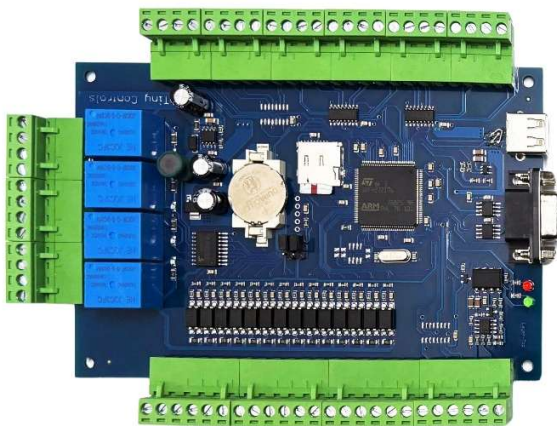




### TNC-M24 (Four Axes Motion Controller)

Document: Operation Manual

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Product Rev: 1.01

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This manual contains information for installing and operating the following product:

### **TNC-M24, Four Axes Offline CNC Motion Controller**

Tiny Controls Private Limited is a numerical control company specializing in the research, development, and production of advanced CNC systems since 2013. Our mission at Tiny Controls is to deliver high-quality, reliable, and affordable solutions tailored to diverse machining applications.

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## TNC-M24 Product Introduction

Thank you for your interest in our 4 Axis CNC Controller and for taking the time to read this manual.

The TNC-M24 is a cutting-edge 4-axis CNC controller designed for stepper and servo systems, embodying years of innovation in a compact, powerful package. Whether you're new to our products or upgrading from a previous model, you'll find the TNC-M24 intuitive to use, with this manual serving as your comprehensive guide. It is ideal for a wide range of CNC machines, operating as a standalone unit without requiring a computer.

### Key Features:

- Supports a comprehensive set of standard G/M codes for versatile programming compatibility across various CNC applications.
- Features ARM processor for high-speed, efficient G-code processing and system responsiveness.
- Equipped with a 7 128x64 graphic display, providing vibrant visuals for clear monitoring and control.
- Includes a 20-key keypad with multi-purpose keys (function, alt-functions and numeric), designed for efficient and intuitive operation.
- Offers USB port for easy file transfers and peripheral connectivity, enhancing workflow flexibility.
- Incorporates an internal SD card, enabling storage of practically unlimited G-code file sizes for complex projects.
- 5V differential outputs for Stepper or Servo driver interface.
- Upgradeable via firmware downloadable from <https://www.tinycontrols.com>
- Delivers exceptional precision and accuracy, with a reliable, user-friendly interface that can be mastered quickly.

Tiny Controls is committed to providing cutting-edge CNC solutions, and the TNC-M24 reflects our dedication to quality and innovation. With its robust feature set and adaptable design, this controller elevates your machining capabilities with ease and efficiency.

**TNC-M24 Technical Specifications**

1. **Inputs:** 14 opto-coupled NPN normally open (N/O) digital inputs, providing robust electrical isolation to ensure reliable signal detection from sensors, switches, or other devices.
2. **Relay Outputs:** 4 integrated relay outputs, offering isolated switching for higher-power applications such as coolant pumps or spindle motors, enhancing control flexibility.
3. **Stepper/Servo Outputs:** 8 differential outputs for precise control of stepper or servo motors.
4. **Spindle Control:** Isolated 0-10V Analog output for spindle speed regulation, with configurable PWM mode option, providing versatile compatibility with various spindle drives.
5. **Processor:** High Speed ARM processor, delivering high-speed processing for real-time G-code execution and responsive user interaction, ensuring efficient standalone operation.
6. **Display and Interface:** Interface: Monochrome display on MPG pendant + 20-key keypad.
7. **Power Supply:** Single 24VDC input at 0.5A, simplifying wiring and reducing setup complexity while powering both the controller and its I/O systems.
8. **Connectivity and Storage:** USB port for file transfer and internal SD card supporting unlimited G-code file sizes, ensuring scalability for complex projects.
9. **Software and Hardware:** Ships with software version 1.01 (upgradeable via firmware from <https://www.tinycontrols.com>) and hardware version 1.0, offering a solid foundation with room for future enhancements.

The TNC-M24 is engineered to meet the demands of modern CNC operations, combining advanced technology with practical design to enhance your workshop's productivity and precision.

