

# Electronic Rotary Table Divider – V3.04

## Operating Manual



## **Legal:**

All documents, code, schematics, firmware etc are offered as an aid to the experienced constructor to allow them to build their own division controller.

I offer no warranty either express or implied, i.e. you build and operate this device at your own risk.

In building and operating this device you accept that there may be bugs or other problems both with the hardware, its associated firmware and documentation that may cause it to function in a manner that could possibly cause injury.

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## **Description.**

The controller is intended to drive rotary table, lathe head indexer etc. Allowing easy, error free division without the use of division plates.

As well as division the controller allows movement by angles (0.01 to 360 degrees), continuous motion (for machining), positioning (jog mode), automatic cutting of gears and a sophisticated program mode which allows complex sequences of movements and events to be executed.

Input is via a 16 key keypad whilst a 4 line by 20 column LCD display provides information in a user friendly format.

## **Features.**

- Jog mode. Keys move CW/CCW in 0.01, 0.1, 1.0 and 10.0 degree steps.
- Division mode. Divide a circle into any number of divisions from 1 to 9999 inclusive.
- Degree mode. Any number of degrees from 0.01 to 359.99 in 0.01 degree steps (note: minimum step size depends on mechanics).
- Continuous drive. Table is driven continuously CW/CCW at one of the (selectable) 9 speeds. (V3.04.1 allows increments of 0.1)
- Gear mode. Drives two axis to facilitate automatic gear cutting.
- Program mode. Allows complex sequences to be carried out. (Up to 10 programs can be stored)
- Configurable for any worm drive from 1:1 to 9999:1.
- Nine speed settings.
- Configurable for all common stepper / driver combinations.
- Six (nameable) machine profiles.
- Backlash compensation.

## General Usage

### Keypad Layout.

The keypad comprises 16 keys normally arranged in a 4 x 4 grid as below.

1 -0.01	2	3 +0.01	Speed
4 -0.1	5	6 +0.1	S
7 -1.0	8	9 +1.0	G
<< -10.0	0	>> +10.0	C

Throughout the following document, a key press is shown in square brackets i.e. [1] means the key 1 etc.

### **[S] – Stop.**

Stop key, if the table is moving pressing [S] will stop it immediately on the current step.

Note the controller stops the table immediately however the mass of the table means it may overshoot and the indicated position may be wrong. Using [C] instead decelerates the table and preserves the position.

### **[C] – Cancel.**

Cancels an edit, backs out of menus/modes. If the table is moving it will bring it to a stop.

Pressing repeatedly will return to the main menu.

Whilst in the main menu press and hold to return to profile select.

### **[G] – Go.**

Enters a value in an editable box.

### **[<<], [>>] – Prev, Next.**

Cursor movement left / right or up / down.

Advances table 1 division CCW or CW in division mode or by angle in degree mode. In V3.04.1 also adjusts speed by +/-0.1 after speed button pressed and speed is flashing.

### **[Speed] - Speed.**

When stationary, press to change the speed followed by a numeric button 1 to 9 to set the speed.

Value flashes to show speed change is active but times out after around 5 seconds if no key pressed.

(Note: press speed a second time or [C] to cancel.)

### ***Numeric (Jog) values.***

In jog mode pressing these buttons will advance the table by the value shown under the key.

### **Editing numbers.**

Numbers to be edited are surrounded by a pair of square brackets (e.g. [0060]) with the cursor visible beneath the left most digit.

Pressing a numeric key will overwrite the digit at the cursor and move the cursor one place to the right.

The cursor can also be moved with the [<] & [>] keys.

Press [G] at any time to enter the number displayed, or [C] to cancel (resetting the number to its original value).

**Note:** It's not possible to overwrite or move a decimal point.

### **Quick Start Guide**

Power on the device and you'll see the main menu.

Each option is preceded by the numeric key to press to select that option.

Try division mode by pressing [2].

The screen will change to "Enter Number Divs:" - just press the [G] key to accept the current value.

We're now in the "Division" screen which will show us the speed in the top right corner, the current position "Pos" in degrees and the current division "Div" along with the total number of divisions.

Press [<] to rotate anti-clockwise and [>] to rotate clockwise.

Press [C] to return to the main menu then do the same again, this time change the number of divisions (See 'Editing numbers' above).

The next step is to tell the controller how many steps are required to make your table rotate through 360 degrees.

To do this we go into Setup [9], press [>] once and we'll be in the "Steps per 360" screen.

The number shown here is obtained by multiplying the number of steps per revolution for the motor from the stepper driver (I normally set this to 400) by the worm (or gear) ratio between the motor and the table. (Common values are 90:1, 45:1 etc). The default value is for a 400 steps/rev driver setting and a 90:1 worm (400 x 90 = 36000).

