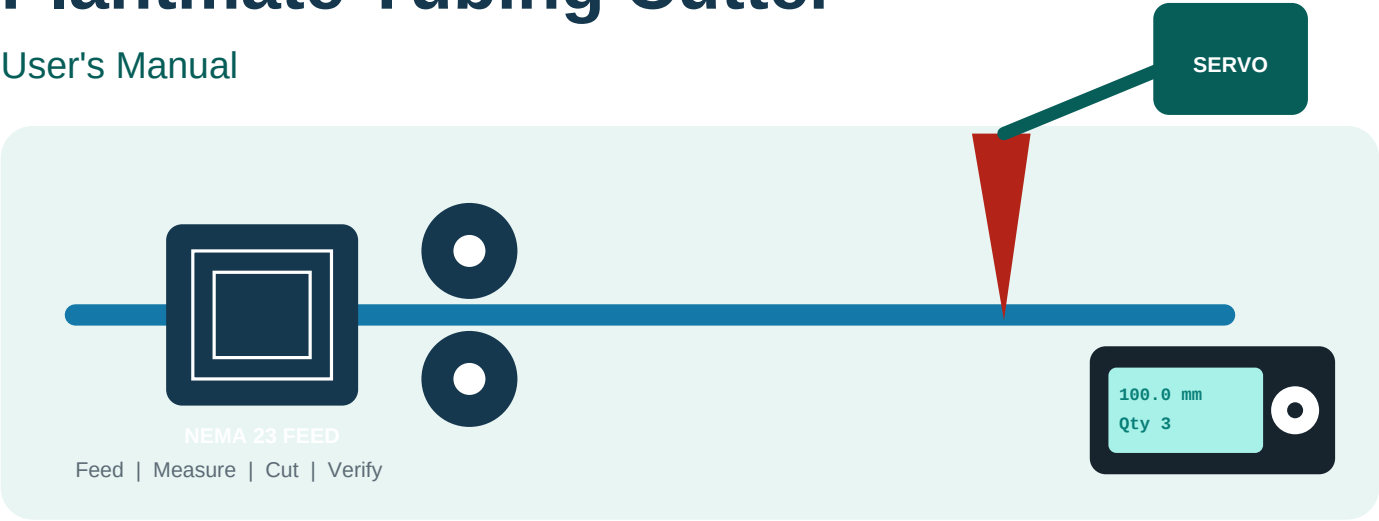


Plantmate Tubing Cutter

User's Manual



Machine	TB6600 / NEMA 23 Tubing Cutter
Controller	Arduino Nano
Display	0.96-inch, 128 x 64 OLED
Firmware	Tubing_Cutter_TB6600_NEMA23_200 v2.3.0
Manual	Revision 1.1 August 13, 2026

CRITICAL SAFETY LIMITATION - SOFTWARE STOP does not disconnect power, and this machine has no blade-position sensor. Always verify physical blade clearance and disconnect input power before entering the mechanism.

Read this manual before operating, setting up, calibrating, cleaning, or servicing the machine.

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Use the Operator Quick Reference at the back for routine operation. Read Sections 1 and 8 in full before first use.

1. Read This First

This machine automatically feeds tubing with a stepper motor and cuts it with a servo-operated blade. The rotary encoder is used to select a length in millimetres, centimetres, or metres, plus quantity, speed, timing, calibration, and setup functions.

WARNING - MOVING BLADE AND PINCH HAZARDS Keep hands, tools, clothing, hair, and loose objects away from the blade, feed rollers, tubing path, and other moving parts whenever power is connected.

WARNING - SOFTWARE STOP IS NOT AN EMERGENCY STOP This machine has no hardware emergency stop. Pressing or holding the encoder requests a software stop, disables the TB6600 through its logic input, and commands the servo to the saved Safe angle. It does not disconnect electrical power or prove that motion stopped.

WARNING - NO BLADE POSITION SENSOR The controller cannot detect the physical blade position. Messages such as **Retract sent** mean only that the command was issued. Always look at the mechanism and verify that the blade is physically clear before approaching the tubing path.

