



Demo Board

User Manual V3.1 – September 2026

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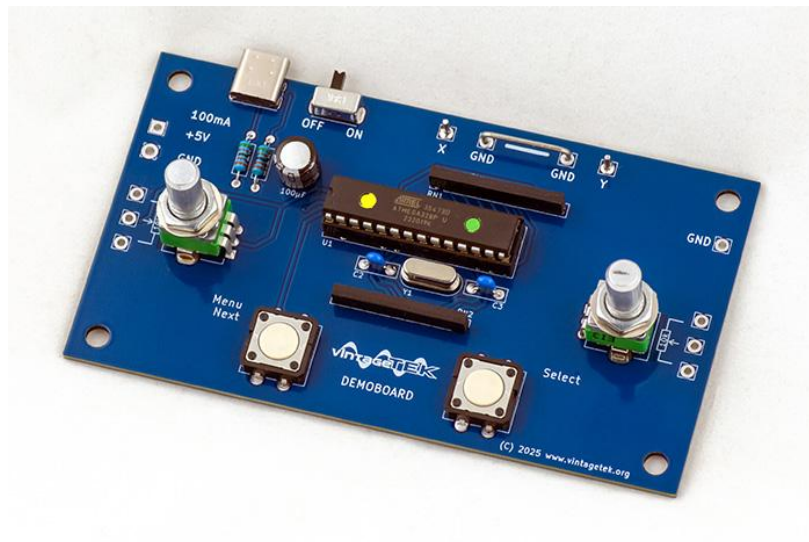


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1. Warning on Screen burn-in

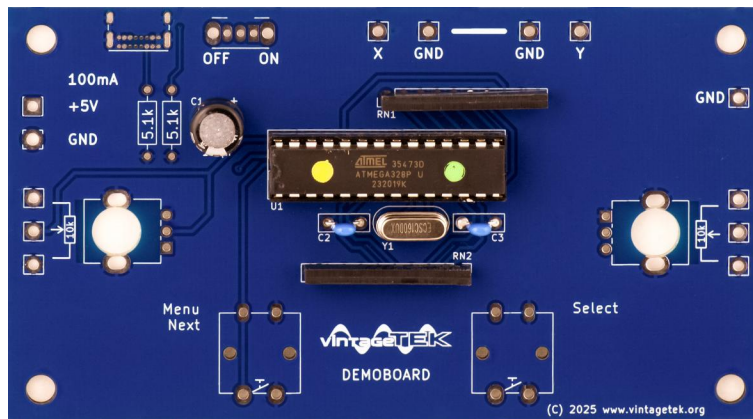
Screen burn-in occurs when a static (unchanging) image or element is displayed on a CRT screen for an extended period of time, causing permanent damage to the phosphor coating inside the CRT. This issue is even more extreme when the oscilloscope is running in X/Y mode or when the intensity settings are set too high.

The firmware of the Demo Board includes automated pixel shifting mechanisms to reduce the risk of burn-in during normal operation.

To protect your CRT, **keep the intensity settings only as high as necessary and do not leave the firmware running unattended for extended periods.** Always turn off the oscilloscope when not in use.

2. Setting up the Demo Board

The new and improved demo board has been designed to allow additional parts to be added for full functionality. The board is sold in a basic configuration with a pre-programmed processor and requires +5V and two momentary switches (not supplied) for basic display of the images. Two 10K linear potentiometers or joysticks (also not supplied) need to be added to play the games. A USB-C connector, two 5.1k resistors, and an on/off switch (also not supplied) can be used for convenient +5V power. These extra parts can be added directly to the PCB and pads have been added for ease of wiring to external components. Part numbers for the additional on-PCB parts are indicated on the rear side of the board. You'll also find a components list in chapter 16 of this manual.



Connect the oscilloscope X, Y, and ground to the indicated pads. Use short leads to connect to the oscilloscope, or use X10 probes. If you use X10 probes, make sure they are correctly compensated. Set the oscilloscope input to DC coupling. Some oscilloscopes have a short input time constant in AC coupling that will distort the images. Most digital oscilloscopes do not work as well in X-Y mode, so an analog oscilloscope is recommended.

