Single Axis WiFi/IR/USB Motion Controller

MJKZZ single axis motion controller is designed for many photographical applications involving motion control, such as time lapse, motorized slider, and in particular, focus stacking. It offers three methods to interact with it, namely WiFi, Infrared Remote, and USB-to-Serial. Though it is designed for MJKZZ products, it can be used for many DIY motion control projects due to its flexible design. In this document, this single axis motion control unit will be denoted as FSSWIU controller.

FEATURES

- WiFi communication interface enables wireless control of motion, allowing MJKZZ Focus Stacking Studio application for Windows(R) to control a single step motor.

- **Units released after Sept 1st, 2023** will also support Android phones, tablets via two type of WiFi modes:

  - WiFi client mode. In this mode, FSSWIU controller will act as a node on a local area network via a wireless router. SSID and password of router can be set via Focus Stacking Studio application for Windows (R). In this mode, FSSWIU can be accessed by any computer on the network, including those computers without wireless network card. An important note is that, when working in the field where the specified router is not available, FSSWIU unit will automatically switch to Access Point mode discussed below. This is perfect for field work. However, this switch is permenent, user needs to use Focus Stacking Studio to switch back to client mode.

  - WiFi Access Point mode. In this mode, FSSWIU acts as an WiFi access point, a mobile phone, tablet, or a laptop with WiFi netowrk card can connect to this access point and control it. By default, this is the mode FSSWIU will operate in.

- Infrared Remote communication interface enables user to control FSSWIU unit via a remote, without touching it.

- USB interface allows Focus Stacking Studio for Windows(R) to communicate with FSSWIU unit.

- 32 levels power control, from 3.125% to 100% with 3.125% increament. This gives FSSWIU finer control for variety projects and situations. For example, less power is needed when driving load horizontally than vertically, thus reducing excessive heat and increase efficiency

- One limit switch input. This is critical for those applications where rail must be stopped when reaching certain position. For example, for a vertically mounted setup, installing a limit switch to stop motor reaching down too far to reach specimen, protect both specimen and lens

- One stablizer input. This input port is designed for external vibration sensor where slight vibration can ruin the stack. Response to vibration can be adjusted and smoothed. More information will be discussed later.

- FSSWIU units uses smooth, silent two-phase step motor driver to ensure quiet operation with almost no vibration from motor. This is particularly important for high magnification focus stacking or controlling a video slider.

PORTS

Power Port -- this is where power supply is plugged in. Power supply voltage must be between 12V to 24V. For typical application 12V is good enough, but for high speed motion applications, 24V is recommended. The power plug must be 2.1mm center positive plug. **Important note: do not exceed 24V** because components used inside FSSWIU are rated for 24V operation.

Motor Port -- this is where a bi-polar step motor is connected to. It has four pins with 2.54mm (0.1 inch) spacing and their arrangement is A+, A-, B+, and B-.

Camera Port -- this is where a camera shutter release cable is plugged in. It is a 2.5mm stereo socket which most of camera cable on the market supports. The tip for the camera port is for the camera trigger signal and the middle ring is for the focus signal.

Limit Switch & Vibration Input Port -- this is where limit stop and vibration signal can be detected by FSSWIU.

- Limit Stop input is active LOW input, ie, it is internally pulled high and it is active when the input is shorted to the ground. This comforms most design in photographical field. Because of this, limit switch should be wired accordingly, ie, normal OPEN and active

CLOSED. The limit switch input is the TIP of the 3.5mm stereo input jack.

- Vibration input is used for external vibration detection. It is also active LOW configuration, ie, the external device should pull this input to ground to active the signal. This input is the MID ring of the 3.5mm stereo input jack.

