TINY CONTROLS PRIVATE LIMITED
Advanced CNC Systems

TNC-M24

4-Axis CNC Controller

Pendant + Mainboard, Standalone Operation

OPERATION MANUAL

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Chapter 1 — Safety Information

Read this chapter before wiring, configuring, or running a machine on the TNC-M24.

1.1 Warning Levels

This manual flags hazards and important operating notes at four levels, shown throughout in the same visual format:

Level	Meaning
DANGER	A hazard that will cause death or serious injury if not avoided.
WARNING	A hazard that can cause death or serious injury if not avoided.
CAUTION	A hazard that can cause minor injury or equipment damage if not avoided.
NOTE	Operational information carrying no injury hazard.

1.2 Electrical Safety

> ⚠ **WARNING**
> Disconnect power at its source before wiring the controller, the pendant, or any connected drive or relay load. Do not work on live connections.

The controller is powered from a single 24V DC supply. Confirm polarity before applying power. Digital inputs are opto-isolated for noise immunity, but the board does not fuse or current-limit whatever load is wired to the relay outputs — size the wiring and any downstream contactor for the actual load (spindle, coolant pump, etc.).

> **NOTE**
> Wire E-STOP to the dedicated E-STOP input. It stops the machine faster than any other input. Moving E-STOP to a spare input still works, but responds more slowly — on the one signal where speed matters most.

1.3 Motion Safety

> **DANGER**
> Homing, probing, tool change and the traverse cycles all move the machine under their own control, without further prompting once started. Stand clear of the machine before starting any of them, and keep a hand near Esc.

Esc stops the machine from anywhere — ahead of every screen, menu, or prompt — and does nothing else. If the machine is moving, the first press only stops it; press it again to navigate.

> ⚠ **WARNING**
> A stop from the keypad or over the pendant link is not a substitute for a hardwired emergency-stop chain that removes power at the drives. The controller’s E-STOP input stops motion; it does not make the machine safe by itself.

> ⚠ **WARNING**
> Hard limits are off by default until you have watched every switch activate correctly on the DIAGNOSTICS INPUTS page (Chapter 10). Soft limits only apply to an axis that has been referenced (homed, or declared referenced in-situ) — an unreferenced axis has no soft-limit protection at all.

Homing drives deliberately into the home switch, so a switch that is also configured as that axis's limit is refused by the homing-sequence setup — arming it would make the limit kill fire at the moment the homing cycle succeeds. Use Limit Override only to jog an axis off a tripped switch, and release it immediately afterward — nothing else about the machine is safer while it is active.

> ⚠ **WARNING**
> A probe cycle (T-Zero) that finds no contact within its configured travel must stop and alarm rather than keep driving — that is how a spindle gets pushed into a table. If the probe input already reads triggered when the cycle starts, the cycle refuses to move: that is a shorted or miswired input, not a surface.

> **NOTE**
> GoZero and Store Location's GO TO always lift Z to a safe height before traversing XY(+A), in that fixed order — a cross-table move with the tool still down is how a cutter gets broken. This lift happens whether or not the destination is plunged to afterward.

"Reference in-situ" declares the machine referenced wherever it currently stands, with no motion — useful when a switch is absent or faulty, but repeated use lets machine coordinates drift with nothing to pull them back. Re-home from the physical switches whenever that is possible instead of relying on in-situ reference session after session.

1.4 General Safety Rules

- Read this manual, in particular Chapter 3 (Installation and Wiring) and Chapter 13 (Before the First Cut), before wiring or commissioning the machine.
- Only qualified personnel should wire, configure, or service the controller.
- Follow the commissioning order in Chapter 13 — inputs, then relays, then E-STOP, then jog, then homing, then probing, then a tool change, then a program. Each step depends on the one before it.
- Do not bypass the external emergency-stop chain or the limit switches to work around a fault — find and fix the cause instead.
- Keep this manual accessible to anyone commissioning, operating or servicing the machine.
- Keep a hand near Esc during the first moves of any new or changed configuration — homing, jogging, and probing especially.

Chapter 2 — Product Overview

Thank you for choosing the TNC-M24 and for taking the time to read this manual. The TNC-M24 is a four-axis CNC controller designed for stepper and servo systems, packaged as a mainboard and a handheld pendant. Whether you are new to our products or upgrading from a previous model, you will find it straightforward to operate, with this manual serving as your guide. It is suited to a wide range of CNC machines and runs as a standalone unit, without requiring a computer.

2.1 Key Features

- Supports a comprehensive set of standard G and M codes, giving broad compatibility with the output of common CAM software.
- Four independent axes (X, Y, Z and a configurable 4th axis), each with differential step and direction outputs for reliable, noise-immune drive signalling.
- 128 × 64 monochrome graphic display on the handheld pendant, providing clear position and status feedback at the machine.
- 20-key pad with multi-purpose keys — primary, numeric and shifted functions on a single overlay — designed for efficient operation without a keyboard.
- USB port and internal SD card for file transfer and storage, allowing large G-code files to be run directly from the controller.
- 14 opto-isolated digital inputs and 4 relay outputs, providing electrical isolation from machine wiring and switching for higher-power devices such as spindles and coolant pumps.
- Isolated 0–10V analog output for spindle speed control, with a configurable PWM mode for compatibility with a range of spindle drives.
- Battery-backed memory that preserves machine position and work offsets through a power cut, enabling an interrupted program to be recovered.

2.2 Technical Specifications

Item	Specification
Axes	Four — X, Y, Z and a configurable 4th axis (rotary or linear)
Axis outputs	Differential step and direction pair per axis
Maximum step rate	125 kHz, shared across all axes (see section 7.9)
Digital inputs	14, opto-isolated
Relay outputs	4, isolated
Spindle control	Isolated 0–10V analog output, or PWM mode
Display	128 × 64 monochrome LCD on the pendant
Keypad	20 keys on the pendant, in five rows of four
Storage	Internal SD card and USB port
Power supply	Single 24V DC input