The ATmega328P processor supplied with your demo board has already been programmed. The firmware provides a variety of sample graphics, a simple drawing editor for your own graphic, multiple versions of classic tennis games and a lunar lander game.

3. Menu structure & Navigation

The “Menu/Next” switch iterates through the menu options, and the “Select” switch executes. The selected mode will be remembered when power is removed and restored.

The “Menu/Next” switch is also used to return from a running program back to the menu.

3.1. Main Menu

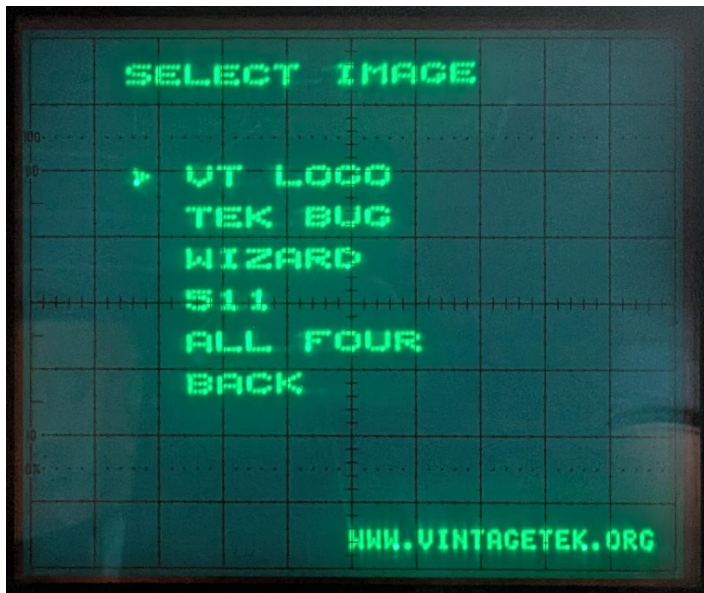


Images	Opens the menu for the various demo graphics to be displayed
Tennis	Opens the menu for starting one of the tennis game variants
Lunar Lander	Starts the lunar lander game
Graphic Editor	Starts the graphic editor
Settings	Opens the menu for various program settings *
About	Shows Info on the vintageTEK museum

* The settings menu entry is hidden in normal operation mode. To enable it power up the board while holding both the “Menu/Next” and the “Select” switch down at the same time.

3.2. Images Menu

The images menu is used to select and start the demo graphics. The firmware comes with four built-in demo images. The user can add their own graphic to the list. See chapter 8 for details on the Graphic Editor.



