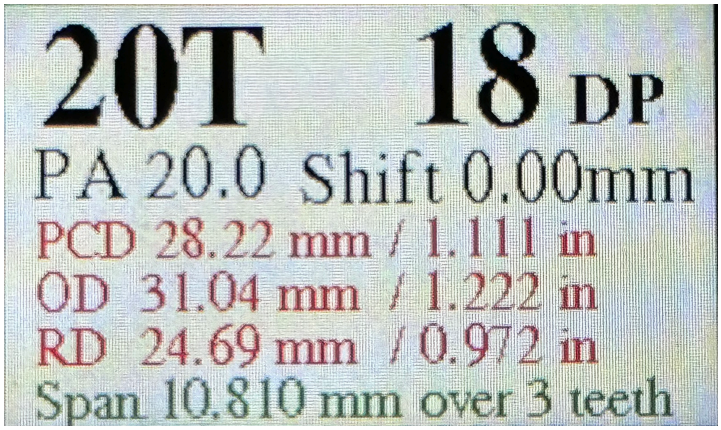
Hobbing controller.

Parts used:

- Controller TTGO T-Display: https://www.amazon.co.uk/dp/B0CQNB38XV
- Motor: 1.2Nm / 2A https://www.amazon.co.uk/dp/B089SRQN1P
- Stepper driver: “TB6600”[1] https://www.amazon.co.uk/dp/B07SBZ9SM5
- Power Supply: 24V 5A https://www.amazon.co.uk/dp/B0CCY2PBQR
- Encoder: https://www.amazon.co.uk/dp/B08KGHT6WY

[1] It isn’t a Toshiba TB6600 driver in there, I don’t know what it is.

Instructions for Use:



The main display shows editable parameters in black and the resulting gear size parameters in red, with an indication of how to check the gear cutting progress in green.

Pressing the rotary knob will cycle through the tooth count (nT), the Pressure Angle (PA), the radius shift (Shift) the tooth size and the standard. The standard will cycle between metric module (Mod) Imperial Diametral Pitch (DP), metric circular pitch (mm) and imperial circular pitch (in). When swapping between standards the tooth size will automatically round to an approximate equivalent of the old size in the new units.

Turning the knob will increment or decrement the selected setting, at which point the gear size and span calculations will update.

The calculations could conceivably be used to identify the size, pitch and pressure angle of an unknown gear, too.

The gear size parameters are shown in metric and imperial. Pitch Circle Diameter (PCD), Outside Diameter, ie the required size of the gear blank (OD) and the root diameter (RD).

The “Span” measurement is based on this web page:
https://web.archive.org/web/20151022013257/http://www.sdp-si.com/D805/D805_PDFS/Technical/8050T081.pdf
It provides a way to check that the gear has been cut to the correct depth using only a conventional caliper. Note that the calculation done in the hobber box does not account for helix angle.

Figure 10-4 shows the span measurement of a spur gear. This measurement is on the outside of the teeth.

For internal gears the tooth profile is opposite to that of the external spur gear. Therefore, the measurement is between the inside of the tooth profiles.

10.2.2 Helical Gears

Tables 10-11 and **10-12** present equations for span measurement of the normal and the radial systems, respectively, of helical gears.

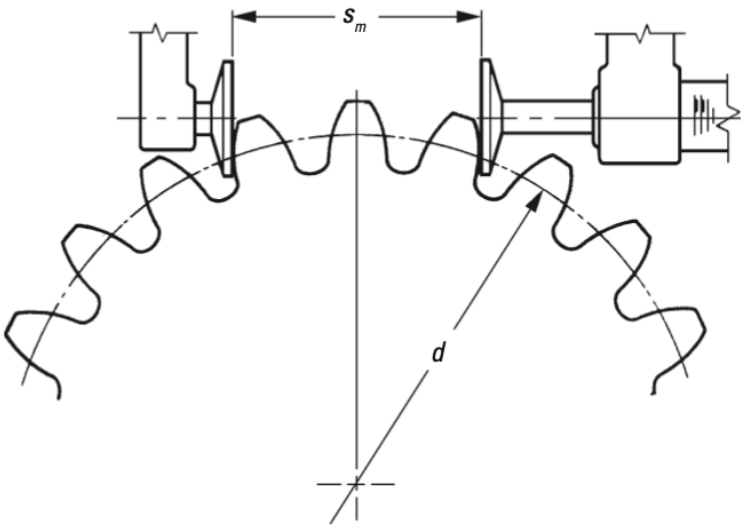


Fig. 10-4 Span Measurement of Teeth (Spur Gear)

Table 10-11 Equations for Span Measurement of the Normal System Helical Gears

No.	Item	Symbol	Formula	Example
1	Span Number of Teeth	z_m	$z_{mth} = zK(f, \beta) + 0.5$ See **NOTE** Select the nearest natural number of z_{mth} as z_m.	$m_n = 3$, $\alpha_n = 20°$, $z = 24$ $\beta = 25° 00' 00''$ $x_n = +0.4$ $\alpha_s = 21.88023°$ $z_{mth} = 4.63009$ $z_m = 5$ $s_m = 42.0085$
2	Span Measurement	s_m	$m_n \cos \alpha_n [\pi (z_m - 0.5) + z \text{ inv } \alpha_t] + 2x_n m_n \sin \alpha_n$	

NOTE:

$$K(f, \beta) = \frac{1}{\pi}\left[\left(1 + \frac{\sin^2\beta}{\cos^2\beta + \tan^2\alpha_n}\right)\sqrt{(\cos^2\beta + \tan^2\alpha_n)(\sec\beta + 2f)^2 - 1} - \text{inv}\,\alpha_t - 2f\tan\alpha_n\right] \quad \textbf{(10-3)}$$

where $f = \frac{x_n}{z}$

Settings:

Pressing and holding the rotary knob for 5 seconds will enter the “setup” page. The entries can be cycled through by pressing the button. The system will automatically return to the main screen after 5 seconds of no activity.

