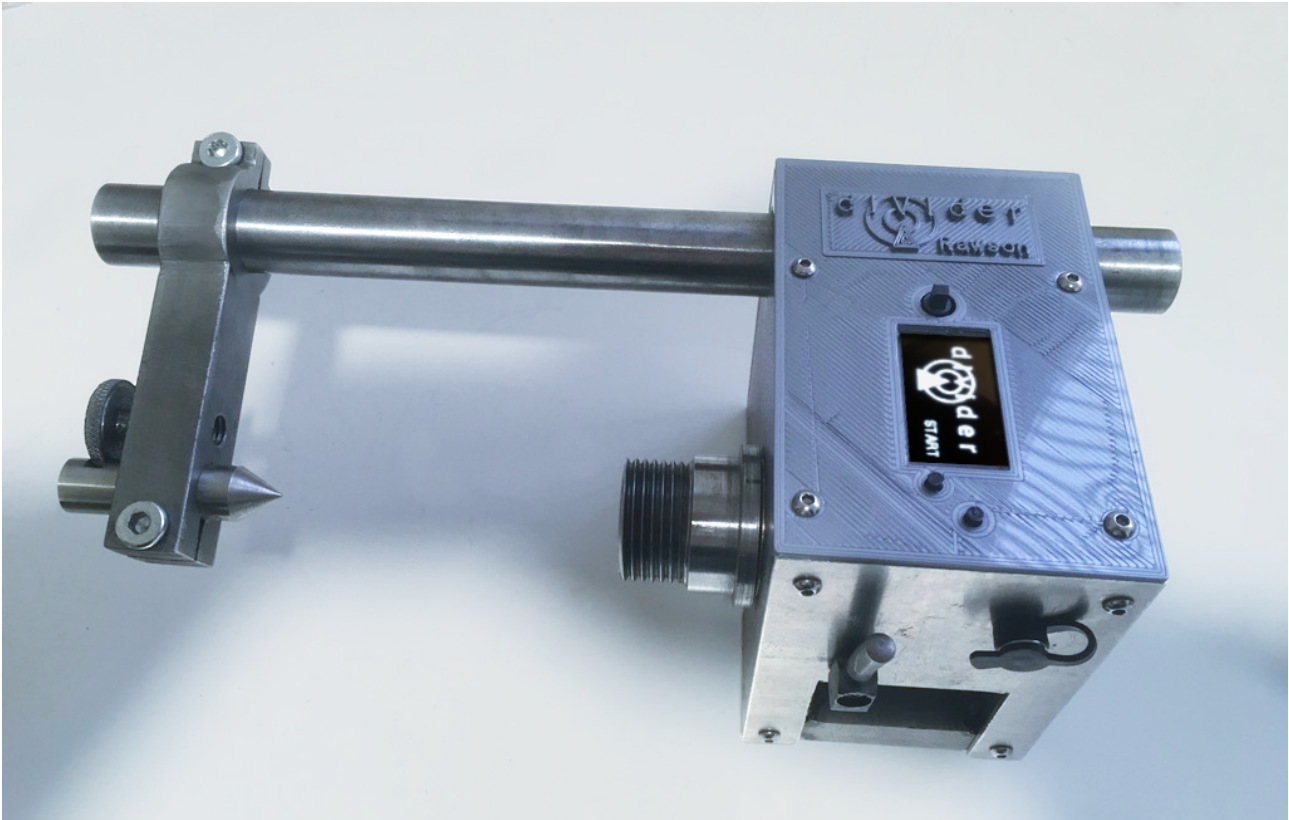# The Rawson Divider User Guide

The original design and prototype was based on a Raspberry PiZero computer but this has now been superseded by an Adafruit 'ItsyBitsy M4' whose core is an ATSAMD51 microcomputer. The reasons for the change are as follows:

1. The smaller size offers a space saving.

2. The fact that this does not require a Linux operating system to run means start up time is greatly reduced.

3. Software is held in internal memory — no SD card.

4. Easier to clone.

Also in rewriting the software for the new hardware many improvements have been added to its functionality.