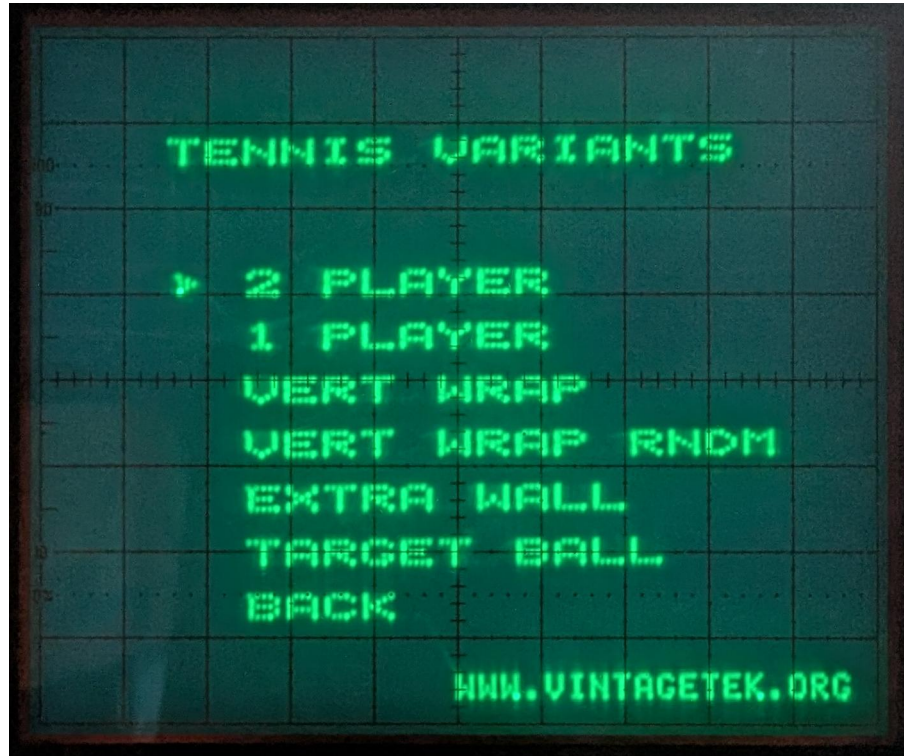
Images menu with the 4 factory graphics



Images menu with the additional user graphic

VT Logo	Displays the logo of the vintageTEK museum
Tek Bug	Displays the Tektronix logo with the square CRT from about 1968 to 1976
Wizard	Displays the Wizard from the 454 manuals
511	Displays the 511 "Vollumscope"
My Graphic	Displays the Users Custom Graphic
All Four (All Five)	Displays all 4 graphics in a loop. 5 graphics when a Custom Graphic was created
Back	Go back to the main menu

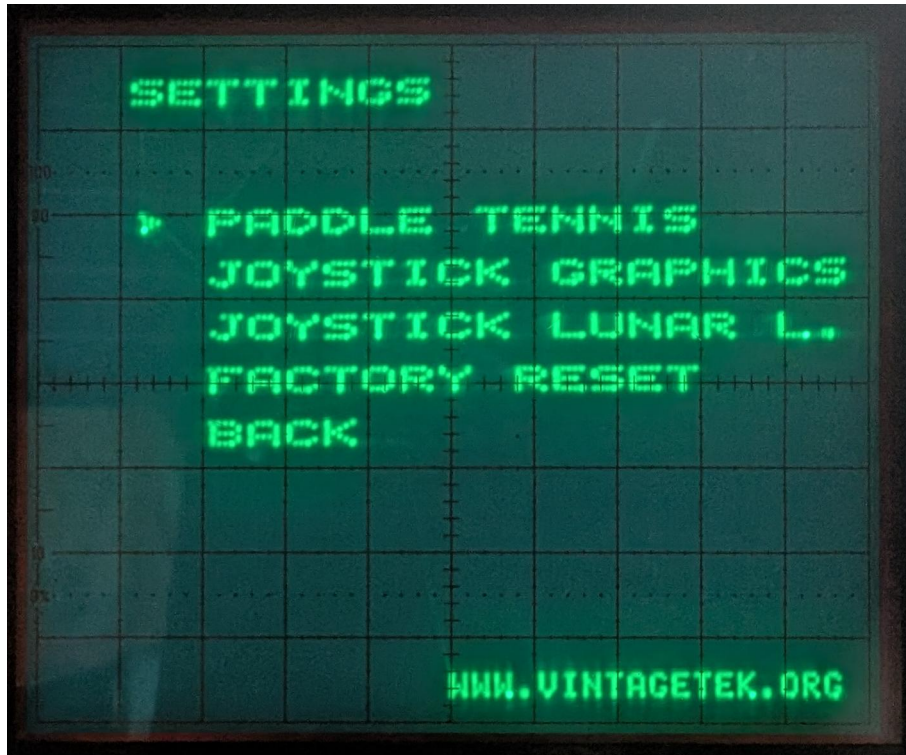
3.3. Tennis Menu



2 Player	Starts the 2-player tennis game
1 Player	Starts the single player against computer tennis game
Vert Wrap	2-player tennis game without floor and ceiling, ball “wraps around”
Vert Warp RNDM	2-player tennis game without floor and ceiling, ball returns randomly
Extra Wall	2-player tennis game with an extra paddle in center of the screen
Target Ball	Starts the Target Ball game
Back	Go back to the main menu

3.4. Settings Menu

The settings menu is normally hidden. It can be added to the main menu by power-cycling the board while holding both the “Menu/Next” and the “Select” switch down at the same time.