2.3 The Pendant

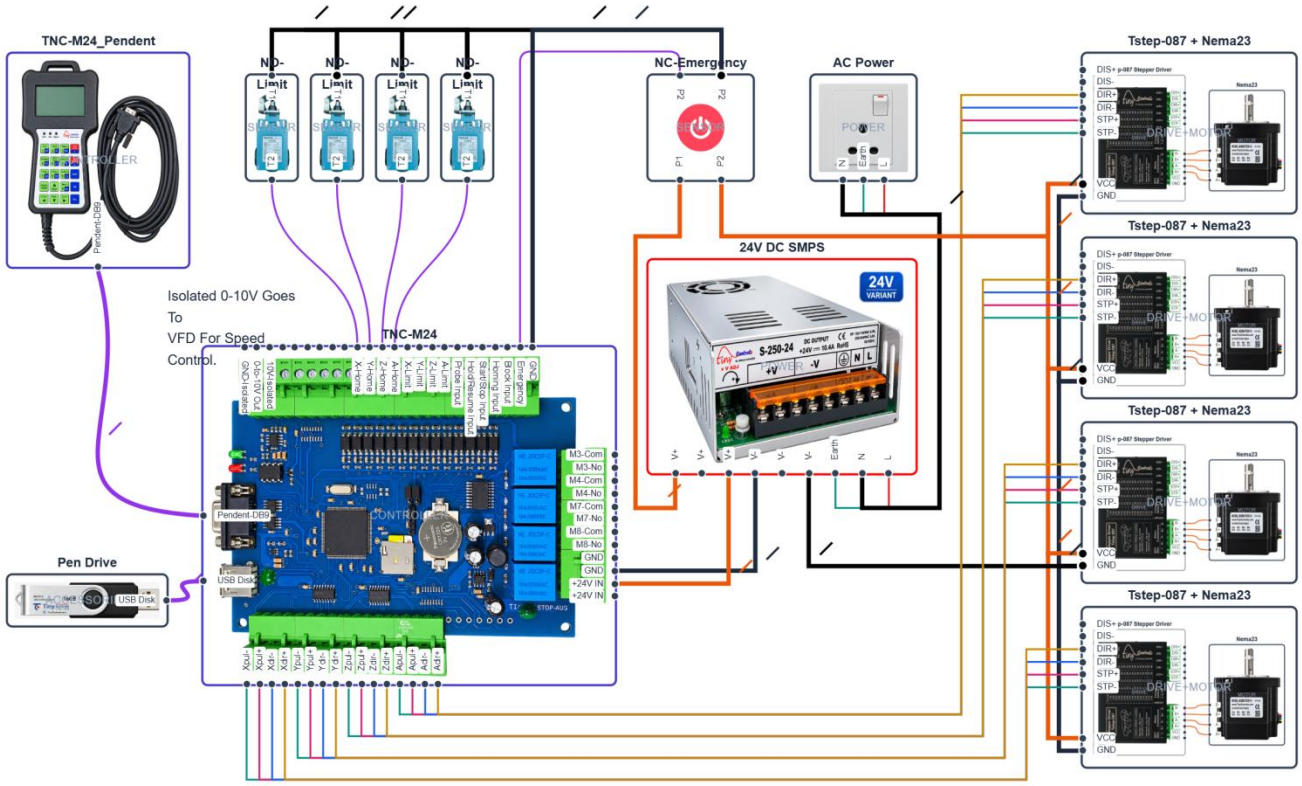
The pendant connects to the mainboard by a single cable and carries the display and keypad. It holds no configuration and performs no motion planning of its own: the mainboard draws every pixel on the

pendant screen and interprets every key press. This keeps the pendant simple, and means a replacement unit needs no setting up — it takes its behaviour entirely from the mainboard it is plugged into.

Chapter 3 — Installation and Wiring

3.1 Electrical Connection Diagram

Figure 3.1 — Electrical Connection Diagram



> **NOTE**
> This diagram shows the mainboard wired into a complete worked system — pendant, USB drive, four limit switches, an emergency-stop switch, a 24V DC supply, and four Tstep-087 + Nema23 drive/motor stacks — as one example, not the only valid configuration. Connect whatever drives, switches, and relay loads the installation needs to the terminals described below.

3.2 Power Supply

The controller is powered from a single 24V DC supply, which simplifies wiring by powering both the controller and its input circuitry from one source. Confirm polarity before applying power — reversed polarity is not protected against.

3.3 Digital Inputs

The board provides 14 opto-isolated digital inputs, IN0 to IN13, carrying the same numbers in the I/O mapping menu (Chapter 9). Opto-isolation keeps machine-side wiring electrically separate from the controller, so switch noise and long cable runs are far less likely to produce false triggers. The default assignment of these inputs is as follows:

Terminal	Default function

IN0–IN3	Home X / Y / Z / A
IN4–IN7	Limit X / Y / Z / A
IN8	Probe
IN9–IN12	Spare — assign in I/O Mapping
IN13	E-STOP — the dedicated emergency-stop input (§1.2)

Every default function can be reassigned to a different physical input, and its polarity (NC/NO) set independently, from the I/O MAPPING menu — see Chapter 9.

3.4 Relay Outputs

Four isolated relay outputs, numbered 0–3, provide switching for higher-power devices such as spindle contactors and coolant pumps. Their default assignment is:

Relay	Default function
0	Spindle enable
1	Spindle direction
2	Flood coolant
3	Mist coolant

3.5 Stepper and Servo Outputs

Each of the four axes (X, Y, Z and the 4th axis) has a differential step and direction output pair for its drive. Differential signalling is used because it rejects electrical noise far better than a single-ended output, which matters on a machine where drive cables run alongside motor and spindle wiring.

3.6 Spindle Speed Output

An isolated 0–10V analog output is provided for spindle speed control into a VFD, alongside the relay-based spindle enable and direction pair described in section 3.4. The output is isolated from the rest of the control board, so a VFD ground that sits at a different potential cannot disturb the controller. Select which mode the spindle uses — 0–10V or PWM — in MACHINE CONFIG, section 7.7.

3.7 Pendant Connection

The pendant connects to the mainboard by a single cable, as described in section 2.3. No configuration is needed on the pendant itself.

Chapter 4 — The Keypad

The overlay prints up to three things on a key: a primary function in green at the top (always active), a green digit at the bottom-left (active only while a numeric field is open), and a blue shifted function at the bottom-right (active only after pressing Shift). Keys with no blue legend have no shifted function — deliberately, since on a machine with one small screen the overlay is the operator's only reference.

4.1 Three Keys to Learn First

Key	Behaviour
Esc	Stops the machine, from anywhere — ahead of every screen, menu, or prompt. If the machine is moving, Esc only stops it; press it again to navigate.
Shift	A one-shot latch, not a held key. Press it, then press the key it modifies. Pressing it twice cancels. A long press latches Shift on until pressed again.
Long press	Held for 0.6 s (450 ms minimum registers). Fires while held, not on release, so the LED cue and the action happen together.

4.2 Jog

Jog is always live on the DRO screen — there is no separate jog mode to enter.

- Jog Axis cycles the selected axis X → Y → Z → A.
- Jog Scale cycles the step size ×1, ×10, ×100, ×1000 — ×1 is one micron, ×1000 is one millimetre.
- Step +/− moves by that increment.
- Cont− ◀ / Cont+ ▶ jog continuously while held.

4.3 Primary Keys

Key	Action
File	File browser — load a program from SD or USB
Start	Cycle start
Pause	Feed hold
Jog Axis	Cycle the active jog axis X → Y → Z → A
GoHome	Short: homing cycle on the switches. Long: reference in-situ (§4.9)
XYA Zero	Zero the selected jog axis, if it is X, Y, or A (§4.7)
Resume	Resume from hold
Jog Scale	Cycle the jog step size
T-Zero	Short: probe the work surface, set Z work zero. Long: measure tool length (§4.8)
Z-Zero	Zero Z in the active work coordinate system — always available, ignores jog selection (§4.7)

GoZero	Lift to Z-safe, then traverse to the active work-zero position (§4.9)
Shift	Modifier — see §4.4
Display Toggle	Short: cycle the DRO view (work / machine / distance-to-go). Long: show the modal-state screen
Step+ / Step−	Step jog, or menu up/down
Menu	Open the settings menu
OK	Confirm / enter
Cont− / Cont+	Continuous jog, or menu left/right
Esc	Cancel / abort (§4.1)

4.4 Shifted Keys

Press Shift, then the key. The blue legend printed on the bottom-right of the key is its shifted meaning.