Capabilities

1. Divide a circle between 1 and 999 divisions with a calculated accuracy better than 108 arc seconds i.e. 0.03 degrees.

2. Rotate repeatedly by a set angle between 0.1 and 999.9 degrees.

3. Selectable preferred direction of rotation clockwise or anticlockwise.

4. Step back to last position.

5. Adjustable backlash compensation.

6. Configurable motor parameters.

7. Configurable gearing.

Switching on

To switch on the divider simply plug in a 12volt supply.

The Divider will display the startup screen after a few seconds.

Controls

To the left and right of the Divider's display screen are switches as shown here.

To the left is a joystick control with a centre push button.
    In general the joystick is used for incrementing and decrementing options while the centre push selects the Preferences Menu.

To the right are Buttons A and B.
    The function of these buttons is always displayed to their left.

The functions provided by these controls depends on the currently active display.

Start

   NB. In Start mode the centre push can be used to select the Preferences Menu (see Preferences Menu).

To **start** dividing press **Button B**

Divide By/Rotate By

This screen shows the currently set divisor, and the number of degrees for each division. This example shows 3 divisions each equating to 120 degrees. This is always the divisor selected at switch on.

If at this point the **centre button is pressed** the Divider's mode will change from 'Divide By' to '**Rotate By**' and the screen display will change, as shown below.

Notice that an extra digit has been added for tenths of a degree.

To return to Divide By mode, press the centre button again.

To change the currently selected numeral (the one in the white box), push the joystick up or down to increase or decrease its value.
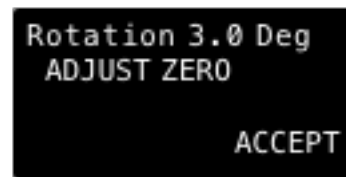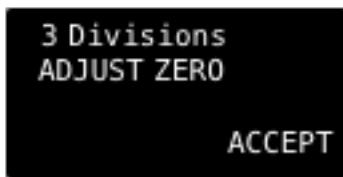
NB. The value will cycle between 0 and 9.

To select a different numeral, push the joystick left or right. This will move the selection box accordingly.

To **accept** the divisor or rotation value press **Button B**

Adust Zero

Depending on the mode (Divide or Rotate), one of the following screens will be displayed.

```
3 Divisions
ADJUST ZERO


        ACCEPT
```

```
Rotation 3.0 Deg
 ADJUST ZERO


        ACCEPT
```

This screen offers the opportunity to nudge the divider forwards or backwards.

Pushing the joystick **right** momentarily nudges the motor **forwards one step**.

Pushing the joystick **left** momentarily nudges the motor **backwards one step**.

Pushing the joystick **up** momentarily nudges the motor **forwards 10 steps.**

Pushing the joystick **down** momentarily nudges the motor **backwards 10 steps.**

NB. if the joystick is held in position, the nudge action will repeat continuously.
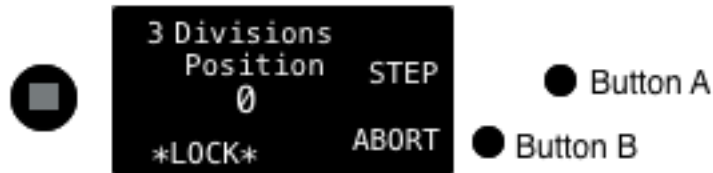
To **accept** the position of the Divider's shaft press **Button B**

For simplicity, only 'Divide By' mode will be shown from now on. All instructions apply to either mode.

If the following screen is displayed when attempting to nudge the motor, the Divider's shaft is locked and must be unlocked before zero adjustment can continue.
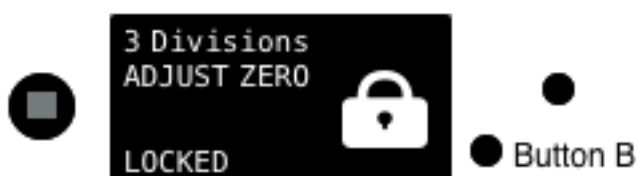
Step

This screen shows the current step position. Shown above is position '0'.

In this mode if **Button A** is pressed, the Divider moves to the **next position.**

If **Button B** is pressed, progress is aborted and the divider returns to the **start** screen.