REMOTE CONTROL

The IR remote control is used to control FSSWIU units via infrared lights. It has 21 buttons on the remote and here are explanations of each button.
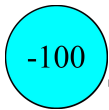
-100 This button has two functions. The first one is to decrease a parameter value being modified by 100. The second fuction is, for some parameters, decrement by one notch. For example, when current position is being modified, it is used to move the rail 1000,000 steps backwards or until STOP button is pressed.
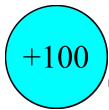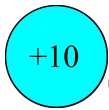
+100 This button has two functions. The first function is to increase a parameter value being modified by 100. The second function is, for some parameters, increment by one notch. When current position is being modified, it is used to move the rail 1000,000 steps forwards or until STOP button is pressed.
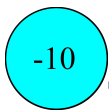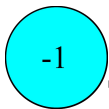
-10 This button has two functions. The first function is to decrease a parameter value being modified by 10. The second function is, for some parameters, decrement by one notch. When modifying the current position, it moves the rail by 10 times step size backwards unless STOP is
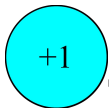
pressed while moving. For example, if step size is 10um (10 microns), it will move the rail 10*10um = 100um backwards.

+10 This button has two functions. The first function is to increase a parameter value being modified by 10. The second function is, for some parameters, increasement by one notch. When modifying the current position, it moves the rail by 10 times step size forwards unless STOP is pressed while moving. For example, if step size is 10um (10 microns), it will move the rail 10*10um = 100um forwards.

-1 This button has two functions. The first function is to decrease a arameter value being modified by 1. The second function is, for some parameters, decrement by one notch. When current position is being modified, it moves the rail by one step size backwards unless STOP is pressed while moving. For example, if step size is 10um (10 microns), it will move the rail 10um backwards.

+1 This button has two functions. The first function is to increase a arameter value being modified by 1. The second function is, for some parameters, increament by one notch. When current position is being modified, it moves the rail by one step size forwards unless STOP is pressed while moving. For example, if step size is 10um (10 microns), it will move the rail 10um forwards .
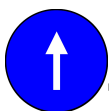
↑ This button is used to navigate menu, to move menu item up by one.
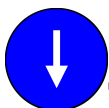
↓ This button is used to navigate menu, to move menu item down by one.
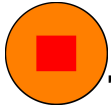
⬛ This button is an important button and it is called STOP button. By pressing this button, all active actions, such as rail motion, stacking, time-lapsing, focusing, etc, will all be stopped.

SP This button is used to move the rail to the starting position. This is useful to do a final check before stacking or time-lapsing.

EP This button is used to move the rail to the end position. This is useful to do a final check before stacking or time-lapsing.

▶| This is the button to start focus stacking or time-lapsing. It is only active in the MAIN menu page, in other menu pages, it does not do anything, so be sure you are in the MAIN page.

MN This is the button to move menu page to MAIN menu so that you can access parameters in the MAIN menu.

PM This is the button to move menu page to PARAM menu so that you can access parameters in the PARAM menu. Most parameters in this menu page are related to motor and rail setup.

TK This is the button to move menu page to TIME menu so that you can access parameters in the TIME menu. Most parameters in this menu page are related to timing, such as hold time, shutter release time, wait time, etc, etc. All these parameters will be explained in details in another section.

F1 This button is to take a picture manually. It can be used as a remote shutter trigger.

F2 This button is currently **UNUSED**, ie, no function at all

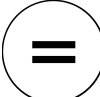**F3** This button allows user to select one of the three operations: focus stacking, time lapse, and motorized slider.

Using menu selection buttons, ⬆ or ⬇ to select which operation, then press ▶❙ or = to make a selection. To cancel out selection, press ■ or any of the following MN, PM, or TK.

= This button is used to copy current position into either start position or end position depending on which one is current menu item being modified. It is also used to make a selection after F3 is pressed. This button does nothing if current menu item is NOT either start position or end position when in main menu.

L This is the button to recall saved settings from controller's non-volatile memory.

S This is the button to save current settings to controller's non volatile memory, meaning, once saved, data will NOT be lost even when power is turned off. This is useful, for example, once rail pitch is set up, it can be saved and recalled upon next power up.

MENU

Main Menu

To access this menu, press (MN) button on the remote. If focus stacking operation is selected, the title of this **"main"** menu is *Stack*. The following are explanation of each menu item in focus stacking mode.