Legend	Press	Does
WT	Shift + File	WCS Table — view and set the work offsets (Chapter 6)
ST	Shift + Start	Spindle toggle
WC	Shift + Pause	Work coordinate correction — Touch Up (§5.8)
FO	Shift + GoHome	Feed override
LO	Shift + XYA Zero	Limit override — jog off a tripped switch (§1.3)
SL	Shift + Resume	Store Location — Store / Go To / Clear (§5.6)
SO	Shift + T-Zero	Spindle override
DR	Shift + Z-Zero	Dry run
JS	Shift + GoZero	Jog speed
. −	Shift + Jog Axis / Jog Scale	Decimal point and minus sign, numeric entry only
del	Shift + Menu	Delete, numeric and text entry only

4.5 Long-Press Actions

Key	Long-press action
Start	Start from Line — prompt for a line number and run from there
GoHome	Reference in-situ — declare the current position referenced, no motion
T-Zero	Measure tool length against the tool setter
Shift	Latch Shift on until pressed again
Display Toggle	Show the modal-state screen — every active G-code modal group

4.6 Numeric Entry

Where a value is typed rather than stepped — the work offset table on Shift + WT is the one an operator meets most often — the green digits printed on the top ten keys become a numeric keypad, with the decimal point and minus sign on Shift + Jog Axis and Shift + Jog Scale. The value is checked against its valid range when it is accepted, not keystroke by keystroke, so typing “50” to reach a minimum of 10 is allowed to pass through “5” on the way. Clearing the field and leaving it empty cancels the edit rather than committing zero.

> **NOTE**
> Settings menu rows are not typed. They are stepped with the Cont keys and OK — see Chapter 7.

4.7 The Two Zero Keys — Deliberately Asymmetric

XYA Zero and Z-Zero are not “zero these three” and “zero that one” — they work differently on purpose:

Key	Scope
XYA Zero	Acts on whichever axis Jog Axis currently selects, and only if that is X, Y, or A. It is ignored — no axis is zeroed — while Z is the selected axis.
Z-Zero	Acts on Z, always, whatever the jog selection is.

The asymmetry follows how each is used. X, Y, and A are zeroed once when a job is set up, right after jogging that axis into position, so routing them through the jog selection costs nothing. Z is re-zeroed at every tool change — far more often, and usually while some other axis is still selected — so making it wait on a selection change would add friction to the most repeated action in the job.

4.8 T-Zero — Two Probing Cycles in One Key

Press	Cycle	Result
Short	Probe down onto the work surface	Sets Z zero in the active work coordinate system
Long	Probe down onto the tool setter	Measures and stores the tool-length offset

Both are motion — the probe drives down at a configured feed until contact, then sets the zero or offset from where contact happened. This is what separates T-Zero from Z-Zero, which only declares a position without moving anything.

4.9 GoHome, GoZero, and Reference In-Situ

GoHome (short press) runs the homing cycle: it seeks the switches on the four home inputs and establishes machine zero. GoHome (long press) instead declares the axes referenced wherever they currently stand, with no motion — the fallback for a machine whose switches are absent or faulty, and the path that trusts the machine position held in battery-backed memory across a power cycle. Because that declaration silently redefines machine zero, it asks for confirmation first (DECLARE POS HERE?); any key other than OK declines.

> ⚠ **WARNING**
> Used repeatedly, in-situ reference lets machine coordinates drift to wherever a session happened to end, with nothing to pull them back. Re-home from the physical switches whenever that is possible.

GoZero always lifts first: it retracts Z to a safe height, traverses XY(+A) to the active work-zero position, and only then — per configuration — either plunges Z to work zero or stays at the safe height. The default is to stay at the safe height: arriving above the work is recoverable, arriving in it is not.

Chapter 5 — Screens

5.1 DRO (Home Screen)

```
+-------------------------+
|G54    T3         x100   |  frame, tool, jog scale
+-------------------------+
| X   -102.483            |  selected axis, large
|                         |
|Y   47.190  Z    -3.025  |  the others
|A    0.000               |
+-------------------------+
|bracket_v3.nc      READY |  loaded program, state
+-------------------------+
```

Display Toggle switches the readout between work and machine coordinates; the frame field reads MCS in machine view.

5.2 Run / Hold

Shown automatically while a program runs. Pause holds, Resume continues, Esc aborts.

5.3 Files

Two panes, SD and USB, newest files first with sizes. OK loads the highlighted file; a long press of OK copies SD to USB; del deletes a file from SD only, with a confirmation naming the file.

5.4 Homing

Opens only when a homing cycle actually starts. Shows each axis as WAITING, SEEKING…, or REFERENCED, with the cycle's own message on the last line — "X FAILED: not seen" tells you it is a wiring fault, not a travel setting.

5.5 Probe

Reached with T-Zero (work Z) or a long press of T-Zero (tool length). OK starts the cycle; the screen shows live Z position and which pass is running.

> **NOTE**
> When probing the work surface through a plate, the controller sets work Z from the plate thickness configured as sensor_height (section 7.8). Work Z0 therefore ends up at the material surface, not at the top of the plate.

5.6 Store Location

Shift + SL. A single machine-coordinate point parked somewhere repeatable — a dowel, a hard stop, a fixture corner — stored in battery-backed memory so it survives a power cut.

```
1 STORE     2 GO      3 CLEAR
```

GO lifts Z to safe height, then traverses. It arrives above the mark, not on it. All three items are only available while the machine is idle.

5.7 Power-Loss Recovery

Offered automatically at power-up when a program was interrupted. Five steps, in an order chosen so nothing irreversible happens early:

Step	What it does	Moves?
ASK	Shows the job, the line, and the position	No
RELOAD	Re-parses the program	No
REFERENCE	Settles the machine datum — you jog by hand	No
OUTPUTS	Pick which outputs come back on	No
RESUME	Re-enters the program	Yes

Esc leaves the wizard without discarding the recovery — it is still offered next time. Only del discards it.

> **NOTE**
> Work offsets need no settling in this wizard — they were saved on the last change and are already restored by the time the wizard appears, so a resumed program computes from the same origin it was cutting to. On RESUME the machine lifts to safe Z, traverses, and only then plunges — in that order, because the tool may still be down in the part.

5.8 Touch Up — Correcting the Datum by Jogging

Shift + WC, available idle or while the machine is held — refused while it is moving, since a correction measured against a position that is still changing is not a correction. This is the answer to “this cut is too shallow” when you do not know the number, because nobody does: you jog until it looks right and the control absorbs the difference.

```
+-------------------------+
|TOUCH UP             G54 |
+-------------------------+
|>  X      0.000          |  chevron = selected axis
|   Y      0.000          |
|   Z     -0.300          |  how far you have moved the datum
|   A      0.000          |
|STEP x100                |
|RESUME APPLY ESC UNDO    |
+-------------------------+
```

Key	Does
Step +/−	Nudge the selected axis
Cont− / Cont+	Select the axis — here they do not move it
Jog Scale	Step size
Resume	Apply the correction, and continue if a program was held
Esc	Put the tool back, and discard

The screen shows only the deltas — the numbers you are deciding about, not machine or work position. Continuous jog is deliberately unavailable here: a correction is a few hundredths, and one long press of a velocity key would put metres into a datum.
What it actually does: the jogged distance is added to the active work offset, so the tool keeps the work coordinate it already had, and every remaining move inherits the correction. That is also what makes it

safe mid-program — a resume replans the rest of the job from the hold point in the work frame, so without the offset shift the first resumed move would drag the tool back onto the old path.
Typical use: a program is cutting air because the blank was not flat. Pause, Shift + WC, nudge Z down until the cutter bites, Resume — the rest of the job runs at the corrected depth.