The screen above shows a '*LOCK*' warning, which flashes on and off, and if 'Lock Alarm' is switched ON (see Preferences Menu) a 'bleep' will also be heard.

> It is important to understand what this means.
> When the lock warning is shown (as above) the motor windings are energised and drawing current. It is advisable not to leave the divider in this state for too long as the motor gets warm when energised and stationary.
> If work is to be carried out at this position then the shaft lock should be engaged. This will in turn cut power to the motor.
> So LOCK the shaft to do work if not stepping to the next position.
> Once the shaft is locked the following screen will appear.
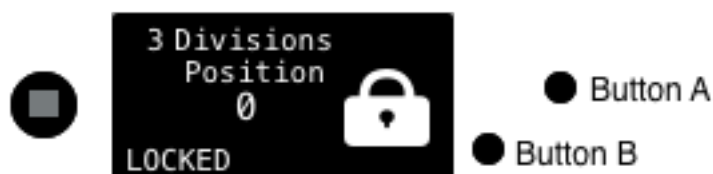
> The above screen should be visible when work is being carried out (at position '0' in this example).

Unlock the shaft to return to the screen below.
When Button A is pressed the motor turns the Divider's shaft to the next position.

While the shaft is in motion the screen below is displayed.

```
3 Divisions
  Position
     0
->> 1333(-0.010)
```
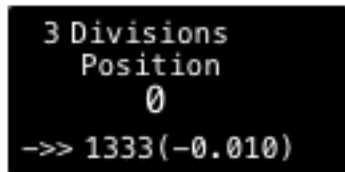
The bottom line shown here details the number of steps being taken to reach the next position and the degrees of error in brackets.
Because the divider moves in discrete steps, it doesn't always divide perfectly.
If the step number is less than the angle desired then a negative error will be shown (example shows -0.010).
NB. *The above scenario is fictitious. In reality there would be zero error when dividing by 3. This example is used to show how the angle error is displayed.*

When the shaft reaches the next position the screen below is displayed.

```
3 Divisions
  Position      STEP        ● Button A
     1
*LOCK*          ABORT       ● Button B
```
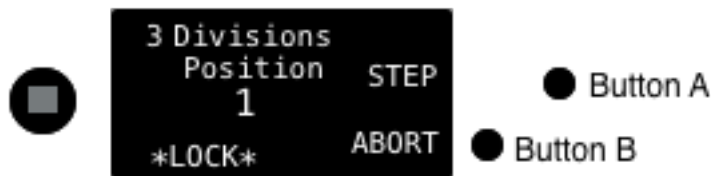
Now the divider is at position '1' so there is an opportunity to step backwards.
To change to **stepping backwards** push the **joystick to the left**.

The screen below will be displayed. The function of Button A has changed to 'BACK'.

```
3 Divisions
  Position      BACK        ● Button A
     1
*LOCK*          ABORT       ● Button B
```
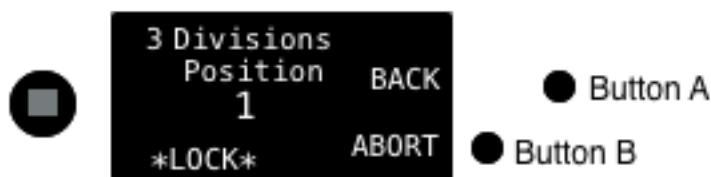
To **step back** press **Button A**

While the shaft is in motion the screen below is displayed.

```
3 Divisions
  Position
     1
<<- 1333
```
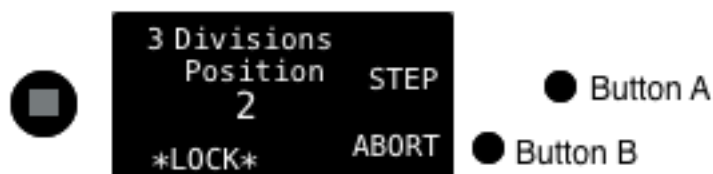
If choosing not to move backwards but continue to position 2, the screen below is displayed.

```
3 Divisions
  Position
     1
->> 1334(0.010)
```

> This time a step has been added to complete the next division. If this hadn't been done the accumulated error would have been -0.02 degrees which is more than half a step (each step is 0.03). Adding 0.03 gives a positive error of 0.01.