- **Pos** – this is the current position of the rail. When it is high lighted, pressing -100 or +100 button will move the rail by 100,000 steps backwards or forwards respectively, essentially moving the rail until STOP button is pressed. Pressing -1 or +1 button will move the rail by one step size backwards or forwards. Pressing -10 or +10 button will move the rail by 10 step sizes either backwards or forwards

- **Start** – this is the start position for the rail to move from. It can be set using -1, +1, -10, +10, -100, and +100 buttons, but it can also be set using the **=** button to copy current position value into Start position.

- **End** – this is the end position for the rail to move to. It can be set using -1, +1, -10, +10, -100, and +100 buttons, but it can also be set using the **=** button to copy current position value into End position.

- **#** – this parameter is total number of shots to be taken during focus stacking or time-lapse. It is READ ONLY under focus stacking mode and it is calculated by system. It is edittable under Timelapse operation. There are some limits on this parameter. If step size is set to one micro step (note, not one micron, it is the smallest step size you can set under micro step settings), this value can not exceed

total number of micro steps as it is not possible to further divide one micro step. It also can not be zero because it would be meaningless. If start and end position are the same, this value is set to one. If start and end position is not the same, the minimum value for this is TWO, one shot at start position and one shot at the end position. It can be set using -1, +1, -10, +10, -100, and +100 buttons.

- **Step** – this is the parameter to specify step size, minimum step size is one micro step (depending on micro step setting, actual physical step size in microns is different). It is READ ONLY under Timelapse mode and is calculated by system. It is edittable under focus stacking operation. When step size is less than 100um, the ending unit will be display as "u"; when step size exceeds 100um, the ending unit will be display as "m" for millimeters; when step size exceeds 100mm, the ending unit will be displayed as "M"for meters. It can be set using -1, +1, -10, +10, -100, and +100 buttons.

- **Depth** – this is the total distance between start and end position. It is read only display.

When in Timelaps operation mode, the title of this "**main**" menu is *Timelapse*. Under this menu, each items has same meaning as in focus stacking mode with exception of READ ONLY item as described above.

When in video slider mode of operation, the title of this "main" menu is *Slider,* menu items of "Pos", "Start", and "End" has same meaning, ie, current position, start position and end position. The "Speed" menu item allows user to specify how fast rail moves. More operation details will be discussed later.

Parameter Menu

To access this menu, press (PM) button on the remote. and the following are explanation of each menu item.

- **M. STP** – this is where you set micro stepping value. The range for this parameter is FULL, ½ step, ¼ step, 1/8 step, 1/16 step, 1/32 step, 1/64 step, 1/128th, and finally, 1/256 step. Setting this value can affect minimum step size and speed of motor. Note, -1, -10, -100 buttons all will decrease this value by one, and +1, +10, +100 buttons all will increase this value by one.

- **Power** – this is the parameter for running power setting where output torque of motor is determined by this value. The higher the current setting, the more torque motor will output. This can also be used for various motors according to their specifications, useful for many DIY projects. Maximum current is 100% and minimum is 3.125%. Note, -1, -10, -100 buttons all will decrease this value by one notch, and +1, +10, +100 buttons all will increase this value by one notch.

- **Idle** – this is the parameter for idling current for motor. When using batteries, it is better to lower the current for the motor to save battery when the rail is not in use. This value can also reduce heating for motor when not moving because if motor is idle, less current is supplied. However, it is also necessary to hold the rail in position while idling, so it is a good idea to balance power saving and idle torque requirement. Note, -1, -10, -100 buttons all will decrease this value by one, and +1, +10, +100 buttons all will increase this value by one.

- **Pitch** – this is where the pitch of lead screw can be specified. Pitch refers to how far the lead screw travels for a full turn and is expressed in microns. For example, MJKZZ focus stacking rail, SR-90P, has pitch value of 1000 (microns), this means, if the lead screw makes a full turn, the rail will travel 1000um, or 1mm. For other lead screws that travel 0.1 inch per turn, it can specified as 2540um

- **S/Rev** – this is the parameter that specifies number of FULL steps per revolution of motor. Typical values are 200(1.8 degrees per step) and 400 (0.9 degrees per step).