Located at the top of the pendant, the small monochrome display provides real-time feedback on the machine's status. It shows the selected axis (X, Y, Z, or A), the current position of the selected axis, and the active scale setting (e.g., 1, 10, 100, 1000). This display mirrors the axis selection and scale indicators on the main controller in currently selected work coordinate (G54 .. G59), ensuring the operator has immediate access to critical information while away from the main screen.

### 1. Jog Axis Selection Button:

## 2. Jog Scale Selection Button:

Sets jogging increment, correspond to the scale settings on the main controller (e.g., 1 micron, 10 microns, 100 microns, or 1000 microns per pulse in step mode). In continuous mode, these settings adjust the jogging speed (e.g., slow, medium, fast). The active scale is indicated by a green LED on the main controller's display (labelled "Scale") and is also shown on the pendant's display.

### 3. Zero Buttons:

**XYA Zero:** Sets the currently selected axis to zero, establishing a reference point for current WCS (working coordinate G54 ... G59). This function is equivalent to the "X-Zero," "Y-Zero," "Z-Zero," and "A-Zero" keys on the main keypad.

**Z Zero:** Sets the Z axis to zero, establishing a reference point for current WCS (working coordinate G54 ... G59). This function is equivalent to the "Z-Zero key on the main keypad.

#### LEDs:

- **Shift**
- **Run**
- **Status.**

## Keypad Layout and Functions

- 1 File (WT)
- 2 Start (ST)
- 3 Pause (WC)
- Jog Axis (red)
- 4 GoHome (FO)
- 5 XYA Zero (LO)
- 6 Resume (SL)
- Jog Scale (red)
- 7 T-Zero (SO)
- 8 Z-Zero (DR)
- 9 GoZero (JS)
- Shift (blue)
- Display Toggle (green)
- Step+ (up triangle)
- 0 Menu (del)
- OK (blue)
- Cont- (left arrow)
- Step- (down triangle)
- Cont+ (right arrow)
- Esc (blue)

### Normal functions (no Shift key):

- 1 FILE: SELECT PROGRAM FILE FROM USB AND COPY IT TO INTERNAL STORAGE FOR EXECUTION.
- 2 START: START SELECTED PROGRAM.
- 3 PAUSE: PAUSE PROGRAM.
- JOG AXIS (RED): CYCLE THROUGH X, Y, Z, A FOR JOGGING.
- 4 GOHOME: GO TO HOME USING HOMING SENSOR IF SENSORS ARE ENABLED.
- 5 XYA ZERO: MAKE SELECTED AXIS WCS ZERO.
- 6 RESUME: RESUME PAUSED PROGRAM.
- JOG SCALE (RED): SET JOG SCALE 1 MICRON / 10 / 100 / 1000 MICRONS.
- 7 T-ZERO: TOOL ZERO USING TOOL SENSOR.
- 8 Z-ZERO: MAKE CURRENT WCS Z ZERO.
- 9 GOZERO: GOTO CURRENT WCS HOME OR ZERO POSITION.
- DISPLAY TOGGLE: SWITCH BETWEEN 2 SCREENS WITH DIFFERENT INFOS.
- STEP+/STEP-: PRECISE SINGLE-STEP JOGGING.
- CONT-/CONT+ (LEFT/RIGHT ARROWS): CONTINUOUS JOGGING.
- 0 MENU: OPEN SETTINGS MENU.
- OK: CONFIRM SELECTIONS OR SAVE SETTINGS.
- ESC: CANCEL OR EXIT CURRENT OPERATION.
- SHIFT (BLUE): ACTIVATE ALT-FUNCTIONS.

**Blue alt-functions activate only when Shift is ON.**

- **WT:** WCS/MCS toggle.
- **ST:** Spindle toggle.
- **WC:** WCS selection (G54 to G59).
- **FO:** Feed override.
- **LO:** Limit override.
- **SL:** Start from line number.
- **SO:** Spindle speed override.
- **DR:** Dry run.
- **JS:** Jog offline mode.

**LEDs: Shift / Run / Status.**

## Settings Menu

The TNC-M24 4 Axis CNC Controller provides a detailed settings menu, accessible via the F1 soft key labelled "Settings" on the main screen. This menu allows users to configure a wide range of parameters to customize the controller's behaviour for specific machining tasks. The settings menu is organized into a hierarchical structure with main categories, subcategories, and individual parameters, ensuring users can easily adjust general settings, axis behaviour, I/O configurations, tool settings, and more. This section outlines the menu structure, the available parameters, and how to navigate and adjust them using the controller's keypad and display.