“Enc PPR” sets the number of quadrature states per revolution of the encoder. This is 1600 for a 400-line encoder.

The “Motor PPR” is the number of step pulses for a single revolution of the gear blank. This is the motor basic step count (200 steps per rev) multiplied by the microstep[2] setting, and by the gear ratio between the motor and the blank.
For a 90:1 dividing head and 16x microstepping the result is 200 * 16 * 90 = 288,000

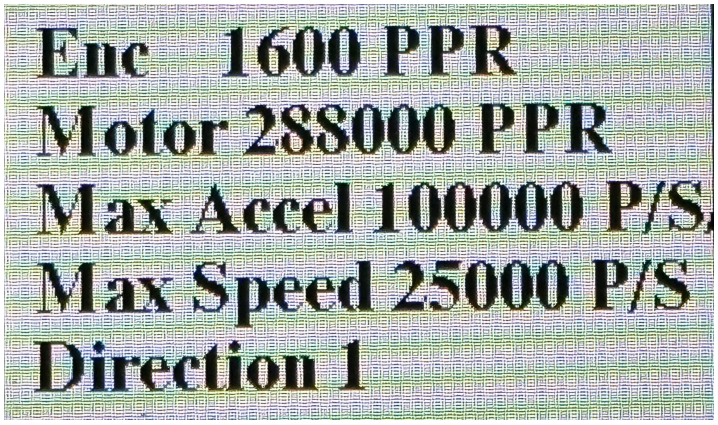
The “Max Accel P/S/S” setting is the maximum rate of motor acceleration in pulses per second squared. This setting may need to be adjusted if the microstep ratio is changed or to account for the inertia of the driven system.

The “Max Speed P/S” setting is the maximum step rate that the system can achieve. This should be set by experiment. The main display will turn to a blank red warning state at 95% of max speed. When hobbing this should be taken as a warning that the hob is turning too fast for the blank to follow, and that gear cutting is likely to fail.

“Direction” should be set to -1 or 1, depending on which direction the work should turn relative to the hob. You might need to change this if you have a left-hand hob, but typically it will just need to be set once to suit the machine configuration.

[2] Stepper motors have a native resolution of 200 steps per rev, but by using current settings less than full current in adjacent coils it is possible to set the motor to intermediate positions.
Stepper drivers take “step” pulses from a controller, and will typically move the motor one step, or one microstep, on the rising edge of the step command pulse from the controller.
The advantage of higher microstep settings is mainly smoother operation. The disadvantage is that eventually the controller simply can’t create pulses fast enough at high motor speeds.

The stepper motor driver is adjustable for current and microstep ratio by use of the DIP switched on the right side of the controller box, under the small pry-off cover.



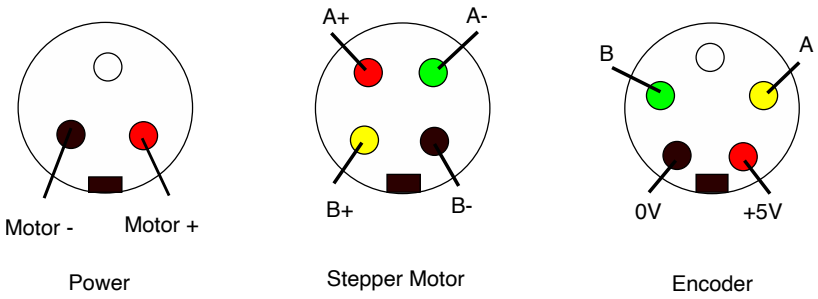
Microstep	PPR	Sw1	Sw2	Sw3
NC	NC	ON	ON	ON
1	200	ON	ON	OFF
2	400	ON	OFF	ON
4	800	ON	OFF	OFF
8	1600	OFF	ON	OFF
16	3200	OFF	OFF	ON
32	6400	OFF	OFF	OFF

Current(A)	Peak Curr (A)	S24	Sw5	Sw6
0.5	0.7	ON	ON	ON
1.0	1.2	ON	OFF	ON
1.5	1.7	ON	ON	OFF
2.0	2.2	ON	OFF	OFF
2.5	2.7	OFF	ON	ON
2.8	2.9	OFF	OFF	ON
3.0	3.2	OFF	ON	OFF
3.5	4.0	OFF	OFF	OFF

The current should be reduced if the heatsink of the motor controller gets more than somewhat warm.
The motor itself may be allowed to get rather hotter. Steppers take maximum current when not moving, and are typically safe to operate up to 105C. This means that “too hot to touch” is actually OK. The controller has been supplied set to 2.5/2.7A but this can be increased if it is found that more torque is needed, within the limits of motor temperature.

Connectors:

The connectors are GX12 “Aviation” connectors. View is looking into the receptacle on the box.



Power should be no more than 24V. The stepper driver is rated to 42V, and that would give more motor speed, but there is an internal DC-DC convertor that converts the supply voltage to 5V to power the T-Display and that is only rated to 24V.
It would be possible to increase motor voltage by powering the control electronics via the USB-C connector, and disconnecting the JST power plug on the T-Display inside the case.

Internal Wiring Diagram: