Electronic Rotary Table Divider – V3.0

Operating Manual

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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: actual accuracy depends on mechanics).
- Continuous drive. Table is driven continuously CW/CCW at one of the (selectable) 5 speeds.
- 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.
- Five speed settings.
- Configurable for all common stepper / driver combinations.
- Five 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 will 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.

[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.

[Speed] - Speed.
> Cycles through speed values of 1 to 5 then repeats. (Only effective if table is stationary)

Numeric (Jog) values.
> Some modes allow table to be jogged. Table is advanced by value shown under 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.

If required the cursor can be moved left and right with the [<<] and [>>] 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.

Profile

The software allows up to 5 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 five different devices, e.g. Rotary table, lathe head indexer, dividing head etc.

Enter Profile.

When the software is first run the 'Enter Profile?' message appears on the screen. You choose your initial profile here. (The profile can also be changed from the set-up options).

```
Enter Profile?

(1 to 5) [1]
```

Enter the required profile and press [G] the software will load/create the profile and move onto the main menu.

To Create a New Profile.

Simply enter the number of a unused profile, the software will automatically set default values for this profile which can be changed in set-up.

Note: If you have only one profile or want to default to a profile then this screen can be removed by setting a default profile in setup.

Main menu.

All options are available from here, you can return here from anywhere by repeatedly pressing the [C] (cancel) key. Display shows options and current machine profile.

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

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 position the table. Note: Jog mode preserves the position, so when entering Jog mode position will show the angle the table was last at. Display shows current speed of table and current position in decimal degrees.
The bottom line shows the machine status.

```
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]   Query and reset indicated position to 0.00.

[Speed]   Cycles through the five speed settings.

Note: 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.

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. 0, 1, 3, 3 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.

```
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]   Cycles through the five table speeds. (Table must be stopped).

[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, use [<<] or [>>] to rotate CCW or CW.
Or press [G] to automatically take the shortest route. [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.

```
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]   Cycles through the five table speeds. (Table must be stopped).

[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, use [<<] or [>>] to rotate CCW or CW.
Or press [G] to automatically take the shortest route. [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).

```
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]   Cycles through the five table speeds. (Table must be stopped).

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 give 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.
From V3.03.1 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.

```
Gear:      Cut Rate: 5
Tooth:   1 of 30
Cutter:     0.00mm
Press [G] to Start
```

Keys:-

[Speed]   Cycles through the five cutter speeds. (Table must be stopped).

[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).

Machine Status

        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.

<u>Setup</u>

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 Keys.

[G]   To change values currently displayed.
[C]   To return to main menu.
[>>]   Next screen.
[<<]   Previous Screen.

Set Rotary Step Rate

Sets the low and high values used during indexing operations.
Display shows the starting speed, the final Lo(w) and Hi(gh) speeds along with the acceleration time (Time).

```
Rotary Step Rate ?
Start:    100
Lo:   200 Hi: 2000
Time: 2.0
```

Press [G] to step through each field and enter new values for any field you wish to change.

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

Notes:

Speeds are in steps per second.

The table will begin to move at "Start" speed and then accelerate to a value between "Lo" (Speed = 1) and "Hi" (Speed = 5) with intermediate "Speed" values interpolated between the two (e.g. Speed = 3 would be half way between Lo and Hi).

Acceleration time is in seconds and is the amount of time it would take to reach a 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.

If Start is too high stepper may be unable to start and will stall. Ditto if acceleration time is too low.

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).

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 x 200 x 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.
In essence 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 low and high.

```
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.

```
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 ?
Start:    100
Lo:   200 Hi:  2000
Time: 2.0
```

Retract Step Rate (Gear Mode Only)

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

```
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 edit value.

```
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.

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.

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

Is Default Profile.

If set to yes current profile is used as the default and the device will no longer ask for a profile when starting. (Profile can still be changed in setup).
Press [G] to toggle yes/no.

```
Is Default Profile ?

No
```

Change Profile.

Allows the user to switch to one of the five machine profiles. Current profile is shown. Press [G] to change to another.

```
Change Profile ?

[G] to select new
```

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, they can be permanently saved and loaded into one of ten slots.

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

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.

```
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:-

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.

```
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.

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
   2  ---
   3  ---
   4  ---
```

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 curser (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.

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.

Command Set.

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

Table Move Commands.

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.

Speed (speed)
Sets a new speed value.

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.

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 6th 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.

Wait Events

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'.

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

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

Wait Sense Lo (v3.03.01+)
Waits for the sense line to go low (i.e. shorted to ground). Shows message 'Wait Sense Lo'.

Wait Sense Hi (v3.03.01+)
Waits for the sense line to go high (i.e. not connected). Shows message 'Wait Sense Hi'.

Program flow.

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)

End
Program terminates and displays appropriate message.

Miscellaneous

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.

Nop

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

Gear Mode (Linear) Commands

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.

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 1/10th 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   ; 1/5th
8. End Loop

9. Move By 36.00   ; move 36 deg (shifts all divs by 1/10th)
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
```