To change this to match your equipment press **[G]** to change the value and type the new value in as a 6 digit number.

So for example if you've got 400 for the driver and a 45:1 worm then you'd enter the six digits; "018000" (400 x 45) into the box.

Press **[G]** to accept this or **[C]** to cancel.

Having accepted the new value press **[C]** to exit the Setup menu.

## **Profiles**

The software allows up to 6 machine profiles.

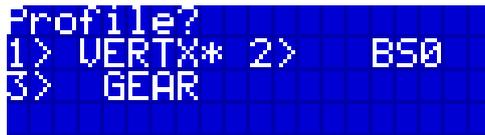
Each profile allows different feed rates, worm ratios and hardware specific settings to be set. This allows the controller to be connected to up to six different devices, e.g. Rotary table, lathe head indexer, dividing head etc.

### **Enter Profile.**

If more than one profile is active when the device is first powered up the device will show a list of active profiles.

Press the number in front to select that profile.

The last active profile will have an asterisk (\*) as a suffix.



```
Profile?
1> VERTX* 2> BS0
3> GEAR
```

### **To Create a New Profile.**

There are two ways to do this:

1. From the main menu press and hold the [C] button until the profile select screen appears. This will show all 6 profiles allowing you to select one. If that profile is currently disabled then it will be enabled.
2. In setup go to “Change Profile” and select the profile from the list that you want to create.

Profiles default to names which are “P:” followed by a number from 1 – 6. However these can be changed to better represent the device you’re controlling. E.g “VERTX” or “BS0” etc

See “Change Profile Name” in Setup for details on doing this.

Once enabled profiles can be disabled which means they won’t appear in the initial profile select list. (Or re-enabled to allow them to appear again). See “Active Profiles” in setup.

## **Main menu.**

All options are available from here, you can return here from anywhere by repeatedly pressing the [C] (cancel) key.

The display shows available options and current machine profile in the top right.

```
Mode? P:1
1> Jog      2> Div
3> Dea     4> Cont
5> Prarm   9> Setup
```

To use simply press the number relating to the mode you wish to use.

- [1] Jog,
- [2] Division
- [3] Degree
- [4] Continuous
- [5] Program (if enabled in setup)
- [6] Gear (if enabled in setup)
- [9] Setup.

Press and hold [C] to return to the 'Enter Profile' screen.

### **Notes:**

Program and Gear mode can both be enabled or disabled in which case the options may not be shown in the main menu.

If both Program and Gear mode are enabled then Setup will not be shown due to lack of space although the [9] key will still enter it.

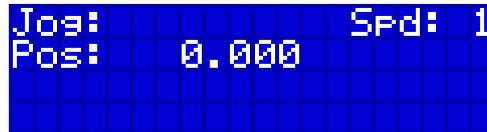
Default is for Program mode to be enabled and Gear mode to be disabled.

### Jog Mode.

Jog mode is primarily used to set the initial position of the table / workpiece.

Display shows current speed of table and current position in decimal degrees.  
The bottom line shows the machine status.

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.



```
Jog: Spd: 1
Pos: 0.000
```

### **Keys:-**

- [1], [3] Move the table CCW / CW by 0.01 degrees for each press.
- [4], [6] Move the table by 0.1 degrees.
- [7], [9] Move by 1.0 degree.
- [<], [>] Move by 10.0 degrees.
  
- [G] To directly enter an angle to turn to.
  
- [C] To return to the main menu.
  
- [0] Reset indicated position to 0.00.
  
- [Speed] Press followed a numeric button to set the speed 1-9.  
From V3.04.1 whilst still flashing the [<] & [>] keys will adjust speed in 0.1 steps.

### **Notes:**

Actual angle moved is to the nearest step.

For example a 60:1 worm with a half step controller has a minimum step of 0.015 deg, so this would be the minimum each step could take with the best accuracy being half that value.

Jog mode preserves the position, so when entering Jog mode position will show the angle the table was last at.

### **Division Mode.**

Division mode is used to divide a circle into a set number of parts. The first screen will prompt you for the number of divisions.

```
Enter Number Divs:
Division =[0060]
```

Enter the number of divisions you want to divide the circle into as four digits. E.g. 0133 to divide into 133 parts.

Press **[G]** to continue or **[C]** to return to main menu.

### **Division Screen.**

This is the main screen division takes place on, it shows mode (Division), speed, current position in degrees and current division out of total divisions. Bottom line shows machine status.

When first entering the position is reset to 0.00 degrees and division to 0.