WARNING - DISCONNECT POWER BEFORE SERVICE Turn off and disconnect the machine's input power before clearing a jam, replacing a blade, touching the feed mechanism, adjusting mechanical parts, or checking wiring.

Use the machine only when a trained operator is present. Never leave an automatic batch unattended.

2. Machine Overview

The controller operates four main parts:

Part	Purpose
Rotary encoder	Turn to move through choices or change a value; press to select
128 x 64 OLED	Shows settings, operating status, prompts, and errors
NEMA 23 stepper with TB6600	Feeds the programmed tubing length
Servo-operated blade	Moves between the saved Safe and Cut angles

The machine does not measure the tubing directly during a job. Feed distance is calculated from the saved steps-per-metre calibration. Slipping, roller compression, mechanical wear, or a changed TB6600 microstep setting can change the actual cut length.

Encoder actions

Action	Normal menus	While feeding or cutting
Turn	Move the selection	Ignored while hazardous motion is active
Short press	Select a button, or enter/leave value editing	Requests SOFTWARE STOP immediately
Long press	Requests SOFTWARE STOP	Requests SOFTWARE STOP

A single frame marks the selected field. A double frame means a numeric value is in edit mode. Press once to enter edit mode, turn to change the value, and press again to leave edit mode. The **Unit** field is different: each press cycles directly through mm, cm, and m.

While editing Length, a slow encoder turn changes the displayed value by 0.1 mm, 0.1 cm, or 0.1 m, according to the selected unit. Faster continuous turning changes it by 10 times the slow increment.

3. Quick Start

Use this procedure only after the machine has been commissioned and calibrated.

1. Disconnect power and inspect the blade, feed rollers, tubing path, servo linkage, fasteners, and wiring.
2. Remove tools and loose material. Make sure the blade area is clear.
3. Insert tubing using the machine's normal loading procedure and position its end at the cutting reference. There is no material-position or homing sensor. Keep hands outside the moving area.
4. Apply power. The OLED shows **STARTUP / Retract sent / Please wait**.
5. Watch the blade. Wait for the Home screen and physically verify that the blade is clear.
6. On the Home screen select **Modify**.
7. Set **Unit**, **Length**, **Qty**, and **Speed**. Select **Save**.
8. After the startup/retract wait returns to the Home screen, confirm the displayed values.
9. Select **Start** and remain at the machine.
10. The machine feeds and cuts one piece, then shows **CHECK PIECE 1**.
11. Measure the first piece:
 - Select **Continue** if it is correct.
 - Select **Adjust** to abandon the batch and change settings.
 - Select **End** to stop the batch and return Home.
12. When **DONE / Batch completed** appears, select **Done**.

If motion is unexpected, press the encoder once during motion. Then disconnect power if the mechanism is not physically safe.

4. Power-Up and Home Screen

Power-up sequence

At power-up the controller:

1. Sets the TB6600 enable output to disabled.
2. Loads and validates saved settings from EEPROM.
3. Commands the servo to the saved Safe angle.
4. Shows **STARTUP** and waits for worst-case servo travel plus the saved Retract time.
5. Opens the Home screen.

The wait is time-based. There is no blade sensor. A Home screen does not prove that the blade moved successfully.

Home screen

The Home screen shows:

Tubing Cutter		

Length	100.0 mm	
Qty	3	
Speed	7	
[Setup]	[Modify]	[Start]

Button	Function
Setup	Opens feed jog, 500 mm calibration, and guarded Blade Test
Modify	Opens job, timing, and servo settings
Start	Validates and saves settings, then begins a new batch

5. Setting Up a Job

Select **Modify** from the Home screen.

Job Settings

Setting	Allowed value	Default	Meaning
Unit	mm, cm, or m	mm	Display and encoder increment used for Length
Length	0.1 to 65535.9 mm (equivalent values in cm or m)	100.0 mm	Programmed feed distance for each piece
Qty	1 to 255	3	Number of pieces in the batch
Speed	1 to 10	7	Stepper speed and acceleration level

Note: The practical maximum may be lower because the firmware also limits a single move to 15,000,000 step pulses. Very short lengths can also be rejected if the current calibration would round to zero steps.