**Settings Menu is accessed by pressing "MENU" Key, Menu Structure is as explained below :**

The settings menu is divided into main categories, with subcategories and parameters nested within them. Users can navigate through the menu using the keypad's **Up** and **Down** keys to scroll, the **OK** key to select an option, and the **ESC** key to return to the previous menu or exit. The structure and parameters are as follows:

### Main Menu

#### 1. General Settings

- **Junction Tolerance:** Sets the maximum controller can deviate (default 0.010 mm), from path while optimizing for speed.
- **Arc Tolerance:** Sets the tolerance for arc approximation (default 0.002 mm), ensuring accurate circular interpolation (G2/G3).
- **STEP Pulse Width:** Sets the duration of the step pulse for motor control (e.g., 1  $\mu$ s), ensuring compatibility with stepper or servo drives.
- **LCD Brightness:** Adjusts the backlight of pendent display (0 to 100 Percent)

#### 2. Axis Settings

- **X-AXIS SETTING**
  - **Drive Enable:** Enable or disable the axis.
  - **Step Pin:** Toggles the direction pin polarity for the X-axis (e.g., High/ Low).
  - **Dir Pin:** Toggles the direction pin polarity for the X-axis (e.g., High/ Low). reversing the motor direction if needed.
  - **Flip Jog Key:** Inverts the X-axis jogging direction for the Jog keys (e.g., Enable/Disable), aligning with user preference.
  - **Steps Per mm:** Sets the number of steps per millimetre for the X-axis (e.g., 1000 steps/mm), defining the resolution of movement.
  - **Max Feedrate:** Defines the maximum feed rate for the X-axis (e.g., 50 mm/Sec), ensuring safe operation.

- **Max Acceleration:** Sets the maximum acceleration for the X-axis (e.g., 50000 mm/s<sup>2</sup>), controlling speed ramp-up.
- **Y-AXIS SETTING**
  - **Drive Enable:** Enable or disable the axis.
  - **Step Pin:** Toggles the direction pin polarity for the Y-axis (e.g., High/ Low).
  - **Dir Pin:** Toggles the direction pin polarity for the Y-axis (e.g., High/ Low). reversing the motor direction if needed.
  - **Flip Jog Key:** Inverts the Y-axis jogging direction for the Jog keys (e.g., Enable/Disable), aligning with user preference.
  - **Steps Per mm:** Sets the number of steps per millimetre for the Y-axis (e.g., 1000 steps/mm), defining the resolution of movement.
  - **Max Feedrate:** Defines the maximum feed rate for the Y-axis (e.g., 50 mm/Sec), ensuring safe operation.
  - **Max Acceleration:** Sets the maximum acceleration for the Y-axis (e.g., 50000 mm/s<sup>2</sup>), controlling speed ramp-up.
- **Z-AXIS SETTING**
  - **Drive Enable:** Enable or disable the axis.
  - **Step Pin:** Toggles the direction pin polarity for the Z-axis (e.g., High/ Low).
  - **Dir Pin:** Toggles the direction pin polarity for the Z-axis (e.g., High/ Low). reversing the motor direction if needed.
  - **Flip Jog Key:** Inverts the Z-axis jogging direction for the Jog keys (e.g., Enable/Disable), aligning with user preference.
  - **Steps Per mm:** Sets the number of steps per millimetre for the Z-axis (e.g., 1000 steps/mm), defining the resolution of movement.
  - **Max Feedrate:** Defines the maximum feed rate for the Z-axis (e.g., 50 mm/Sec), ensuring safe operation.
  - **Max Acceleration:** Sets the maximum acceleration for the Z-axis (e.g., 50000 mm/s<sup>2</sup>), controlling speed ramp-up.
- **4th-AXIS Settings**
  - **Drive Enable:** Enable or disable the axis.
  - **Step Pin:** Toggles the direction pin polarity for the X-axis (e.g., High/ Low).