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.

```
Division:      Spd: 1
Pos:      0.000
Div:      0 of 60
```

### **Keys:-**

**[<]** Indexes (moves) table CCW by one division.

**[>]** Indexes (moves) table CW by one division.

**[Speed]** Press followed a numeric button to set the speed 1-9. (Table must be stopped). From V3.04.1 whilst still flashing the **[<]** & **[>]** keys will adjust speed in 0.1 steps.

**[C]** Returns to the main menu. (Or stops table if moving).

**[S]** Emergency stop – table stops immediately.

**[G]** Allows Div to be directly edited. Table will go directly to this division. Once entered you'll be asked for the direction, press **[G]** to take the shortest path or use **[<]** or **[>]** to rotate CCW or CW. **[C]** will cancel at any point.

**[0]** Query and reset indicated position to 0.00.

### Degrees Mode

Degree mode is used whenever you wish to move by an absolute angle each time.

The first screen will prompt for the number of degrees to use for each move.

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.

```
Enter Num Degrees:
Degrees =[060.00]
```

Enter the number of degrees as 5 digits (you can't change the decimal point), e.g. for 75.50 degrees press 0, 7, 5, 5, 0.

Press [G] to continue or [C] to return to the main menu.

### **Degree Screen.**

This is the main screen for degree mode.

The screen shows mode (Degree), speed, current position in degrees and the initial angle setting.

Bottom line is machine status.

When first entering the position is reset to 0.00 degrees.

```
Degree:          Spd: 1
Pos:      0.000
Deg:     60.00
```

### **Keys:-**

[<]            Indexes (moves) table CCW by Deg.

[>]            Indexes (moves) table CW by Deg.

[Speed]        Press followed a numeric button to set the speed 1-9. (Table must be stopped). From V3.04.1 whilst still flashing the [<] & [>] keys will adjust speed in 0.1 steps.

[C]            Returns to the main menu. (Or stops table if moving).

[S]            Emergency stop – table stops immediately.

**[G]** Allows Pos to be directly edited. Table will go directly to this angle. Once entered you'll be asked for the direction, press **[G]** to take the shortest path or use **[<]** or **[>]** to rotate CCW or CW. **[C]** will cancel at any point.

**[0]** Query and reset indicated position to 0.00.

### Continuous Mode

This is the main screen for continuous movement.

The screen shows mode (Continuous), position in degrees and speed.  
Bottom line shows machine status (and direction query).

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.

```
Continuous:   Spd: 1
Pos:         0.000
Press direction
```

### **Keys:-**

[<]            Begins rotation CCW. Press [C] or [S] to stop.

[>]            Begins rotation CW. Press [C] or [S] to stop.

**[Speed]**        Press followed a numeric button to set the speed 1-9. (Table must be stopped). From V3.04.1 whilst still flashing the [<] & [>] keys will adjust speed in 0.1 steps.

### Gear Mode

Gear mode divides a circle into the number of teeth which it then automatically indexes, after each index the controller will cut the tooth using the second stepper motor port to drive the cutter.

Note that at the start (0mm) the cutter should be in the fully retracted position.

The first screen will ask for the total number of teeth.

```
Enter Total Teeth:
Total = [0030]
```

When you've entered the number of teeth you will be given the option to cut a subset of these, the default value is to cut all the teeth (just press [G] again to accept the default).

For example if you only want to cut teeth over a 90 degree quadrant which had 10 teeth then the total teeth would be 40 (over 360 deg) and the number to cut would be 10.

```
Enter Total Teeth:
Total = 0030
Number To Cut:
To Cut = [0030]
```

Finally you'll be asked for the Cutter Travel.

This is the distance the cutter will travel and should be large enough for it to make a complete pass through the material.

The value defaults to the last value entered and is saved in NVRAM simply press [G] to accept or enter a new value.

Note: Correct operation of this requires "Steps per 100mm" to be correctly set in Setup.

The limit switches can also be used to set maximum travel for the cutter, i.e. the cutter will travel until it hits the limit switch (Limit 2).

```
Cutter Travel
[40.00]mm
```

### ***Gear Screen.***

This is the main screen that gear cutting takes place on, it shows mode (Gear), cut rate, current tooth being cut, current position of cutter (in mm).

The bottom line shows machine status.

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.

```
Gear:      Cut Rate: 5
Tooth:    1 of 30
Cutter:    Ø.ØØmm
Press [G] to Start
```

### ***Keys:-***

**[Speed]** Press followed a numeric button to set the speed 1-9. (Table must be stopped). From V3.04.1 whilst still flashing the [<] & [>] keys will adjust speed in 0.1 steps.

Note that this is the ‘cut’ speed. The indexing speed is the current value set in Division mode.

**[C]** Returns to the main menu. (Or stops table if moving).

**[S]** Emergency stop – table stops immediately.

**[0]** Query and reset indicated position to 0.00.

**[G]** Begins gear cutting.

### ***Status Line:-***

Whilst cutting the status cycles through the following:

“**Cut Tooth**” – Cutter advances and cuts the tooth at the set speed.