To change units, select **Unit** and press the encoder. Each press cycles mm -> cm -> m -> mm. Changing Unit does not convert, round, or move the tubing; it changes only how the same physical length is displayed and edited.

Select **Length**, press to enter edit mode, turn to adjust it, and press again to leave edit mode. The display retains the full 0.1 mm internal precision:

Unit	Display range	Slow turn	Fast turn
mm	0.1 to 65535.9 mm	0.1 mm	1 mm
cm	0.01 to 6553.59 cm	0.1 cm	1 cm
m	0.0001 to 65.5359 m	0.1 m	1 m

For a 1.5 m piece, select m and edit Length to 1.5000 m. From the 100 mm default, this takes 14 slow increments. For a long value such as 10 m, turn quickly for 1 m increments, then turn slowly to trim by 0.1 m.

Select **More** for timing settings, or **Save** to save all current job, timing, and servo settings.

Job Settings has no Cancel button. The normal exit is **Save**. To deliberately discard uncommitted edits, request SOFTWARE STOP, wait for the stop to latch, and RESET.

Speed guidance

- Begin with a low speed during commissioning or when changing tubing.
- Increase speed only if the feed remains accurate and does not slip or stall.
- Lower the speed if lengths vary, the motor stalls, tubing slips, or the mechanism vibrates.
- Speed is a stepper level, not a direct millimetres-per-second value. Actual tube speed depends on calibration and mechanics.

Timing Settings

All timing values are shown in units of 0.1 second.

OLED setting	Allowed value	Default	Actual time	Purpose
Settle	0 to 50	2	0.0 to 5.0 s	Wait after feeding before the blade moves
Cut hold	1 to 100	12	0.1 to 10.0 s	Extra hold time at the Cut angle
Retract	1 to 100	8	0.1 to 10.0 s	Extra wait after estimated retract travel

Examples: 2 means 0.2 seconds, 12 means 1.2 seconds, and 25 means 2.5 seconds.

Use the shortest times that give reliable mechanical operation. If the blade starts before the tubing settles, increase **Settle**. If the cut is incomplete, inspect the blade and mechanism first, then increase **Cut hold** only if more hold time is genuinely needed. If a new feed begins before the blade is physically clear, stop using the machine and correct the servo/mechanical issue; a longer **Retract** time is not a substitute for a working mechanism.

Select **Servo** for the blade endpoints, or **Save** to save all current settings.

Timing has no direct Back button to Job Settings. Select **Servo** to open the next page, or **Save** to store the complete settings set and return through STARTUP to Home.

Blade Clear - Servo Settings

Setting	Allowed value	Default	Meaning
Safe angle	0 to 180 degrees	90	Commanded blade-clear position
Cut angle	0 to 180 degrees	0	Commanded cutting position

Safe and Cut must be different.

Change servo angles only with the blade area clear and the operator ready to disconnect power. Make small changes. An incorrect endpoint can drive the servo or linkage against a hard stop, damage parts, overheat the servo, or leave the blade in the tubing path.

Editing an angle does not move the servo immediately. Selecting **Save** stores all settings, immediately commands the new Safe angle, shows the startup/retract wait, and then returns Home. Physically verify the safe position. Use the guarded Blade Test before production.

6. Running a Batch

Start

Manually position the tubing end at the machine's cutting reference. The controller cannot find this position automatically. On the Home screen, confirm Length, Qty, and Speed, then select **Start**.

The controller validates the settings and saves them. For each piece it:

1. Sets feed direction with the TB6600 disabled.
2. Enables the TB6600 after the direction setup delay.
3. Accelerates and feeds the calculated number of steps.
4. Waits for the saved Settle time.
5. Commands the servo to the Cut angle.
6. Waits for estimated servo travel and the saved Cut hold time.
7. Commands the servo to the Safe angle.
8. Waits for estimated servo travel and the saved Retract time.

The RUNNING screen shows the current piece and total quantity. Keep watching the tubing and blade.

The stepper remains energized through Settle, cutting, and retraction so it can hold the tubing. A stationary stepper can therefore still be energized and hot. Display refresh may pause during timing-critical motion, but encoder STOP scanning continues.

