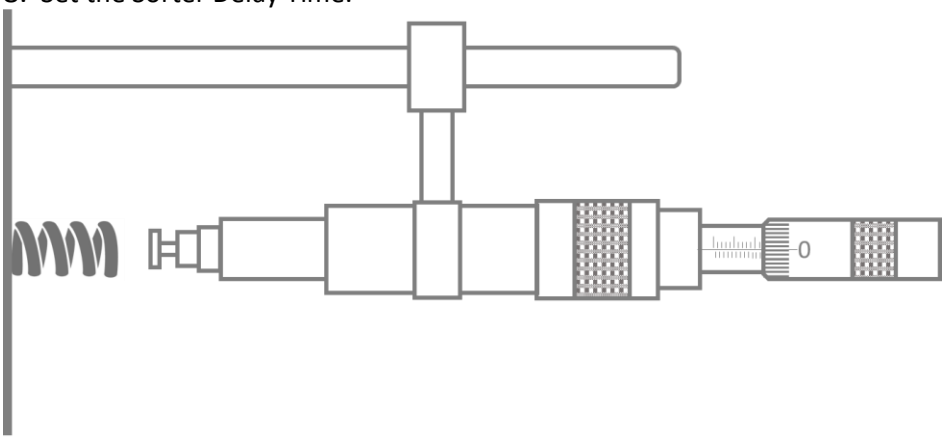


Figure 47 S.L.D Setup diagram

13. CIRCUIT DIAGRAM

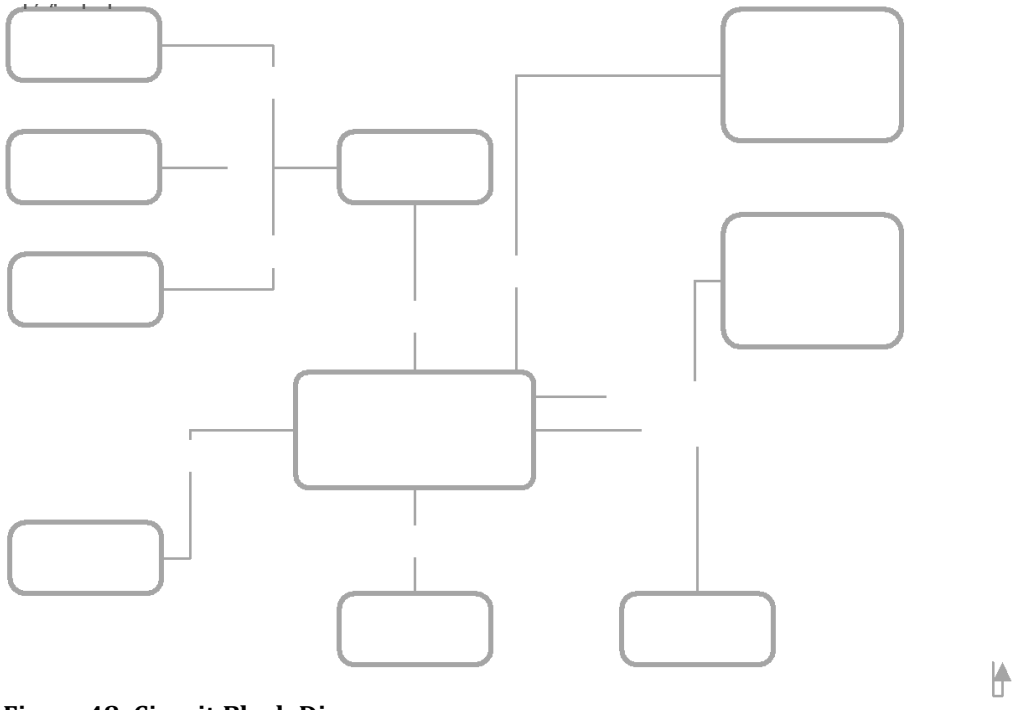


Figure 48. Circuit Block Diagram

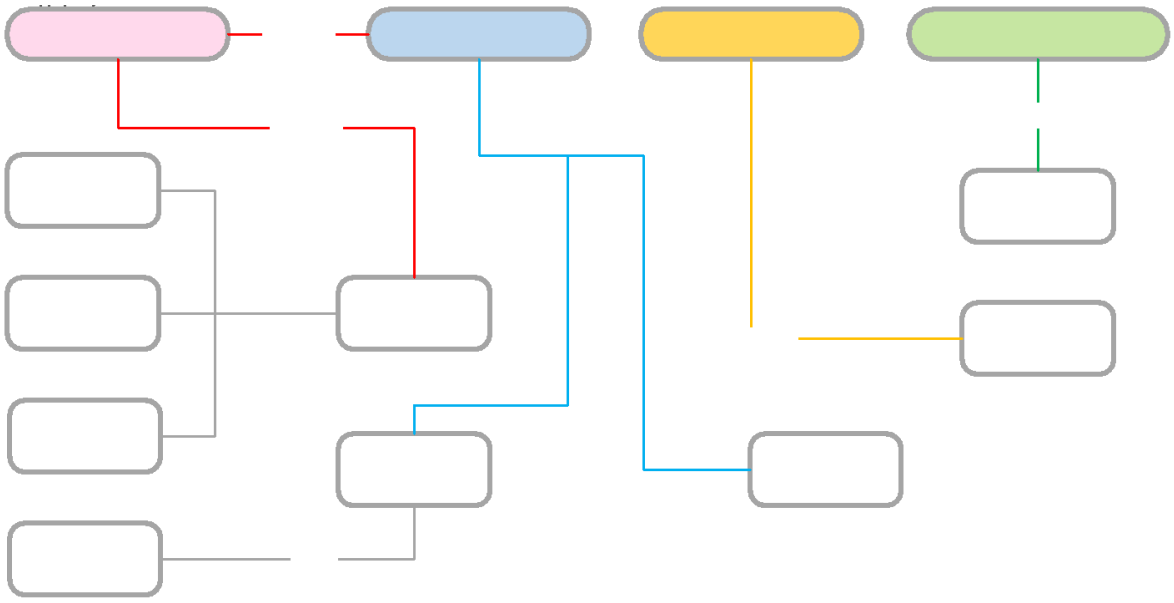


Figure 49. Power Diagram

HANDWHEEL SIGNAL AND CONNECTION TO MTIO					
No.	Signal Definition	Wire Color	Wire function description	MTIO signal	
				Pin No.	Description
1	Vcc	Red	Handwheel pulse generator power positive	1	5V
2	0V	Black	Handwheel pulse generator power negative	9	GND
3	A	Green	Handwheel pulse generator A pulse positive phase	2	HA+
4	A-	Purple	Handwheel pulse generator A pulse negative phase	3	HA-
5	B	White	Handwheel pulse generator B pulse positive phase	4	HB+
6	B-	Purple Black	Handwheel l pulse generator B pulse negative phase	5	HB-
7	X	Yellow	Handwheel Axis X	10	HSX
8	Y	Yellow Black	Handwheel Axis Y	11	HSY
9	Z	Brown	Handwheel Axis Z	12	HSZ
10	4	Brown Black	Handwheel Axis 4	13	HSU
11	x 1	Gray	1x Handwheel magnification	6	HX1
12	x 10	Gray Black	10x Handwheel magnification	7	HX10
13	x 100	Orange	100x Handwheel magnification	8	HX100
14	LED+	Green Black	Positive voltage for LED		
15	LED-	White Black	Negative voltage for LED	DO08	LED-
16	COM	Orange Black	COM port	9	GND
17	5	Pink	Handwheel Axis 5	14	HSV
18	6	Pink Black	Handwheel Axis 6	15	HSW
19	Emergency stop switch	Blue	Emergency stop switch	-	-
20	Emergency stop switch	Blue Black	Emergency stop switch	-	-
21	Shielded wire	Metal Wire	Connect to effective ground	-	-
22	spare	Red Black	spare signal wire	-	-