“**Retract**” – Cutter retracts at high speed.

“**Indexing**” – Workpiece is rotated for next tooth.

(If you're using the limit switches to set the range it will also show when it hits a limit switch before continuing).

**For gear mode to function correctly the following values should be set in Setup for correct operation.**

**“Enable Gear Mode”** should be set to **“Yes”**.

**“Cutter Step Rate”** should have suitable values for the range of cutter speeds required.

**“Retract Step Rate”** should be set to a suitable speed to retract the cutter.

**“Steps per 100mm”** should be approximately the right number of steps to move the cutter 100mm (this ensures the values you enter for “cutter travel” and any values displayed make sense).

## **Setup**

Entering setup will go directly to the first setup option.

The options displayed are relevant to the current machine profile. If you have more than one profile make sure you have selected the profile whose options you want to change.

Any options changed in setup are automatically saved to the selected machine profile in NVRAM (non-volatile RAM) and so are kept even if the power is removed.

### ***Generic Navigation Keys For Setup.***

- |     |  |
|-----|--|
| [G] | To change values currently displayed.                |
| [C] | To return to main menu (or cancel a current change). |
| [>] | Next screen.   |
| [<] | Previous Screen.                                     |

### ***Set Rotary Step Rate***

Sets the low and high values used during indexing operations.

Lo is the speed used when Speed is set to '1' and Hi when Speed is set to '9'.  
Values between are interpolated, i.e. Speed 5 is half way between the two values.

Display shows the starting speed, the final Lo(w) and Hi(gh) speeds along with the acceleration time (Time).

```
Rotary Step Rate ?  
Lo (Speed 1): 500  
Hi (Speed 9): 2000  
Time: 2.0
```

Press [G] to change these and step through each field. The field you are currently editing will be surrounded by square brackets i.e. [2000].

Pressing [G] at the final field (Time) completes changes to this screen.

#### **Notes:**

Speeds are in steps per second.

Acceleration time is in seconds and is the amount of time it would take to reach the maximum step speed of 9999 per second.

Lower speeds take proportionally less time, i.e. the acceleration is a constant.

So if this is set to 9.9 seconds then it would take (aprox) 10 seconds to get to 10,000 steps/second and 2 seconds to get to 2,000.

The maximum value for Hi can be determined experimentally by increasing it until the motor stalls and then backed off slightly.

Bear in mind that for typical division applications there's not much to be gained by making this too high.

Lo should be the slowest you're likely to want to the table to rotate (usually for cutting whilst rotating).

(I find having a separate profile with a range of low values for performing cuts whilst rotating works best.)

### ***Set Steps Per 360***

Sets the number of step that need to be sent to the stepper for a single complete turn (360 degrees) of the table.

Press [G] to change.

```
Steps Per 360 ?  
36000
```

### **Notes:**

Value is the number of steps per rev of stepper motor (eg 400 steps if half stepping) multiplied by the worm ratio of the table. So if you're using a half step driver and a 200 step motor along with a 90 to 1 ratio table then that would be  $2 \times 200 \times 90 = 36000$ .

Maximum value is 999,999.

Try to avoid having too large a value in here. 36,000 is ideal, increasing micro-stepping to increase this value is handled internally by firing multiple steps so the resolution can never exceed 36,000 steps.

The ideal value is the first value at or above 36,000 you can set. (Higher values also reduce the maximum speed of the motor since the controller is limited to 10,000 steps per second at max step rate).

### ***Swap Rotation Direction***

Allows you to set the direction the table rotates to match the controller.

Press [G] to toggle between CW (clockwise) and CCW (counter clockwise).

```
Swap Rotation Dir ?  
CW
```

### ***Set Backlash***

Allows you to set the amount of movement required to compensate for backlash.

Press [G] to edit the value.

```
Backlash ?  
Num Steps: 10
```

#### **Notes:**

Backlash is removed by always finishing rotations CW, to do this the table overshoots any CCW rotation by the number of steps set here, then rotates CW by that same number of steps – the same as you would do manually.

If the number is too small then the backlash won't be taken up fully, too large and the table will move more than is required.

### ***Set Clock Pulse***

Allows the user to set the polarity of the clock pulse to match that of the stepper controller hardware.

Press [G] to toggle between high and low.

```
Rot Clock Polarity ?  
High --
```

#### **Notes:**

If the polarity is incorrect the stepper controller may not step or be unreliable. Some controllers work fine regardless of polarity.

### ***Enable Polarity***

The enable line signals that the controller is about to move the motor.

Historically this would connect to the driver to turn it on or off but modern drivers don't require this and I recommend you don't use it for this purpose.