5.9 Menu

```
MACHINE CONFIG      the machine itself (Chapter 7)
CONTROLLER CONFIG   behaviour and display (Chapter 8)
I/O MAPPING         pins and polarity (Chapter 9)
DIAGNOSTICS         inputs, outputs, link (Chapter 10)
UPDATE PENDANT      reflash the pendant over the link (Chapter 14)
SECURITY            device ID and licence
```

NOTE

There is no tool-offset table in this menu. Tool length is measured by probing, never typed — see Chapter 11.

The settings entries lead to sections, and each section to the rows within it — three levels at most, and an entry with only one section skips straight to its rows. Values are changed in place with the Step and Cont keys, and Esc backs out one level at a time, offering SAVE or DISCARD on the way out if anything was altered. Chapter 7 describes this in full.

Chapter 6 — Work Offsets

Three ways to set a work offset, suited to different moments:

Method	What it does
XYA Zero / Z-Zero	“This position is zero” — a declaration, no motion
T-Zero	Probe down and set Z zero from the contact point (§5.5)
Shift + WC	Correct an existing datum by jogging (§5.8)

Shift + WT shows the whole offset table, chooses the active frame with Cont− ◀ and Cont+ ▶, and lets you type a value directly.

> **NOTE**
> All six work coordinate frames (G54–G59), and which one is active, are written both to the settings file on the SD card and to battery-backed memory on every change — a G10, a G92, an axis-zero key press, the offset table, or a touch-up. The card copy is durable and readable by a machine builder; the battery-backed copy survives a power cut that happened before the card write finished, and it is the one restored at startup. After a power cut the machine restores its position, its active frame, and its offsets together, so a resumed program computes from the right origin.

Chapter 7 — Machine Configuration

The MACHINE CONFIG menu describes the machine itself — how far it travels, how fast it may move, and how its switches and spindle behave. These settings are specific to your mechanics, and getting them right is the foundation everything else in this manual depends on. The menu is organised into sections, each covering one part of the machine.
Settings are edited in place. There is no edit mode to enter and no key that opens a value for editing — the two Step keys move the cursor, and the two Cont keys change whatever the cursor is sitting on. Nothing is hidden behind a mode, so a key press either moves the cursor or changes the value, and it is always clear which:

Press	Action
Step+ ▲ / Step− ▼	Move the cursor between rows.
Cont− ◀ / Cont+ ▶	Change the highlighted value. On a number this is the coarse step — ten times the fine step.
OK	Fine step, one increment up. On a toggle or a list, moves to the next value.
Esc	Back out one level.

How a value changes depends on what kind of value it is. Toggles switch between their two states. Settings that offer a fixed list of choices cycle through the list and wrap round from the last back to the first, so every choice is reachable without a keyboard. Numbers step by an amount that scales with their size — a setting reading in the hundreds steps by whole units, one reading in tens by a tenth, and a small number such as a backlash figure by a thousandth — and each is held inside its permitted range, so a value cannot be stepped past the limits shown in §7.1. An input or output pin set to -- has no pin assigned.

> **NOTE**
> A change takes effect on the machine as soon as it is made, so its result can be seen while the value is being adjusted. Saving it to the card is a separate decision, taken on the way out.

Pressing Esc from the top of the settings menu leaves it, and if anything was changed it asks first:

```
+-------------------------+
|    SETTINGS CHANGED     |
+-------------------------+
|  > SAVE      DISCARD    |
|                         |
|  < > CHOOSE   OK APPLY  |
|  ESC KEEPS EDITING      |
+-------------------------+
```

SAVE writes the configuration to the SD card, so the values survive a power cut. DISCARD puts everything back to how it was when the menu was entered, undoing the whole editing session rather than the last change. Esc cancels the prompt and returns to editing. The prompt appears only if something actually changed — looking through the settings without altering anything leaves the menu without asking.

> **CAUTION**
> Leaving the menu with DISCARD reverses every change made since entering it, including changes already visible on the machine. Save before leaving if the values are ones you want to keep.