- **Dir Pin:** Toggles the direction pin polarity for the axis (e.g., High/ Low). reversing the motor direction if needed.
- **Flip Jog Key:** Inverts the axis jogging direction for the Jog keys (e.g., Enable/Disable), aligning with user preference.
- **Steps Per mm:** Sets the number of steps per millimetre for the axis (e.g., 1000 steps/mm), defining the resolution of movement.
- **Max Feedrate:** Defines the maximum feed rate for the axis (e.g., 50 mm/Sec), ensuring safe operation.
- **Max Acceleration:** Sets the maximum acceleration for the axis (e.g., 50000 mm/s<sup>2</sup>), controlling speed ramp-up.

### 3. I/O Settings

#### ○ Spindle Settings

- **SPINDLE:** Type of spindle control (Disable 0-10V or Step/PWM).
- **Step Pin:** Toggles the Step pin polarity when used in Step mode.
- **Dir Pin:** : Toggles the direction pin polarity when used in Step mode.
- **MIN RPM:** Sets the minimum spindle speed (e.g., 0 RPM) for the 0-10V output.
- **MAX RPM:** Sets the maximum spindle speed (e.g., 24,000 RPM) for the 0-10V output.
- **SPINDLE ON DELAY:** Sets the delay after turning on the spindle (e.g., 2 seconds) to allow it to reach speed.
- **PWM FREQ:** Sets the PWM frequency for spindle control (e.g., 1000 Hz) if using PWM mode.

#### ○ Homing Settings

- **Home Seekrate:** Sets the fine seek rate for homing (e.g., 500 mm/min).
- **Home Feedrate:** Sets the initial homing feed rate (e.g., 2000 mm/min).
- **Pulloff:** Sets the pulloff distance for the X-axis after homing (e.g., 5 mm).
- **Z Safe Height:** Defines a safe Z-axis height during homing (e.g., 50 mm) to avoid collisions.
- **Home Debounce:** Defines the debounce time for home switches (e.g., 10 ms) to filter noise.

#### ○ Sensor Settings

- **X-Home:** Inverts the X-axis home sensor polarity (Disable/High/Low).

- **Y-Home:** Inverts the Y-axis home sensor polarity (Disable/High/Low)
- **Z-Home:** Inverts the Z-axis home sensor polarity (Disable/High/Low)
- **A-Home:** Inverts the A-axis home sensor polarity (Disable/High/Low)
- **X-Limit:** Inverts the X-axis limit sensor polarity (Disable/High/Low).
- **Y- Limit:** Inverts the Y-axis limit sensor polarity (Disable/High/Low)
- **Z- Limit:** Inverts the Z-axis limit sensor polarity (Disable/High/Low)
- **A- Limit:** Inverts the A-axis limit sensor polarity (Disable/High/Low)
- **Limit Settings**
  - **X-sLimit:** Enables/disables soft limits based on travel limits (e.g., Enable/Disable).
  - **Y-sLimit:** Enables/disables soft limits based on travel limits (e.g., Enable/Disable).
  - **Z-sLimit:** Enables/disables soft limits based on travel limits (e.g., Enable/Disable).
  - **A-sLimit:** Enables/disables soft limits based on travel limits (e.g., Enable/Disable).
  - **X-Travel:** Set positive travel limit for the X Axis
  - **Y-Travel:** Set positive travel limit for the Y Axis
  - **Z-Travel:** Set positive travel limit for the Z Axis
  - **A-Travel:** Set positive travel limit for the A Axis

#### 4. Tool Settings

- **TZ Setting (Tool Zero Setting)**
  - **Sensor Height (mm) :** Set the tool sensor height in mm.
  - **backOff distance:(mm) :** How much to retract after touch off.
- **Auto Read Offset**
  - **Tool 0**
  - **Tool 1**
  - **Tool 2**
  - **Tool 3**
  - **Tool 4**
  - **Tool 5**

- **Tool 6**

- **Manual Edit Offsets**

- **Tool0 mm:** Sets the reference tool offset (e.g., 0 mm).
- **Tool1 mm:** Sets the offset for Tool 1 (e.g., 50 mm).
- **Tool2 mm:** Sets the offset for Tool 2 (e.g., 52 mm).
- **Tool3 mm:** Sets the offset for Tool 3 (e.g., 48 mm).
- **Tool4 mm:** Sets the offset for Tool 4 (e.g., 55 mm).
- **Tool5 mm:** Sets the offset for Tool 5 (e.g., 53 mm).
- **Tool6 mm:** Sets the offset for Tool 6 (e.g., 51 mm).