- **Rvrs** -- this is the parameter to reverses direction of movment, this is used for situation where direction of "forwards" and "backwards" is not intuitive. For example, it is customary to define "forwards" as moving towards subject and "backwards" as away from subject. But if rail, particularly DIY rail, does not behave that way, this parameter can solve that problem.

Time Menu

To access this menu, press TK button on the remote. and the following are explanation of each menu item.

- **Wait** – this parameter specifies amount of time, in milliseconds, to wait before taking a picture after moving. This is to ensure all mechanical parts are settled before taking a picture.

- **Hold** – this parameter specifies amount of time, in milliseconds, to hold AFTER camera is triggered to take a picture. This is used to

synchronize with camera shutter. For example, if camera shutter is set to 1 second, the rail must hold at least 1 second before moving, else the image will be blurred by motion.

- **Snap** – this is the parameter that specifies amount of time the shutter release must be held to trigger camera release. This value depends on camera model, but most of the time, 300ms is enough to trigger any camera unless some camera IR remote is used.

- **Speed** -- this parameter specifies how fast the rail moves.

- **# Img** -- this is the parameter that specifies number of images to take for each step.

- **Vibr** -- this is the parameter to specifies how long to wait AFTER vibration input is active. This will effectively smooth out the vibration response because usually, once vibration is detected, it will be detected again until the source of vibration goes away. For example, a car passing by, vibration caused by it will last a few seconds with higher frequency. With this parameter, FSSWIU will wait till the car passes, instead of activating vibration condition number of times.

Loading and Saving Settings

This controller loads the following settings from its non-volatile memory (ie, even after power off, data will not be lost in these memories) by pressing **(L)** button.

- Pitch expressed in microns (Pitch)

- Turn per revolution of motor (T/Rev)

- Running power level (Power)

- Idle power level (Idle)

- Micro stepping value (M.STP)

- Wait time (Wait)

- Hold time (Hold)

- Snap time (Snap)

- WiFi settings:

  - WiFi SSID

  - WiFi password

  - WiFi Host name used in Access Point mode

  - WiFi password used in Access Point mode

Note, WiFi settings can only be editted by using Focus Stacking Studio for Windows(R). These values can be modified and saved by pressing (S) button.

OPERATIONS

To select operation mode, press (F3) button on the remote. When mode

menu shows up, use ⬇ or ⬆ button to select one of the following mode:

- Stacking

- Video Slider

- Timelapse

For more details, please read description for (F3) button in previous section.

Focus Stacking Mode

This is the mode for focus stacking where either camera or subject can be mounted on a moving rail and capture a series of images. These images will be fed into a computer program, namely focus stacking software, to compose a final image.

In focus stacking mode, moving the rail where the front of subject is just start to be in focus, and then move the rail till the back of subject is in focus. FSSWIU allows this two positions to be set.

In focus stacking mode, step size, ie, the spacing for the series of images, can be set, too. Then based on starting, ending position, and this step size, number of images will be calculated. Note, this number of images value is not editable in focus stacking mode.

Video Slider Mode

This is the mode where a rail can be operated as motorized video slider. In this mode, user can set a starting position, an ending position, and how fast the rail should move, ie, speed. When ▶ is pressed on the remote, FSSWIU controller will move the rail from the two positions at specified

speed. Because this process can be accurated repeated, many video effects can be achieved.

Timelapse Mode

This is the mode where motion timelapse can be achieved where two positions can be specified, as well as number of images to capture. Note, Timelapse screen is very similar to Stacking screen with one key difference: in Timelapse mode, number of images can be changed and step size, ie, spacing between two images is calculated. Setting **Wait** and **Hold** (see description above) will specify timelapse interval.

Stationary timelapse can be achieved by setting starting and ending positions to be the same.