First-piece verification

After the first piece, the stepper driver is disabled and the screen shows **CHECK PIECE 1**.

Measure the actual piece with an appropriate measuring tool.

Choice	Result
Continue	Runs the remaining pieces using the same settings
Adjust	Abandons the current batch and opens Job Settings
End	Abandons the current batch and returns Home

After **Adjust**, change the settings, select **Save**, return Home, and select **Start** to begin a new batch from piece 1.

Batch complete

After the programmed quantity is completed, the TB6600 is disabled and **DONE / Batch completed** appears. Select **Done** to return Home. Before handling finished pieces, visually confirm that the blade is clear and all motion has stopped.

7. Setup Menu

Select **Setup** from the Home screen. The header reminds the operator: **SETUP: BLADE CLEAR**.

Feed jog

The six jog buttons move the feed by a calibrated distance:

Negative direction	Positive direction
-1 mm	+1 mm
-10 mm	+10 mm
-100 mm	+100 mm

Before any jog, make sure the blade is physically clear and the tube can move without striking an obstruction. Select the smallest distance first when confirming direction. The screen shows **JOGGING / Feed only**. The blade does not perform a cut.

Positive and negative refer to the configured motor direction. If the installed mechanism moves opposite to its intended feed direction, stop and have the machine serviced. Do not use an incorrect calibration to conceal a direction or wiring problem.

500 mm feed calibration

Calibration corrects the relationship between TB6600 step pulses and actual tubing movement.

Prepare a straight length of the normal production tubing and an accurate measuring tool. Calibration performs feed motion only; it does not cut.

1. Make sure the blade is physically clear.
2. Load the same tubing and roller pressure used for production.
3. Establish a repeatable measurement reference or mark on the tubing.
4. From Setup, select **Cal500**.
5. The machine commands the number of steps currently believed to equal 500.0 mm.
6. Press the encoder to SOFTWARE STOP if anything moves incorrectly.
7. After motion stops, accurately measure the actual tubing movement.
8. On **CAL RESULT**, select and edit each of the three whole-millimetre digits and the decimal digit.
9. Select **Save**. Values from 250.0 to 750.0 mm are accepted.

10. Repeat the 500 mm test and confirm the result before production.

Enter what the tubing actually moved, not the desired 500.0 mm. For example, if the commanded test moved 487.6 mm, enter 487.6.

If the actual movement is outside 250.0 to 750.0 mm, the result cannot be saved. Check for tube slip, a stall, an incorrect TB6600 microstep setting, loose couplings, or another mechanical problem.

Recalibrate whenever any of these changes:

- Tubing material or diameter significantly changes
- Feed roller diameter, pressure, or surface changes
- TB6600 microstep switches are changed
- Stepper, gearing, coupling, or roller is serviced
- Measured pieces develop a consistent length error

Guarded Blade Test

1. Make sure the tubing path and blade area are completely clear.
2. Select **Blade** in Setup.
3. Read the confirmation screen **Clear blade area**.
4. Leave **Cancel** selected if conditions are not safe. Turn to **Run** only when ready.
5. Press **Run**. The blade moves to Cut, holds, and automatically returns to Safe.
6. Watch the complete movement. Press the encoder to SOFTWARE STOP if needed.

The test uses the saved Safe angle, Cut angle, Cut hold, and Retract time. It does not confirm blade position. If the blade fails to retract, disconnect power and service the mechanism.

8. SOFTWARE STOP and Reset

Requesting a stop

- During RUNNING, JOGGING, CAL FEED, or BLADE TEST, press the encoder once.
- From a normal menu, press and hold the encoder to request SOFTWARE STOP.

The controller then:

1. Stops issuing step pulses.
2. Sends the TB6600 disable logic level.
3. Restores the last committed settings if an unsaved edit was in progress.
4. Commands the servo to the saved Safe angle.
5. Shows **SOFTWARE STOP / Disable sent / Retract sent**.
6. Waits for estimated servo travel plus Retract time and latches the stop state.

This is a command sequence, not proof of safety. The motor supply and servo power can remain energized. If motion does not stop or the blade is not physically safe, disconnect input power without entering the hazard area.