## 5. RESET Settings

- Reset Coordinates only.
- Reset All settings.
- Reset Coordinates and settings together.

## 6. Diagnostics

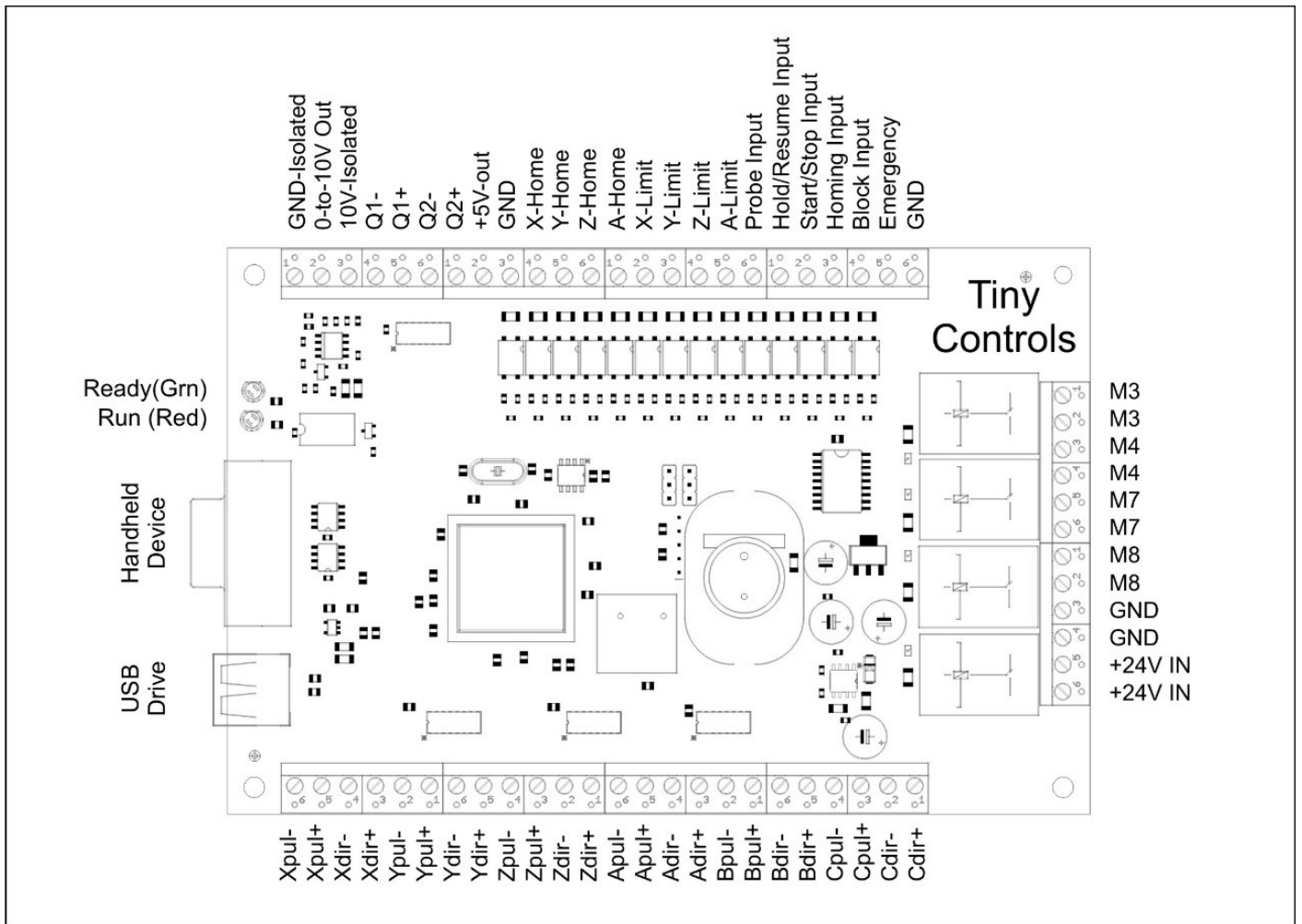
- Use this menu to test input, outputs and axis.

## 7. Firmware Version

- On main screen when machine is not running, press Esc button to display the Software and Hardware versions.