Paddle Tennis	Adjust potentiometer sensitivity for tennis games
Joystick Graphics	Adjust potentiometer sensitivity for the graphics editor
Joystick Lunar L.	Configure input device type for the lunar lander game
Factory Reset	Shows the options for a factory reset
Back	Go back to the main menu

4. Displaying Images (Demo Mode)

The firmware comes with four built-in demo images: The vintageTEK logo, Tek Bug, Wizard and the 511 “Vollumscope”. If the user has created their own graphic, this image will be automatically added to the list.

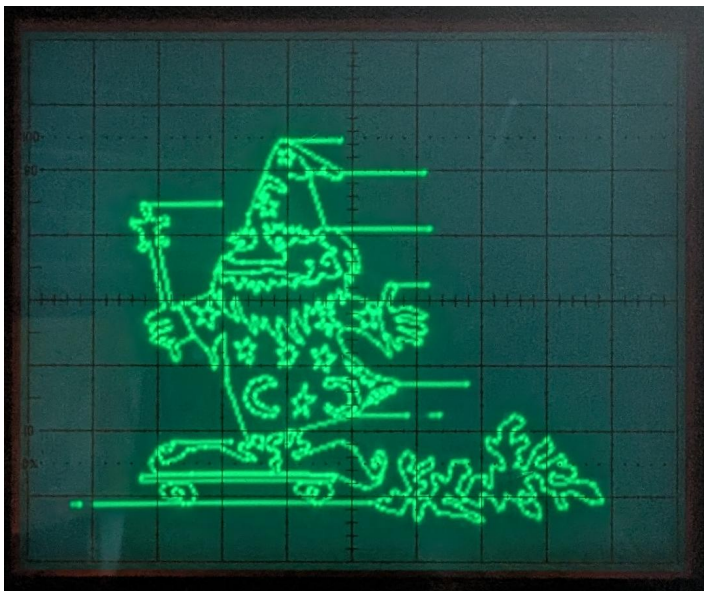
The user can select between demonstrating a specific single image or all images in a loop.



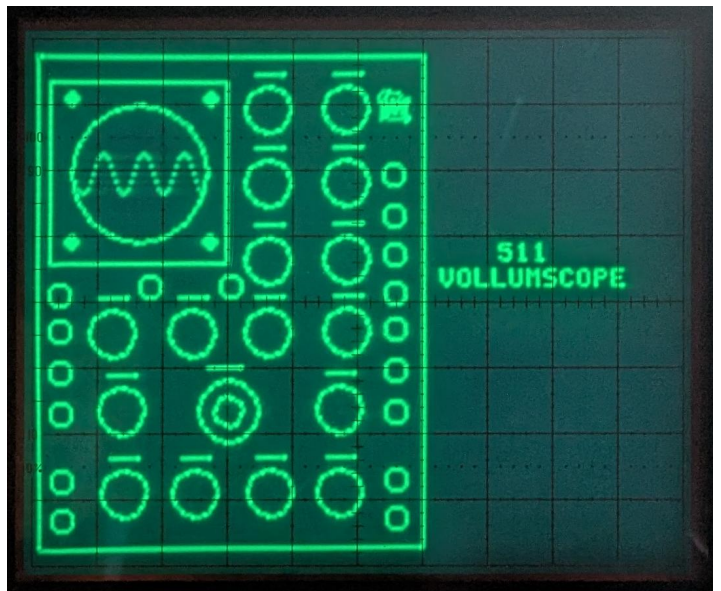
VintageTEK museum logo



Tektronix logo



Tek Wizard



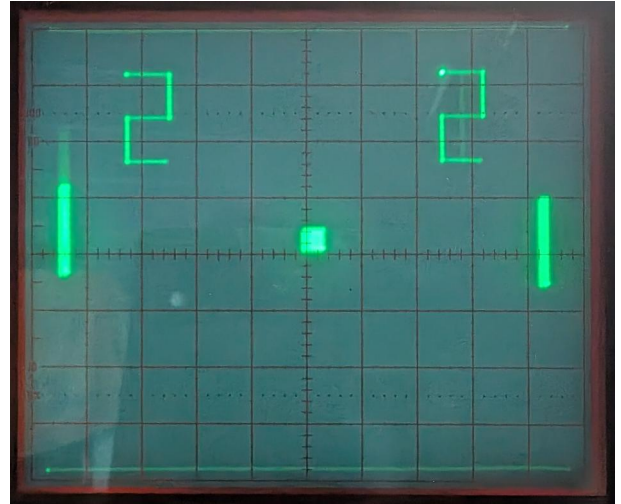
511 “Vollumscope”

5. Tennis Games

5.1. 2-Player Tennis

The tennis game starts with the ball in the center moving toward the right paddle. The paddles are drawn straight, but are slightly curved in effect.