Resetting after a stop

1. Correct the reason for the stop. Disconnect power first if hands, tools, or service work must enter the machine.
2. Restore power if it was disconnected and keep the blade area clear.
3. Wait for the commanded retract interval to finish.

4. Select **RESET**. If pressed too early, it may have no effect; wait and select it again.
5. The controller commands Safe again, shows STARTUP, waits, and returns Home.
6. Physically verify the blade-clear position.

An interrupted batch is cancelled. The piece counter returns to zero. The machine does not resume where it stopped.

9. Error Messages

Display	Meaning	Operator action
Check all settings	A setting is outside its permitted range, Safe equals Cut, or the calculated move is invalid/too large	Select Back, review all values, correct them, and save again
Measure 250-750 mm	The entered calibration result is outside the accepted range or would create an invalid calibration	Select Back, verify the measurement, and inspect for slip, stall, or incorrect microstepping
EEPROM save failed	The controller could not verify saved settings	Do not rely on the new values. Select Back and retry. If it repeats, power off and have the controller serviced

Error **Back** returns to the previous screen and preserves the values so they can be corrected.

10. Troubleshooting

Always disconnect input power before touching wiring or mechanical parts.

Symptom	Likely checks and actions
OLED is blank	Do not operate from memory or press controls blindly. Verify the installed power supply, 5 V logic power, ground, and OLED connector. Firmware expects an SSD1306 128 x 64 hardware-I2C display on Nano A4/A5
OLED appears frozen during motion	This can be normal: display refresh pauses during timing-critical feed and blade stages. Encoder STOP scanning continues. If the mechanism behaves incorrectly, press the encoder or disconnect input power
Encoder does not navigate	Navigation is intentionally ignored during hazardous motion. Press to stop and wait. Otherwise inspect the encoder connector and D2/D3/D4 wiring with power disconnected
RESET does not respond immediately	The stop/retract timer may still be active. Wait until physical motion is finished, then select RESET again
Stepper does not feed	Check for a jam, TB6600 power/fault, enable wiring, motor wiring, loose coupling, and DIP switch settings. Disconnect power before inspection
Stepper stalls or tubing slips	Lower Speed, inspect roller pressure and alignment, clear contamination, reduce obstruction, and verify driver current/microstep settings
Feed direction is wrong	Stop. Confirm operation with a 1 mm jog. The machine requires service if the installed feed direction is incorrect
Pieces are consistently too long or short	Perform Cal500 using production tubing and roller pressure. Verify that microstep settings have not changed
Piece lengths vary	Check tubing slip, roller cleanliness/pressure, loose couplings, a motor stall, excessive Speed, and inconsistent tubing
Blade does not fully cut	Stop and disconnect power. Inspect blade sharpness, linkage, alignment, servo strength, and obstructions. Then verify Cut angle and Cut hold with a guarded Blade Test
Blade does not fully retract	Disconnect power and keep clear. Inspect servo power, linkage, obstruction, Safe angle, and mechanical travel. Do not continue production

Symptom	Likely checks and actions
Servo chatters, overheats, or controller resets	Stop and disconnect power. Check for a mechanical hard stop, overloaded linkage, unsuitable endpoints, and inadequate servo power
STARTUP remains displayed unexpectedly	Keep clear. The wait includes servo travel and Retract time. If the controller does not return Home after the expected delay, disconnect power and service it
First piece is incorrect	Select Adjust or End. Correct settings or recalibrate; do not select Continue

11. Inspection and Maintenance

Before every use

- Check that guards and covers supplied with the machine are installed.
- Inspect the blade for damage, looseness, and dullness.
- Check the servo linkage and fasteners.
- Check feed rollers, guides, couplings, and tubing path.
- Look for damaged cables, loose connectors, or signs of overheating.
- Remove chips and debris with power disconnected.
- Run a low-risk jog and guarded Blade Test after service or unusual behavior.
- Confirm calibration with the production tubing.

During operation

- Supervise the machine continuously.
- Verify the first piece of every batch.
- Stop if sound, vibration, feed force, or cut quality changes.
- Keep the work area clean and keep finished pieces from obstructing movement.