When the shaft reaches the next position the screen below is displayed.

```
3 Divisions
  Position   STEP        ● Button A
     2
 *LOCK*     ABORT   ● Button B
```

The final step in the cycle of 3 divisions will bring the position back to '0'
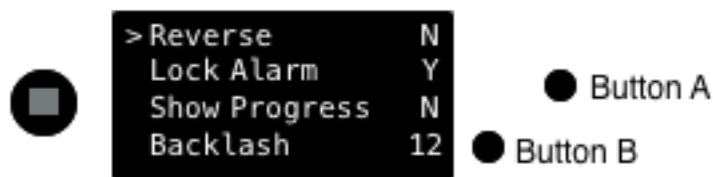
> **NB**. It is not possible to step backwards from position zero, only from positions '1' and above.

> **NB.** In 'Rotate By' mode the position counter resets to '0' when '999' is reached.

Preferences Menu

When the **start** screen is visible, which is immediately after **Power On** or an **Abort, Pressing** the **centre button** on the **joystick** activates the **Preferences Menu** as shown below.


The currently selected item is indicated by the '**>**' character to its left. In the example above 'Reverse' is selected.

Pushing the **joystick Up** or **Down** changes the item **selection**.

Pushing the **joystick Right** or **Left** changes the selected item's **value**.

Pressing the **joystick centre button exits** the **Preferences Menu** and the screen below is displayed, but only if changes are detected.
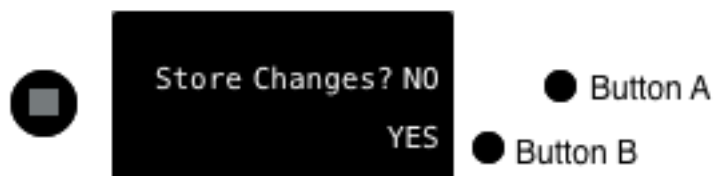
Answer **YES** by pressing **Button B** or
Answer **NO** by pressing **Button A**.

      NB. Saved changes are stored for subsequent uses of the Divider.

The various menu options are as follows:

Reverse

Normal direction of rotation is clockwise. Set to 'Y' for anticlockwise.

Options: Y or N

Lock Alarm

Sounds a bleep alarm when waiting for shaft lock. Set to 'Y' for ON

Options: Y or N

Note. If set to 'N' for 'OFF', bleeps will still be heard during power on, but the Lock Alarm will be silenced.

Show Progress

Shows a progress bar during rotation between positions. Set to 'Y' for ON

Options: Y or N

Note. This option, when activated, causes motor noise.

Backlash

Sets a step number value for backlash compensation. Set to number required.

Options: 0 and above

Note. Backlash value can be found by advancing and reversing the motor during the Adjust Zero phase and counting how many steps cause no movement.

Microsteps

The higher the number the quieter and slower the motor rotates. Set as desired.

Options: 1, 2, 4, 8, 16, 32

Note. 2 or 4 will give best results.

Frequency

The higher the number the faster the motor rotates. Increase value until motor stalls during operation.

Options: 100 and above in steps of 100

Note. This is a bit experimental and does not relate directly to frequency. It reduces the hold delay between steps. Once this gets too small the motor starts to oscillate. A value around 1600 should work OK. This oscillation may not show up on Adjust Zero as the motor will only accelerate to maximum speed during multi-step division.

Steps/Rev

Number of steps per revolution for stepper motor. Set according to motor fitted.

Options: 100, 200, 400

Gear Ratio

Number of worm teeth. Set according to worm fitted.

Options: 1 and above

Note. This would normally be either 30 or 60.

Version

Displays the current software version

Options: None

Serial

Displays the device serial number

Options: None

Important

When stepping between divisions the **Divider must be free to rotate**.
If tooling fouls its rotation it may miss some steps, or worse, damage
the worm. Either way it will lose its place.
If just steps are lost it will have to be zeroed-in on the work before
accurate dividing can continue.

It must become second nature to make sure the work is withdrawn fully
from the tooling before unlocking and stepping the Divider.