The angle at which the ball rebounds off the paddle depends on where it strikes the paddle. If the ball misses a paddle and hits a left or right wall, a point is scored for the opposite side and the game restarts with the ball in the middle, headed toward the side that scored the last point. As each side scores a point, its score is incremented, but once a score reaches 9, it does not increment. To restart the game and reset the score, cycle the power to the board.



5.2. 1-Player Tennis

Same as 2-player tennis, but the paddle of the left player is controlled by the firmware.

5.3. Vert Wrap

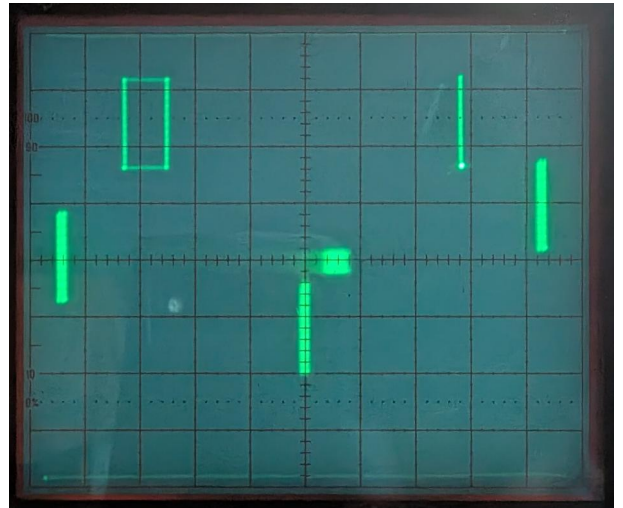
Same as 2-player tennis, but with a twist: the playing field has no ceiling or floor. Instead, if the ball goes off the top of the screen, it wraps around and reappears at the bottom (and vice versa), keeping its initial horizontal position and direction.

5.4. Vert Wrap RNDM

Same as “Vert Warp” but when the ball wraps around and reappears on the screen, it loops back into play at a random position and travels in an unpredictable direction.

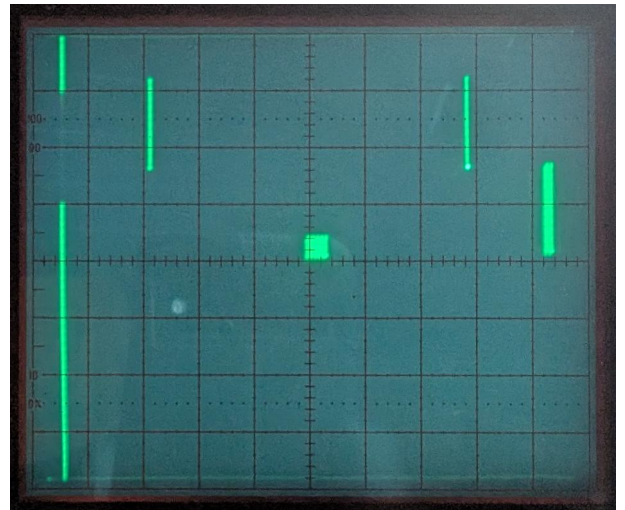
5.5. Extra Wall

Same as 2-player tennis, but with a third paddle in the center of the screen. The additional paddle moves slowly up and down on its own.