It could however be used to drive a mechanical 'brake' to lock the table between operations, to this end you can set a delay between the enable going active and the motor being driven (see Enable Delay below).

Press **[G]** to toggle between high and low.

```
enable Polarity ?
Low
```

### ***Enable Delay***

Set a delay between the enable line signalling active and the stepper motor operating. This can be used to give time for a mechanical brake to disengage before driving the motor.

Time is in seconds; 0 to 9.9 (default is 0.0).

Press **[G]** to change the value.

```
enable Delay ?
0.0
```

### ***Enable Program Mode***

Enables or disables program mode (removing it from the front menu).

Press [G] to toggle between Yes (enabled) and No (disabled).

```
Enable Program Mode?  
Yes
```

### ***Enable Gear Mode***

Enables or disables Gear mode (removing it from the front menu).

If set to Yes it also enables setup options for gear mode (Gear Mode Only options).  
If set to No then skip to “Is Default Profile” setup.

Press [G] to toggle.

```
Enable Gear Mode ?  
Yes
```

### ***Set Cutter Step Rate (Gear Mode Only)***

This works identically to “Set Rotary Step Rate” except it acts on the linear step output.

```
Cutter Step Rate ?  
Lo (Speed 1): 500  
Hi (Speed 9): 2000  
Time: 2.0
```

### ***Retract Step Rate (Gear Mode Only)***

Sets the step rate used when retracting the cutter on the linear step output.

Press [G] to change.

```
Retract Step Rate ?  
Value: 2000
```

### ***Steps per 100mm (Gear Mode Only)***

This specifies how many steps it takes for the cutter to move 100mm along the linear axis.

This number is 100mm divided by the pitch in mm (i.e. number of turns the motor has to make to move 100mm) multiplied by the number of steps per revolution of the motor.

So a 3mm pitch leadscrew with a 400 step motor would give  $100 / 3 * 400 = 13,333$ . Maximum value is 65535.

Press [G] to change.

```
Steps Per 100mm ?  
8000
```

### ***Invert Linear Clock Pulse (Gear Mode Only)***

Inverts direction of clock pulse sent to linear stepper.

Press [G] to toggle between high and low.

```
Lin Clock Polarity ?  
High _-
```

### ***Swap Linear Direction (Gear Mode Only)***

Toggles the direction the linear output travels.

This should be set so that during the cut phase the cutter is driven towards the work (returning during retract).

Press [G] to toggle between Forwards and Backwards (these are notional values and don't necessarily indicate the direction of the cutter).

```
Swap Linear Dir ?  
Forwards
```

***Swap Linear Enable (Gear Mode Only).***

The enable line is a line that signals the controller is about to move the motor.

Whilst I don't recommend using it for the rotary side, on the linear side it's use will turn off the stepper driver when it's not in use (i.e. during rotary only operations).

```
Swap Linear Enable ?  
High
```

***Swap Ports.***

Allows both ports to be connected to different drivers and switched when changing machine profiles (for example).

(If you're not using 'Gear' mode in this profile then ignore the linear port)

Press [G] to toggle between the two.

**Note:**

On the “ready built unit” this swaps between the internal (Rotary) and external (Linear – which is available on the 9 pin socket).

```
Swap Ports ?  
Port1: Rotary  
Port2: Linear
```

***Active Profiles.***

Shows a list of currently active profiles.

Press [G] to change.

You can then toggle each profile by pressing the appropriate number button.

Note you can't disable the current profile, you must change profiles first and then disable it.

```
Active Profiles  
Active: [1 3 ]
```

### Change Profile.

Allows the user to switch to one of the six machine profiles. Current profile is shown.

Press [G] to change to another.

```
Change Profile ?
[G] to select new
```

Once [G] is pressed screen will show all six profiles (even inactive ones).

You can now select any by pressing the associated number.

Once selected profiles are automatically enabled and will appear in the list on power up.

```
Profile?
1> P:1+ 2> P:2
3> P:3 4> P:4
5> P:5 6> P:6
```

### Change Profile Name.

Allows the user to rename the profile to something more meaningful.

Press [G] to change the name. The name will be bounded by “[“ and “]” to show it can be edited.

Use the [<] and [>] keys to move the cursor under the character you wish to change. Then use the numeric buttons to cycle through characters in “old style telephone” fashion.

i.e. pressing 2 will cycle through the following characters: “ABC2” and repeat.

Characters available on each button are:

[1] *+~/@_?&\$'#1	[2] ABC2	[3] DEF3
[4] GHI4	[5] JKL5	[6] MNO6
[7] PQRS7	[8] TUV8	[9] WXYZ9
	[0] <space>0	

```
Change Profile Name?
Name:      F:1
```

**Autorun Program.**

If a program has been entered and saved it can be selected to auto-run when the device is turned on (used for production).