- **Safety Considerations:** Adjusting parameters like "Max Feedrate," "Max Travel Limit," or "Hard Limit" should be done with caution to avoid exceeding the machine's mechanical limits. Always test changes in a safe environment (e.g., using DryRun mode).

The settings menu of the TNC-M24 provides extensive customization options, allowing users to tailor the controller to their specific machine and application needs. For detailed operational procedures, such as running a G-code program after configuration, refer to the "Software & Operation" section.



## Supported G/M Codes

The TNC-M24 4 Axis CNC Controller supports a wide range of standard G and M codes, enabling precise control over motion, spindle operation, and auxiliary functions. These codes are compatible with common CNC workflows and are processed efficiently by the dual-core ARM processor. This section outlines the primary G and M codes supported by the TNC-M24, ensuring versatility for milling, routing, and other 4-axis applications. For the latest firmware updates and additional code support, refer to <https://www.tinycontrols.com>.

The TNC-M24 interprets these codes in real-time, supporting up to 500 kHz pulse frequency per axis for smooth operation. It includes acceleration management with look-ahead planning to optimize velocity and minimize jerk during complex motions. While the controller supports core motion and operational commands, advanced features like macro variables or arithmetic operations are not included, as these are better handled by external CAM software or GUIs.

### Supported G Codes

- **G0:** Rapid positioning move to specified coordinates at maximum speed.
- **G1:** Linear interpolation move at the programmed feed rate (e.g., F value).
- **G2:** Clockwise circular interpolation (arc or helix) using I, J, K offsets or R radius.
- **G3:** Counterclockwise circular interpolation (arc or helix) using I, J, K offsets or R radius.
- **G4:** Dwell (pause) for a specified time (e.g., P value in seconds or milliseconds).
- **G17:** Select XY plane for circular interpolation (default plane).
- **G18:** Select XZ plane for circular interpolation.
- **G19:** Select YZ plane for circular interpolation.
- **G20:** Set units to inches.
- **G21:** Set units to millimetres.
- **G28:** Return to predefined home position (machine zero or intermediate point if specified).
- **G30:** Return to secondary predefined position (similar to G28).
- **G38.2:** Probing cycle toward workpiece, stops on contact, reports position (probe must be connected).
- **G40:** Cancel cutter compensation (default state).
- **G43.1:** Tool length offset applied dynamically (requires tool data).
- **G49:** Cancel tool length offset.
- **G53:** Move in machine coordinate system (non-modal, overrides work offsets).
- **G54-G59:** Select work coordinate system 1 through 6 for offset positioning.
- **G90:** Absolute distance mode (coordinates relative to origin).

- **G91:** Incremental distance mode (coordinates relative to current position).
- **G92:** Set temporary coordinate system offset (resettable).
- **G93:** Inverse time feed mode (feed rate based on time per move).
- **G94:** Units per minute feed mode (standard feed rate).

### Supported M Codes

- **M0:** Program pause (stops execution until resumed manually).
- **M1:** Optional program pause (stops if configured, otherwise ignored).
- **M2:** Program end (stops execution without reset).
- **M3:** Spindle on, clockwise rotation (requires S value for speed).
- **M4:** Spindle on, counterclockwise rotation (requires S value for speed).
- **M5:** Spindle off.
- **M7:** Mist coolant on (if equipped and configured).
- **M8:** Flood coolant on (if equipped and configured).
- **M9:** Coolant off.
- **M30:** Program end and reset (returns to initial state).
- **M62-M66:** Digital I/O control and input waiting:
  - **M62:** Turns on a specified output in sync with motion (e.g., M62 P0 turns on output 0; supports up to 14 open collector outputs).
  - **M63:** Turns off a specified output in sync with motion (e.g., M63 P0 turns off output 0).
  - **M64:** Turns on a specified output immediately, independent of motion (e.g., M64 P0 turns on output 0).
  - **M65:** Turns off a specified output immediately, independent of motion (e.g., M65 P0 turns off output 0).
  - **M66:** Waits for a specified input to reach a defined state inputs (e.g., M66 P0 L1 waits for input 0 to go high).  
Supports remaining NPN unused, that are not used as limit/homing/start-stop, probing etc.
- **Relay Output Control:** The 4 integrated relay outputs are controlled by M3, M4, M5, M7, M8, and M9, controlling high-power devices like spindle motors and coolant pumps.