7.1 Complete Menu Tree

Every settable value on the panel, in menu order, with the range the editor enforces. These are the figures the controller actually clamps to, so a value printed here cannot disagree with what the panel will accept. The sections that follow explain the settings that need explaining; this is the index to all of them.

```
MENU
|
+- MACHINE CONFIG
|  +- GENERAL
|  |    opt_stop .......... IGNORE M1 | HONOR M1
|  |    tool_change ....... IGNORE | PAUSE
|  |    step_pulse_us ..... 1 ... 100        whole us
|  |    step_delay_us ..... 0 ... 100        us, DIR setup
|  |    junction_dev ...... 0.0001 ... 10    mm
|  |    arc_tol ........... 0.0001 ... 10    mm
|  |    smooth_time ....... 0 ... 0.5        s
|  |    motion_mode ....... G64 BLEND | G61 EXACT
|  |    block_run ......... OFF | ON
|  +- X-AXIS / Y-AXIS / Z-AXIS   (identical rows, one page each)
|  |    steps_per_mm ...... 1 ... 100000
|  |    max_rate .......... 1 ... 200000     mm/min
|  |    accel ............. 1 ... 200000     mm/s2
|  |    travel_min ........ +/-100000        mm, machine frame
|  |    travel_max ........ +/-100000        mm, machine frame
|  |    invert ............ NORMAL | REVERSED   direction output
|  |    flip_jog .......... NORMAL | FLIPPED    jog keys only
|  |    backlash .......... 0 ... 100        mm
|  +- 4TH AXIS
|  |    type .............. ROTARY | LINEAR
|  |    rollover .......... OFF | ON
|  |    letter ............ A | B | C
|  |    steps_deg ......... 1 ... 100000
|  |    max_rate .......... 1 ... 200000     deg/min
|  |    accel ............. 1 ... 200000     deg/s2
|  |    continuous ........ OFF | ON         unlimited, no soft limits
|  |    travel_min ........ +/-100000        deg
|  |    travel_max ........ +/-100000        deg
|  |    invert ............ NORMAL | REVERSED
|  |    flip_jog .......... NORMAL | FLIPPED
|  |    backlash .......... 0 ... 100        deg
|  +- HOMING
|  |    enable_x y z a .... NO | YES              (4 rows)
|  |    invert_x y z a .... TOWARD - | TOWARD +   (4 rows)
|  |    park_x  y z a ..... +/-100000  mm    (4 rows) where it ends up
|  |    pos_x   y z a ..... +/-100000  mm    (4 rows) the SWITCH coord
|  |    search_cycles ..... 1 ... 10
|  |    debounce_ms ....... 0 ... 1000       ms
|  |    sensor_clear ...... 0 ... 1000       mm
|  |    feedrate .......... 1 ... 200000     mm/min, FAST approach
|  |    seekrate .......... 1 ... 200000     mm/min, SLOW confirm
|  |    z_safe ............ +/-100000        mm, WORK frame
|  |    z_safe_enable ..... OFF | ON
|  |    gz_lift_enable .... OFF | ON
|  |    abort_retract ..... OFF | ON
|  +- HOMING SEQ
```

```
|  |    seq_x y z a ....... 1 ... 4               (4 rows)
|  +- LIMITS
|  |    hard .............. OFF | ON
|  |    soft .............. OFF | ON
|  +- SPINDLE
|  |    on_delay .......... 0 ... 600        s
|  |    mode .............. 0-10V | PWM
|  |    min_rpm ........... 0 ... 300000
|  |    max_rpm ........... 0 ... 300000
|  |    pwm_freq .......... 1 ... 1000000    Hz
|  |    pwm_min_duty ...... 0 ... 100        %
|  |    pwm_max_duty ...... 0 ... 100        %
|  +- TOOL ZERO
|       sensor_height ..... +/-100000        mm
|       backoff ........... +/-100000        mm
|       distance .......... +/-100000        mm
|       feed .............. 1 ... 200000     mm/min, FAST
|       seek .............. 1 ... 200000     mm/min, SLOW
|       pulloff ........... +/-100000        mm
|       use_pos ........... OFF | ON
|       setter_x .......... +/-100000        mm, machine frame
|       setter_y .......... +/-100000        mm, machine frame
|
+- CONTROLLER CONFIG
|  +- RATES
|  |    fixed_feed ........ 0 ... 200000     mm/min, 0 = off
|  |    fixed_rapid ....... 0 ... 200000     mm/min, 0 = off
|  |    jog_vel ........... 1 ... 200000     mm/min, continuous jog
|  +- DISPLAY
|       pend_backl ........ 0 ... 100        %
|       pend_contrast ..... -1 ... 63        -1 = panel default
|       pend_ratio ........ 0 ... 7
|       led_shift ......... 0 ... 100        %
|       led_run ........... 0 ... 100        %
|       led_status ........ 0 ... 100        %
|
+- I/O MAPPING        two rows per function: PIN then POLARITY
|    inputs  x14 ......... pin -1 ... 15 (-1 = none), pol NC | NO
|    outputs x4 .......... pin -1 ... 15 (-1 = none), pol HI | LO
|
+- DIAGNOSTICS ......... INPUTS / OUTPUTS / LINK, no settings
+- UPDATE PENDANT ...... reflash the panel over the link, no settings
+- SECURITY ............ device ID and licence, read-only
```

NOTE

Three groups of settings that exist on related products are deliberately not offered on this panel: the clock (this board has no battery-backed calendar, so a clock setting could not survive power-off), key reassignment, and stock display settings. Work offsets and the tool table are not in this menu either — offsets are reached with Shift + WT and the tool table is measured rather than typed (Chapter 11).

7.2 X-Axis / Y-Axis / Z-Axis

One section per linear axis, each holding the same set of parameters:

Setting	Range	Meaning

steps_per_mm	1 – 100,000	Sets the number of drive steps required to move the axis one millimetre, defining the resolution of movement. Calculate it from your motor, drive microstepping and mechanics rather than estimating it.
max_rate	1 – 200,000	Defines the maximum feed rate for the axis in mm/min, capping how fast the axis may be driven regardless of what a program requests.
accel	1 – 200,000	Sets the maximum acceleration in mm/s², controlling how sharply the axis ramps up to speed. Too high a value stalls a stepper; too low makes the machine sluggish on short moves.
travel_min / travel_max	±100,000	Sets the soft-limit bounds in machine coordinates, defining the region the axis is permitted to move within. Shipped defaults are X/Y 0…+1000 and Z −100…0.
invert	ON/OFF	Reverses the direction output for the axis, correcting a motor that runs the wrong way without rewiring it.
flip_jog	ON/OFF	Reverses the jog keys for this axis only, so that jogging matches the operator's view of the machine. Motion under program control is unaffected.
backlash	0 – 100	Sets the mechanical lost motion in mm, which the controller takes up automatically whenever the axis reverses direction.

NOTE

Z runs negative-down: machine zero is the top of Z travel and the tool works downward, which is what the controller expects throughout — a Z travel maximum of 0 means "never above the top of travel". The shipped defaults have the right shape for a typical mill; narrow them to your machine rather than expecting to flip the signs.

7.3 4th Axis

The 4th axis carries the same parameters as the linear axes, with four additions that describe what kind of axis it is: type (ROTARY or LINEAR), letter (A, B or C — the address the axis answers to in a program), rollover, and continuous, which permits unlimited rotation and disables soft limits for that axis. On a rotary axis, steps_deg replaces steps_per_mm, setting the number of drive steps per degree of rotation.

7.4 Homing

Homing establishes machine zero by driving each axis onto its home switch. The cycle makes a fast first approach to find the switch, backs off, and repeats slowly to confirm the position accurately — which is why two separate rates are configured.

Setting	Range	Meaning
enable (per axis)	ON/OFF	Enables homing for this axis. An axis with no home switch fitted should be left off.
invert (per axis)	ON/OFF	Sets the direction the axis seeks in when looking for its

		switch.
pos (per axis)	±100,000	Sets the machine coordinate of the switch itself. This value becomes the datum — the machine position the axis is assigned the moment the switch is found.
park (per axis)	±100,000	Sets the position the axis moves to once referencing is complete, typically clear of the switch and out of the working area.
feedrate	1 – 200,000	Sets the fast first approach speed in mm/min, used to find the switch quickly. The panel labels this row FEEDRATE-FAST.
seekrate	1 – 200,000	Sets the slow confirming pass speed in mm/min. A slower rate here gives a more repeatable datum. The panel labels this row SEEKRATE-SLOW.
search_cycles	1 – 10	Sets how many approach-and-confirm passes the cycle makes before accepting the position.
debounce_ms	0 – 1000	Sets the debounce time in milliseconds for the home switches, filtering contact bounce and electrical noise so a single approach is not read as several.
sensor_clear	0 – 1000	Sets the back-off margin in mm travelled after the switch releases, ensuring the axis finishes clear of the switch rather than resting on it.
z_safe	±100,000	Sets the traverse height in the work frame, used whenever the controller lifts Z before a cross-table move.
z_safe_enable	ON/OFF	Enables the lift to Z-safe before cross-table moves.
gz_lift_enable	ON/OFF	Enables the lift before a GoZero or Store Location Go To traverse.
abort_retract	ON/OFF	Retracts Z automatically when a cycle is aborted, lifting the tool clear of the work.

7.5 Homing Sequence

One number, 1–4, per axis. Axes sharing a number home together; lower numbers go first. Ties break Z, X, Y, A. Axes sharing one switch input are homed one at a time automatically. A switch configured as both a home and a limit input for the same axis is refused — homing drives deliberately into the switch, and the limit kill would otherwise fire the instant the cycle succeeds (see §1.3).

7.6 Limits

The controller offers two independent kinds of limit protection, and they guard against different things: hard limits react to a physical switch being struck, while soft limits prevent a move being started that would leave the configured travel in the first place.