Press [G] to toggle yes/no and enter program number for [yes].



Autorun Program ?  
No

**Factory Defaults**

Resets all values for current profile only.

Press [G] to reset.



Factory Defaults ?  
[G] Resets

## **Programming – overview.**

Programming mode allows a sophisticated sequence of events to take place. It also facilitates the communication with other equipment.

Programs are edited and run from RAM, however they can be permanently saved and loaded into one of ten slots.

### **Notes:**

If you only want the controller for basic division etc then you can completely ignore this section (you can disable it in setup).

Any program not saved will be lost when the device is powered down.

## **Programming Menu**

All programming functionality is available from here.



```
Program:
1> Run   2> Step
3> Edit  4> New
5> Load 6> Save
```

Press the number relating to the mode you wish to use.

- [1] Run – run current program in RAM.
- [2] Step – single step (debug) program.
- [3] Edit – edit current program in RAM.
- [4] New – clear RAM.
- [5] Load – load stored program into RAM for run or edit.
- [6] Save – save RAM to store for later use.

### **Run**

Starts the current program in RAM running.

Whilst running the following screen is shown, information shown is mode (Run), speed and current position.

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.



```
Run:      Spd: 1
Pos:      0.000
```

### **Keys:-**

- [S] Terminates the program immediately.
- [C] Switches to Single Step mode on the next instruction.

### **Notes:**

Whilst running the program can pause – waiting on an event. The following events are described by their associated command:-

### **Status display:**

#### ***Wait Sense.***

Displays “*Waiting for SENSE*” on the bottom line and the program will wait for the SENSE line to cycle high then low.

#### ***Wait Operator.***

Displays “*Press [G] When Ready*” and wait for the operator to press the [G] key.

#### ***Wait Time.***

Displays “*Wait Time: nn*” (where nn is the number of remaining seconds) when time reaches 00 controller will continue automatically.

#### ***Terminating.***

The program finishes normally when the *End* command is reached and displays “*Program finished*” and “*--- Press [G] ---*” along with final table position.

If the user terminates the program with the [S] key the messages “*User Terminated*” and “*--- Press [G] ---*” are displayed.

### Single Step

Allows you to run the currently loaded program one step at a time, mainly used for debugging.

Whilst running the following screen is shown, displaying mode (Step), speed, current position and the next command to be executed displayed after the '>' prompt.

Note: V3.04.1 onwards shows speed as two digits, i.e. 1.0, 2.0 etc.

```
Step:                               Spd: 1
Pos:    0.000
> 1 End
```

### Keys:-

- [>] Executes current command, screen updates to reflect next command.
- [G] Enters Run mode and continues full speed program execution from current point.
- [S] Terminate program.

### Edit

Edits the currently loaded program.

(See Editing Programs below).

### New.

Erases current program in RAM and goes into Edit mode.

**Note:** Program will be lost if power is removed, if you wish to keep it then remember to save before removing power.

You don't need to save a program in order to run it.

### Load.

Allows user to load a previously saved program into RAM from one of the ten slots.

The load screen shows mode (Load), prompts for the slot to load and the bottom line (Used) shows a list of slots that have a program stored in them. (So from the example shown below, slots 3 and 7 have programs in them and the rest are empty).

```
Load:
Slot [0-9]? [0]
Used: [ 3 7 ]
```

### **Keys:**

[0] ... [9] The number keys [0] through to [9] change the number of the slot you wish to load.

[G] Loads slot shown in brackets.

[C] Cancels and returns to programming menu.

### **Note:**

Loading an empty slot simply clears the program memory.

### Save.

Allows user to save the current program in RAM into one of the ten available slots.

The save screen shows mode (Save), prompts for the slot to save into and the bottom line (Free) shows a list of slots that are empty. (So the example shown below all the slots are empty with the exception of 3 and 7 which have a program stored in them).

```
Save:
Slot [0-9]? [0]
Free: [012 456 89]
```

### **Keys:**

[0] ... [9] The number keys [0] through to [9] change the number of the slot you wish to save to.

[G] Saves into slot shown in brackets.

[C] Cancels and returns to programming menu.

### **Note.**

If RAM is empty then saving it will clear the slot.

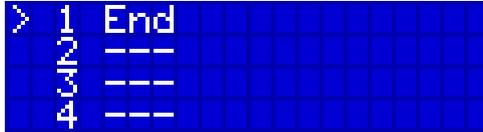
## **Editing the Program**

Allows the user to enter a program or edit an existing one.

The screen shows a window of 4 lines on the program along with a cursor (>).

Lines begin with the current line number followed by the command.