After use

1. Wait for all movement to stop and visually verify the blade is clear.
2. Disconnect input power.
3. Remove tubing and debris without placing fingers against the blade edge.
4. Inspect for wear or loose parts.
5. Store the machine so it cannot be energized unintentionally.

There is no hour-based maintenance counter in this firmware. Maintenance intervals must be based on use, material, cut quality, and component condition.

12. Stored Settings and Defaults

Core settings are stored in the Arduino Nano EEPROM with a version identifier, range validation, CRC check, and readback comparison. The selected display unit is stored separately; it never replaces the canonical 0.1 mm physical length. The following values persist across power cycles:

- Physical length and selected mm/cm/m display unit
- Quantity
- Speed level

- Feed calibration in steps per metre
- Settle, Cut hold, and Retract timing
- Safe and Cut servo angles

Starting a batch also saves the current settings. A successful Cal500 saves the new calibration. A software stop or normal return to Home discards uncommitted menu edits and restores the last valid saved record.

If no valid record exists, firmware defaults are used. Existing v2.2 records retain their exact physical length and initially use mm; valid v2.1 records are migrated and compatible metric unit choices are preserved.

Factory firmware defaults

Item	Default
Length	100.0 mm
Unit	mm
Quantity	3
Speed	7
Calibration	15,000 steps per metre
Settle	0.2 s
Cut hold	1.2 s
Retract	0.8 s
Safe angle	90 degrees
Cut angle	0 degrees

These are firmware defaults, not guaranteed mechanical settings for every assembled machine. Commission and verify the installed mechanism before use.

13. Technical Reference

Fixed Arduino Nano connections

Function	Nano pin
Encoder DT	D2
Encoder CLK	D3
Encoder switch	D4
Servo signal	D5
TB6600 enable	D12
TB6600 direction	A0
TB6600 pulse/step	A1
OLED SDA	A4
OLED SCL	A5

The installed TB6600 interface is configured in firmware as common-cathode logic with LOW enable and HIGH disable. The minimum STEP pulse is 10 microseconds.

Speed levels

Level	Maximum step rate	Acceleration
1	100 steps/s	50 steps/s ²
2	422 steps/s	267 steps/s ²
3	744 steps/s	483 steps/s ²
4	1067 steps/s	700 steps/s ²
5	1389 steps/s	917 steps/s ²
6	1711 steps/s	1133 steps/s ²
7	2033 steps/s	1350 steps/s ²
8	2356 steps/s	1567 steps/s ²
9	2678 steps/s	1783 steps/s ²
10	3000 steps/s	2000 steps/s ²

Jog and Cal500 use 700 steps/s and 400 steps/s². These are pulse-domain values; actual tubing speed depends on the saved steps-per-metre calibration.

Firmware limitations

- No hardware emergency stop input
- No blade position sensor
- No tubing presence or feed-distance sensor
- No direct stall or slip detection
- No automatic cut-quality detection
- Maximum calculated move: 15,000,000 step pulses
- Calibration storage range: 1,000 to 200,000 steps per metre

14. Operator Quick Reference

Normal batch

```
POWER ON -> wait for STARTUP -> verify blade clear  
HOME -> Modify -> set Unit / Length / Qty / Speed -> Save  
HOME -> Start -> supervise first feed and cut  
CHECK PIECE 1 -> measure -> Continue, Adjust, or End  
DONE -> verify safe -> Done -> disconnect power when finished
```

Calibration

```
HOME -> Setup -> verify blade clear -> Cal500  
Measure actual movement -> enter actual value -> Save  
Repeat Cal500 to verify -> run a quantity-1 test piece
```

Unexpected motion

```
Press encoder -> SOFTWARE STOP command  
If motion is not physically safe -> disconnect input power  
Correct cause -> wait for retract interval -> RESET  
Verify blade clear -> begin a new batch from piece 1
```

Document Control

This manual applies to firmware Tubing_Cutter_TB6600_NEMA23_200 v2.3.0 and the fixed Arduino Nano hardware described above. If firmware, wiring, servo linkage, feed mechanics, TB6600 settings, or the cutting mechanism changes, review and update this manual before operation.

Project reference: www.plantmate.ca