Setting	Meaning
hard	Arms the limit kill, stopping motion when a limit switch activates. Left off by default until every switch has been watched behaving correctly on the DIAGNOSTICS INPUTS page (Chapter 10).

soft	Refuses moves that would take an axis outside its configured travel bounds. This applies only to an axis that has been referenced — the controller cannot police a boundary on an axis whose position it does not yet trust.

When a hard limit trips, motion stops at once and an alarm is raised naming the axis that caused it — for example LIMIT on Z. The alarm latches: releasing the switch, or jogging the axis off it by hand, does not clear the alarm and does not restore motion. Press Esc to clear the alarm and return to the DRO. If the axis is still resting on the switch, the next move will trip it again, which is correct — use Limit Override (Shift + XYA Zero) to jog clear, then release it.

7.7 Spindle

These settings describe how the controller drives the spindle and how it converts a programmed S word into an output signal.

Setting	Range	Meaning
on_delay	0 – 600 s	Sets the delay after the spindle is commanded on, allowing it to reach speed before cutting begins.
mode	0–10V / PWM	Selects the type of spindle speed signal the controller produces, for compatibility with different spindle drives.
min_rpm / max_rpm	—	Sets the spindle speed range the output represents, so a programmed S word is scaled correctly onto the output signal.
pwm_freq	1 – 1,000,000	Sets the PWM carrier frequency in Hz, used when the spindle is in PWM mode.
pwm_min_duty / pwm_max_duty	0 – 100 %	Sets the duty-cycle range the speed signal is scaled into, matching the input expectations of the spindle drive.

7.8 Tool Zero

These settings govern both probing cycles — probing the work surface to set Z zero, and probing the tool setter to measure tool length. As with homing, the probe makes a fast approach followed by a slow confirming pass, which is why two rates are configured.

Setting	Meaning
sensor_height	Sets the height of the tool-setter pad above machine Z0, or the thickness of the plate used for work-Z probing. One field serves both cycles, because the two are never in use at the same time.
backoff	Sets how far the probe retracts between the fast and the slow confirming pass.
distance	Sets the maximum travel the probe may make before the cycle gives up and reports no contact. This is what prevents a probe move driving indefinitely when nothing answers.
feed	Sets the fast approach speed used to find the surface.
seek	Sets the slow confirming speed, which determines how repeatable the

	captured position is.
pulloff	Sets the final retract distance after the position has been captured, lifting the probe clear of the surface.
use_pos	Selects where tool-length probing happens. OFF probes from wherever the machine currently stands, and setter_x/setter_y are ignored entirely. ON lifts to safe Z and traverses to the stored setter position first.
setter_x / setter_y	Sets the machine coordinates of the tool setter. Read only when use_pos is ON.

7.9 General

These settings tune how the controller interprets a program and how it generates drive pulses.

Setting	Range	Meaning
opt_stop	Ignore / Honor M1	Selects whether an optional stop in the program is acted on or passed over.
tool_change	Ignore / Pause	Selects how an M6 tool change in the program is handled — see Chapter 11.
step_pulse_us	1 – 100 µs	Sets the duration of the step pulse sent to the drives, ensuring compatibility with the minimum pulse width your stepper or servo drives require.
step_delay_us	0 – 100 µs	Sets how long the direction line must be stable before the first step pulse follows it, for drives that require a direction setup time.
junction_dev	0.0001 – 10 mm	Sets how far the controller may deviate from the exact path at a corner while maintaining speed. A larger value gives smoother, faster cornering; a smaller one follows the programmed path more closely.
arc_tol	0.0001 – 10 mm	Sets the chord tolerance used when approximating an arc, controlling how accurately circular interpolation is reproduced.
smooth_time	0 – 0.5 s	Applies smoothing to acceleration changes, reducing mechanical shock on the machine. A value of 0 disables it.
motion_mode	G64 Blend / G61 Exact	Selects whether the controller blends consecutive moves for continuous motion, or comes to an exact stop at the end of each one.
block_run	ON/OFF	Enables single-block mode, in which the program advances one line per press of Start. Useful while proving out a new program.

NOTE

The controller cannot produce more than 125,000 steps per second. If max_rate ×

steps_per_mm exceeds it, that axis simply runs slower than the number says — the settings page warns on the rate rows as well as the pulse-width row. A step pulse width is also checked against the maximum step rate: a wide pulse cannot coexist with a fast step rate, since the pulse would not finish before the next one is due.

CAUTION

Adjusting parameters such as max_rate, accel, the travel bounds or the limit settings should be done with care, so that the machine is not asked to exceed its mechanical capability. Test any change in a safe way — with Dry Run, or with the tool clear of the work — before cutting with it.

Chapter 8 — Controller Configuration

Menu → CONTROLLER CONFIG. Three sections.

8.1 Rates

fixed_feed, fixed_rapid, and jog velocity.

> ⚠ **WARNING**
> A non-zero fixed feed or fixed rapid overrides every F word in the program. Useful while proving out a machine; left set afterward, it presents as a program cutting at the wrong speed with no bad number anywhere in the G-code.

8.2 Display

Pendant contrast and backlight percentage, and Shift/Run/Status LED brightness (0–100%). Percent rows are edited and shown as whole numbers — the hardware quantises backlight to 100 levels and LED brightness to 32, so a fraction of a percent is not a distinction either can make.

Chapter 9 — I/O Mapping

The I/O MAPPING menu determines which physical pin each function is connected to, and how that pin is interpreted. Every function has two rows: the pin it uses (0–15, or -- for none), and its polarity — NC or NO for an input, HI or LO for an output. Setting the polarity to match the switch you actually fitted saves rewiring a normally-closed switch that the controller expected to be normally open.
Functions are assigned to pins, never pins to functions. A function that is not wired is set to -- and is simply not looked for.

9.1 Input Functions

Fourteen functions can be assigned to inputs. The four homing and four limit functions cover X, Y, Z and the 4th axis individually, so a machine with switches on only some axes leaves the rest unassigned.

Function	What it is for
Home X / Y / Z / 4th	The homing switch on each axis, used by the homing cycle.
Limit X / Y / Z / 4th	The travel limit switch on each axis. These stop the machine, and only take effect when hard limits are switched on (section 7.6).
Probe	The probe or tool setter, used by G38 probing moves and by automatic tool length measurement.
Ext E-Stop	An external emergency stop chain wired into the controller.
Cycle Start	A physical start button. It starts a program only — it will not resume a held one, so a knock on the button cannot restart a job that was deliberately paused.
Feed Hold	A physical hold button, equivalent to the panel Pause key.
Stop	A physical abort button.
Block Run	A single-block mode switch. It selects the mode; it is not a press-to-advance button.

9.2 Output Functions

Four functions can be assigned to the relay outputs: Spindle Enable, Spindle Direction, Coolant and Mist. In the shipped arrangement these sit on relays 1 to 4 in that order — see §3.4.

9.3 Polarity

The polarity row tells the controller what a working switch looks like at rest, so that the switch you actually fitted does not have to be rewired to suit the controller.