With an empty program the screen looks like this.



```
> 1 End
---
---
---
```

### ***Keys:-***

[>] Moves the cursor down towards the end of the program. (Cursor can't move past the End command.)

[<] Moves the cursor up.

[C] Returns to the program menu.

[G] Edit the line the cursor is at.

[C] Press and hold for 1 second to delete the line at the cursor (lines above are moved up to close the gap).

[G] Press and hold for 1 second to insert a new line at the cursor (lines beneath are moved down to make space).

### ***Editing a line.***

Allows the user to add a new line (by editing the End command) or change an existing line. Commands are changed by cycling through the available list.



```
Enter Command:
 1 End
```

### ***Keys:-***

[<] Cycles backwards through list of commands.

[>] Cycles forward through the list of commands.

[G] Accepts current command (if command has parameters then it will prompt for them to be edited)

[C] Cancels changes and returns to program listing.

From V3.04.1 pressing a numeric key allows you to cycle through the instructions – see list below.

## **Command Set.**

This is a list of all available commands; these are broken down into groups.

From V3.04.1 these have been arranged by numeric key to allow short cuts.  
i.e. when in Edit mode, repeatedly pressing the indicated key will cycle through the commands under that key.

### **Key [1]      Speed & direction**

#### ***Speed (speed)***

Sets a new speed value.

#### ***Direction CW***

All movements after this are CW.

#### ***Direction CCW***

All movements are now CCW

#### ***Direction Flip***

Flips the direction.

E.g. If the table was CW it will be CCW after this command.

### **Key [2]      Angular movement**

#### ***Go To (angle)***

Moves the table to an absolute value (angle).

E.g. Go To 100.00 - moves the table to 100 degrees.

#### ***Move By (angle)***

Moves the table relative to it's current position.

E.g. Move By 35.00 – turns the table through 35 degrees

#### ***Set Pos (angle)***

Sets current position without moving table.

E.g. Set Pos 75.00 - table position is reported as 75 degrees.

## Key [3]      **Division commands**

### ***Set Divs (num)***

Sets the number of divisions used by move dive etc.  
E.g. Set Divs 12.  
Note. Current division is zeroed.

### ***Move To Div (num)***

Moves to division num.  
E.g. Move To Div 6. Moves to the 6<sup>th</sup> division.  
Note: number wraps if greater than that set by SetDivs.

### ***Move By Div (num)***

Moves by num divisions from current position.  
E.g Move By 3. Moves 3 divisions in current direction.  
Note: number wraps if greater than that set by SetDivs.

## Key [4]      **Wait operator / time**

### ***Wait Operator***

Shows message '--- Press [G] to Continue ---' and waits until operator presses [G].

### ***Wait Time (secs)***

Waits for secs time before continuing. Shows message 'Wait Time: nn'.

## Key [5]      **Loops**

### ***Loop Forever***

Loops back here when End Loop command reached. (Loops can be nested)

### ***Loop For (count)***

Loops back count times when End Loop reached then continues. (Loops can be nested)

### ***Loop End***

Goes back to matching loop command (unless count is reached on Loop For in which case continues)

## Key [6]      **Linear movement**

### *Lin Goto (mm)*

Moves the linear axis to the absolute position in mm.

### *Pos Set (mm)*

Sets the value of the current linear position.

### *Lin Speed (n)*

Sets the cut speed of the linear axis.

### *Retract*

Retracts the linear axis to position 0mm.

## Key [7]      **Jog & Beep**

### *Rotary Jog*

Enters Jog mode and allows user to position table. Note: Table position is altered by this – probably use a Set Pos after it to set the current position.

### *Beep*

Plays a beep from the internal sounder to alert the operator.

## Key [8]      **External Hardware**

### *Acknowledge*

Sends an acknowledge to another machine. (Ack line connected to sense line – see Wait Sense)

### *Wait Sense*

Waits for the sense line to trigger. Shows message ‘Wait Sense’. (See also Acknowledge.)

### *Wait Sense Lo*

Waits for the sense line to go low (i.e. shorted to ground). Shows message ‘Wait Sense Lo’.

### *Wait Sense Hi*

Waits for the sense line to go high (i.e. not connected). Shows message ‘Wait Sense Hi’.

Key [0]      **System NOP / End**

*Nop*

No operation. Does nothing, can be used to temporarily remove an instruction. Inserting a line adds a NOP.

*End*

Program terminates at this point and displays appropriate message. Always the last instruction in the list.

## Programming Keyboard Cheat Sheet (V3.04.1 onwards)

Cheat sheet for numeric keys in edit mode.  
Pressing a key repeatedly will cycle through the commands shown.