Setting	Use it when
NO (inputs)	The switch is normally open and closes to ground when it operates — the ordinary case, and the setting a newly assigned input starts from.
NC (inputs)	The switch is normally closed and opens when it operates. A broken wire then reads as an operated switch, which is why safety switches are usually wired this way.
LO (outputs)	The device being driven turns on when the output is pulled low.

HI (outputs)	The device being driven turns on when the output is driven high.

If a switch works but reads backwards, the polarity row is the setting to change, not the wiring. The DIAGNOSTICS INPUTS page (Chapter 10) shows the raw pin and the decoded function side by side, which makes a polarity error obvious.

9.4 Input Terminals

Terminal	Default function
IN0–IN3	Home X/Y/Z/A
IN4–IN7	Limit X/Y/Z/A
IN8	Probe
IN9–IN12	Spare
IN13	E-STOP

> ⚠ **WARNING**
> The dedicated E-STOP input stops the machine faster than any other input. Moving E-STOP elsewhere still works, but responds more slowly — on the signal where speed matters most. If any other function is assigned to the E-STOP pin, both rows warn: whenever that input activates, the machine stops.

Chapter 10 — Diagnostics

The DIAGNOSTICS menu exists to answer the two questions that come up most often when commissioning a machine: is this switch wired the way I think it is, and does this relay actually click? It offers three screens.

Page	Shows	Keys
LINK COUNTERS	Baud rate, TX/RX frame counts, CRC errors, timeouts	Read only
INPUTS (LIVE)	All input pins as a raw bit row, plus every input function decoded by name with its pin and state	Scroll
OUTPUTS (FORCE)	All output pins as a bit row; pick a pin and toggle it	Pick pin, OK toggles, Shift+OK turns all off

The INPUTS page shows the raw pin row and the decoded function deliberately — the raw row is mapping-independent, the decoded list is the “is my E-stop seen as pressed” view. A disagreement between the two is the diagnosis: a pin that changes while its decoded function stays off means the mapping or polarity is wrong, not the switch.

Bit row	Function row	Meaning
1	ON	Wiring, mapping, and polarity all agree
1	off	Polarity is set the wrong way
No change	—	Not wired to the pin the table claims
1 at rest	—	Stuck or shorted input

Forcing an output on the OUTPUTS page is refused unless the machine is idle — otherwise the forced state and the running program would be driving the same output against each other.

Chapter 11 — Tool Changes and Tool Length

> **NOTE**
> There is no tool table you can type values into, and that is deliberate — tool length is measured, never typed.

With tool_change set to PAUSE, an M6 in the program stops the machine and the spindle and shows TOOL CHANGE Tn. Change the tool by hand, then press Resume. The controller then:

1. re-probes the new tool (lifting and traversing to the tool setter first, if use_pos is on),
2. shifts work Z by the difference between this tool and the last one measured,
3. continues the program.

Three deliberate refusals:

- The first measurement of a session sets the reference and shifts nothing — there is no previous tool to differ from.
- A probe that finds nothing does not resume. The new tool is unmeasured, which is exactly what the re-probe exists to catch.
- With no probe input mapped, the hold behaves as a plain pause — no automatic measurement takes place.

> **NOTE**
> The remembered tool length is lost on a power cut, on purpose — the next probe re-establishes it rather than shifting work zero against a length carried over from before the outage.

Chapter 12 — G-code Reference

The TNC-M24 supports a broad set of standard G and M codes, giving compatibility with the output of common CAM software. This chapter lists what the controller executes, what it accepts without acting on, and what it declines — and, where a code is declined, why. Advanced features such as macro variables and arithmetic are not included, as these are better handled by the CAM software that generates the program.

12.1 Supported G Codes

Code	Function
G0	Rapid positioning move to the specified coordinates at maximum speed.
G1	Linear interpolation move at the programmed feed rate.
G2	Clockwise circular interpolation, in any of the three planes.
G3	Counter-clockwise circular interpolation, in any of the three planes.
G4	Dwell — pause for a specified time before continuing.
G17 / G18 / G19	Select the XY, XZ or YZ plane for circular interpolation.
G20 / G21	Set units to inches or millimetres.
G28 / G30	Return to a predefined reference position. The .1 forms set that position instead of travelling to it.
G52	Apply a local coordinate offset on top of the active work coordinate system.
G53	Move in machine coordinates for this line only, overriding the active work offset.
G54 – G59	Select work coordinate system 1 through 6.
G10 L2 / L20	Set a work coordinate offset from within the program.
G61 / G64	Select exact-stop or blended motion mode.
G90 / G91	Absolute or incremental distance mode.
G90.1 / G91.1	Absolute or incremental arc-centre mode.
G92	Set a temporary coordinate system offset at the current position.
G93 / G94	Inverse-time or units-per-minute feed rate mode.

12.2 Supported M Codes

Code	Function
M0	Program pause — stops execution until resumed manually.
M1	Optional program pause — acted on only if opt_stop is set to honour it (section 7.9).
M2 / M30	Program end. M30 also resets to the initial state.

M3 / M4	Spindle on, clockwise or counter-clockwise, at the speed given by the S word.
M5	Spindle off.
M6	Tool change — see Chapter 11.
M7 / M8	Mist or flood coolant on.
M9	Coolant off.
M13 / M14	Spindle on and flood coolant on together, in one command.
M48 / M49	Enable or disable feed and speed override.
M62 / M63	Turn a specified output on or off, synchronised with motion.
M64 / M65	Turn a specified output on or off immediately, independent of motion.
M66	Wait for a specified input to reach a defined state before continuing.

12.3 Canned Cycles

The following drilling and boring cycles are implemented and produce real motion:

Code	Cycle
G81	Plain drill
G82	Drill with dwell at depth
G83	Peck, full retract to R each peck
G73	Peck, partial retract (chip break)
G84	Tap — feed in, feed out
G85	Bore — feed in, feed out
G86	Bore — feed in, rapid out
G88	As G86, with dwell
G89	Bore — feed in with dwell, feed out

G80 cancels; G98/G99 select the return plane. Q sets the peck increment, P the dwell, R the retract plane.

> **NOTE**
> G86 and G88 are specified to stop or reverse the spindle at depth. The motion is exact; the spindle action is not performed, and a one-time console message says so rather than letting it pass unremarked.

12.4 Accepted but Ignored

Code	Why
G43	Tool length is measured, not typed (Chapter 11) — the compensation is already in the coordinate frame by the time a program reaches G43, so

	applying a table entry on top would double it. Accepted rather than refused because ordinary post-processors emit it.
G49	Cancel — already the default
G40	Cutter comp off — already the default
G15, G50, G69	Polar / scaling / rotation cancel — harmless
G80	Cancel canned cycle
G98, G99	Canned-cycle return mode

12.5 Refused — the Program Will Not Run

G16 (polar), G41/G42 (cutter compensation), G51 (scaling), G68 (rotation), G95 (feed-per-revolution), and three canned cycles: G74 (left-hand tapping), G76 (fine boring), G87 (back boring).

NOTE

These are refused outright rather than skipped because each changes the meaning of every line that follows it — running the file with the defining line dropped would cut the wrong shape. A canned cycle is modal: bare X/Y lines after one are further holes of that same cycle, so skipping only the defining line would silently omit every hole while still running the moves between them.

12.6 Not Supported — the Line Is Skipped

- G38.x probing inside a program. Probing is a panel cycle here (Chapter 5, Chapter 11), not a program instruction. The line is skipped and the axis does not move — and, importantly, any F word on that line does not become the modal feed rate.
- Any other M-word — a warning is shown per occurrence, and the motion on that line still runs.
- U, V and W axis words — these are not axis addresses on this controller, and a program using them is flagged.
- Scripting or macro variables — not supported by design on this product.

NOTE

A cutting move with no feed rate ever established is refused, naming the line. A program that relies on the controller carrying a feed rate over from a previous job will not run — the F word must appear in the file.

12.7 File Names

Long file names are supported on the card, so the descriptive names CAM software typically produces can be used directly without shortening them. Only files handled by the bootloader must use strict 8.3 naming.

Chapter 13 — Before the First Cut

13.1 Commissioning Order

Commissioning a machine follows a fixed order, because each step depends on the position, wiring or setting established by the one before it. Work through them in sequence rather than skipping ahead:

1. Set the machine table — steps/mm, rates, accelerations, travel (Chapter 7). The shipped values are deliberately slow placeholders and are certainly wrong for your machine.
2. Watch the inputs (Chapter 10) before arming limits/hard. Every switch should show 1/ON when pressed and nothing at rest.
3. Test the relays on the OUTPUTS page — four presses should give four distinct clicks.
4. Check the E-STOP on the INPUTS page.
5. Check jog on each axis and at each scale, confirming that only the selected axis moves and that it moves the distance the scale names. Every step that follows depends on the controller reading position correctly.
6. Set homing — direction, switch position, park position, rates — then home one axis at a time, with a hand near Esc.
7. Then probing, which needs a referenced axis.
8. Then a tool change, which needs probing.
9. Then a program, and only then touch-up mid-program.

Esc stops the machine at any point in this sequence.

> **NOTE**
> Once settings have been saved, the board keeps those values — a machine that has been configured before will not pick up new defaults on its own. Edit the row directly, or delete the saved configuration file from the SD card and let it re-default. This matters for the travel bounds in step 1, which homing depends on.

13.2 Z-Inhibit — Running the Path in the Air

Shift + DR. Z is held where it stands while X, Y and the 4th axis run the program at the programmed rate. This is not a mode in which the machine stays still: there is no toolpath drawing on this panel, so watching the machine trace the path is the preview, and the movement is the whole point of it.
While Z-Inhibit is on, the banner ** Z-INHIBIT ** replaces everything else on that line of the DRO and the RUN screen, so the mode is never active without being visible.

> ⚠ **WARNING**
> Raise Z clear of the workpiece before you start. A Z-inhibited run is refused until the tool is at or above the safe height (section 7.4, z_safe), and the message names the height required. Z genuinely does not move during the pass, so the tool traverses the whole program at whatever height it was left at — starting from the workpiece surface would rake the tool across the part and every clamp at rapid.

The mode is captured when a run begins, so switching it on or off part-way through changes the banner and nothing else; the screen says NEXT RUN ONLY to make that clear. The usual order is:

1. Set work zero on the job as normal.
2. Press Shift + DR to switch Z-Inhibit on.
3. Raise Z clear of the work.
4. Press Start and watch the path run in the air.
5. Press Shift + DR again to switch it off.

6. Return Z to the work zero and press Start for the real cut.

Chapter 14 — Updating the Pendant

The pendant runs its own firmware, which is updated from the mainboard over the same cable that carries the display and keypad. Menu → UPDATE PENDANT shows the version currently on the pendant above the version available on the mainboard, together with the size of the update and whether the two differ or already match.

Press OK to begin. The screen reports each stage with a progress bar. Part-way through, the pendant is placed into its bootloader and the panel goes dark for a short period — this is expected, and the display returns by itself once the transfer completes. When it finishes, the screen reports that the panel matches.

> **CAUTION**
> Esc is deliberately ignored once an update is under way. Interrupting a partly written pendant would leave it unable to start, and recovering it would require opening the unit and connecting a programmer. Do not remove power during an update, for the same reason.

Chapter 15 — Messages and Alarms

The controller refuses an action rather than performing a partial or unsafe version of it, and names the reason on screen when it does. The messages below are the ones most often met while setting a machine up.

15.1 Homing

Message	Meaning and what to do
NO AXIS SET TO HOME	No axis has homing enabled, so there is nothing for the cycle to do. Enable the axes that have home switches fitted, in MACHINE CONFIG → homing (section 7.4).
<axis> FAILED: NOT SEEN	The axis travelled its full search distance without the switch activating. The switch is not wired, not mapped to the pin the I/O table claims, or the seek direction is inverted. Check it on the DIAGNOSTICS INPUTS page (Chapter 10).
<axis> HOME IS A LIMIT	The same input is mapped as both the home and the limit switch for that axis. Homing drives deliberately onto the switch, so the limit would stop the machine at the moment the cycle succeeded. Separate the two functions, or map the axis to a different input.

15.2 Probing

Message	Meaning and what to do
AXIS NOT REFERENCED	The probe cycle needs a referenced axis to work against. Home the machine, or declare it referenced, before probing.
ALREADY TRIGGERED	The probe input reads active before the cycle has moved. The probe is shorted, miswired, or its polarity is set the wrong way — the cycle refuses rather than capturing a position instantly at the wrong height.
PROBE PIN IS A LIMIT	The probe function is mapped to an input already serving as a limit. Map the probe to its own input.
NO CONTACT	The probe travelled the full configured distance without touching anything. No offset is written. Check the probe wiring, and that the surface is within the configured search distance (section 7.8).

15.3 Motion and Traverses

Message	Meaning and what to do
LIMIT — <axis>	A hard limit switch activated on the named axis. The alarm latches: press Esc to clear it, then use Limit Override (Shift + XYA Zero) to jog the axis clear (section 7.6).
GO ZERO: NOT REF	GoZero needs a referenced machine position to travel to. Home the machine, or declare it referenced, first.
DECLARE POS HERE?	Confirmation prompt shown by a long press of GoHome before it

	declares the current position referenced. Press OK to accept; any other key declines (section 4.9).

15.4 Tool Change

Message	Meaning and what to do
TOOL CHANGE T<n>	The program has reached an M6 and is holding. Change the tool by hand, then press Resume (Chapter 11).
TOOL REF	The first tool measurement of the session has been taken. This sets the reference length; work Z is not shifted, because there is no previous tool to compare against.
TOOL APPLIED	A subsequent tool has been measured, and work Z has been shifted by the difference from the previous tool.

15.5 Settings

Message	Meaning and what to do
RATE > 125k STEP/S	The combination of max_rate and steps_per_mm asks for more steps per second than the controller can produce. The axis will run slower than the figure suggests. Reduce either value (section 7.9).
SAVE FAILED — NOT WRITTEN	The settings could not be written to the SD card. The edits are still live, so they can be retried or discarded. Check that a card is fitted, has space, and is not write-protected.

15.6 Program

A program using a code the controller declines is refused before it starts, with the code and the line number named — see sections 12.5 and 12.6. A cutting move with no feed rate ever set is refused the same way. Codes that are accepted but not acted on, and unknown M-words, produce a note rather than stopping the program.

End of Document