<b>Key [1] - Rotary</b> Speed (n) Direction CW Direction CCW Direction Flip	<b>Key [2] - Degrees</b> Go To (angle) Move By (angle) Deg Set (angle)	<b>Key [3] - Division</b> Set Divs (n) Div Goto (n) Div Add (n)
<b>Key [4] - Wait</b> Wait Time (secs) Wait Operator	<b>Key [5] - Loop</b> Loop Forever Loop For (count) End Loop	<b>Key [6] - Linear</b> Lin Goto (pos-mm) Pos Set (mm) Lin Speed (n) Retract
<b>Key [7] - Misc</b> Rotary Jog Beep	<b>Key [8] - External</b> Acknowledge Wait Sense Wait Sense Low Wait Sense High	<b>Key [9]</b>
	<b>Key [0] - System</b> End Nop	

## Example Programs

Some sample programs. Note I've spaced out and added comments for readability.

### *Program 1*

We want the table to rotate 180 degrees, wait for the operator, then rotate back in the opposite direction and repeat.

```
1   Speed 5           ; set speed to 5
2   Loop Forever      ; loop forever
3   Direction CW      ; clockwise rotation
4   Go To 0.00        ; go to 0.00
5   Wait Operator     ; wait for the operator to press [G]
6   Direction CCW    ; counter clockwise rotation
7   Go To 180.00     ; go to 180.00
8   Wait Operator     ; wait for the operator to press [G]
9   End Loop          ; back to line 2
10  End              ; end of program
```

A slightly shorter version of the above using Direction Flip:

```
1   Speed 5
2   Direction CW
3   Loop Forever
4   Wait Operator
5   Move By 180
6   Direction Flip
7   End Loop
8   End
```

## ***Program 2***

We want to drill 10 holes equally spaced around a circle, such that every other hole is 3mm and the remainder are 5mm. So we divide by 5, drill and step. Then move 1/10<sup>th</sup> and divide by 5 again drill and step.

Example using move by degrees.

```
1  Speed 3                ; set speed to 3 (or whatever suits)
2  Direction CW           ; Direction is CW

3  Loop 2                 ; two sets of 5

4  Loop 5                 ; loop for first set of 5
5  Wait Operator          ; wait for operator to press [G]
6  Move By 72.00         ; 1/5th of a circle
7  End Loop               ; back to line 4

8  Move By 36.00         ; move 1/10th in readiness for next set
9  End Loop               ; back to line 3

10 End
```

Example using move by division.

```
1. Speed 3
2. Direction CW
3. Set Divs 10           ; 10 divisions

4. Loop 2                 ; in two groups of 5

5. Loop 5
6. Wait Operator         ; wait until we've finished drilling.
7. Move By Div 2         ; 1/5th ( 2 divs )
8. End Loop              ; back to line 5

9. Move By Div 1         ; then move 1/10th for next set
10. End Loop             ; back to line 4

11. End
```

Example showing that move by angle changes the angle a division is at.

```
1. Speed 3
2. Direction CW
3. Set Divs 5           ; 5 divisions
```

4. Loop 2
5. Loop 5
6. Wait Operator
7. Move By Div 1 ; 1/5<sup>th</sup>
8. End Loop
9. Move By 36.00 ; move 36 deg (shifts all divs by 1/10<sup>th</sup>)
10. End Loop
11. End

### ***Program 3***

We want to move the table to five positions in turn and repeat, waiting for the operator after each one.

```
1  Speed 3
2  Loop Forever

3  Direction CW           ; set direction to CW
4  Go To 38.00           ; go to 38.00 degrees
5  Wait Operator         ; and wait for the operator to press [G]

6  Go To 77.00           ; go to 77.00 and wait
7  Wait Operator

8  Go To 148.00          ; 148 and wait
9  Wait Operator

10 Go To 240.00          ; 240 and wait
11 Wait Operator

12 Direction CCW        ; move back to 170.00
13 Go To 170.00
14 Wait Operator

15 End Loop
16 End
```

## **Machine Status Line**

The bottom line of the display is used to show the machine status when the table is running, the following messages can be shown.

“Working...”

Machine is stepping the table.

“\*\*\* Stopped \*\*\*”

User stopped the machine using 'S' key.

“\*\*\* Cancelled \*\*\*”

User cancelled current operation. ('C' key)

“\*\*\* Limit 1 \*\*\*”

Table has activated limit one (CW) switch (if used).

“\*\*\* Limit 2 \*\*\*”

Table has activated limit two (CCW) switch (if used).

“\*\*\* LOCKED! \*\*\*”

User has activated both limit switches (used to lock the device).

And in Gear mode (when enabled)

“Cut Tooth”

Cutter advances and cuts the tooth at the set speed.

“Retract”

Cutter is retracting.

“Indexing...”

Workpiece is rotated for next tooth.

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