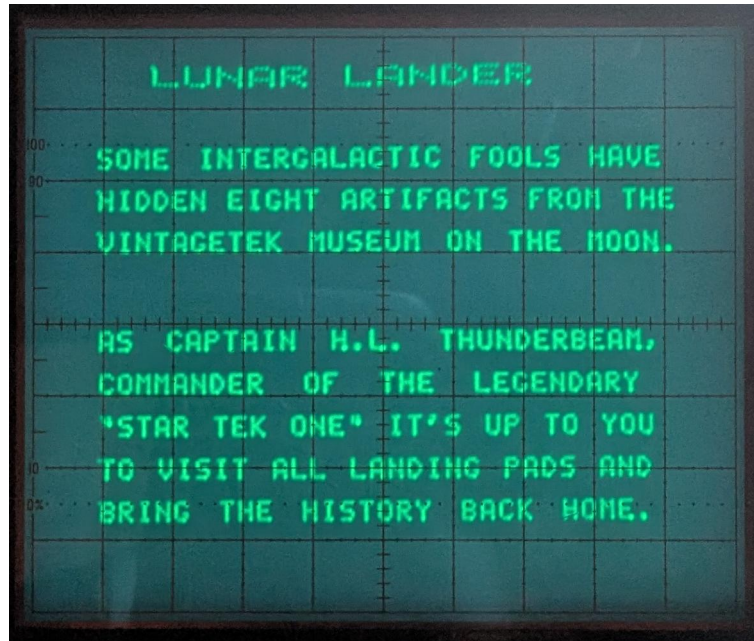
6. Target Ball

The target ball game starts with only the right paddle. A solid wall is shown on the left with a gap. The object is to hit the ball, similar to tennis, to exit through the gap. The gap moves to a new position each round, and decreases in size to increase the difficulty. Again, to restart the game and reset the score, cycle the power to the board.



7. Lunar Lander Game

The goal of the game is to pilot a lunar lander safely across the moon's surface and land it on eight different pads to recover items from the vintageTEK museum. This is the mission briefing which is shown at each start of the game.



7.1. Controls

The lander can be controlled using either two potentiometers or an analog joystick. The chosen input device can be set the first time you start the game. This choice can be changed later within the settings dialog – see chapter 9.3.

When playing with two potentiometers, the left one controls the thrust and the right one controls the rotation of the lander. When playing with a joystick, both the direction and thrust level follow the movement of the joystick.

See chapters 11 - 13 for more details.



7.2. Gameplay

The landing pads are spread across three playing screens. You can travel between them by simply flying to the left or right edge. This will cause the lander to wrap around to the next screen. Each round of the game starts on a random screen.

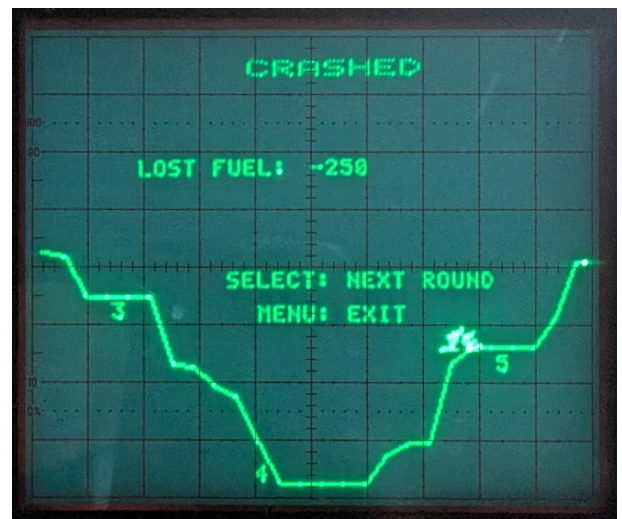
The images below show the 3 screens with the numbered landing pads



Flight parameters are shown at the top of the screen: fuel, altitude, horizontal speed, and vertical speed. Keep an eye on these while flying around. A parameter flashes when its value becomes critical.

To achieve a successful landing, you must ensure the lander is facing upright, with a maximum horizontal speed of 10 and a maximum vertical speed of -20.

You start with 500 units of fuel. A safe landing rewards you with an extra 60 units, while landing on a pad for the first time to recover an artifact grants an additional 90 units (150 in total). Crashing the lander costs you 250 units of fuel. Any artifacts you have already recovered will safely survive a crash.



The eight artifacts to collect are:

- "OUR 511 SCOPE"
- "SIX SCOPE CARTS"
- "A 4662 PLOTTER"
- "A 4051 COMPUTER"
- "THIRTEEN 7K PLUGINS"
- "OUR TEKWEK COLLECTION"
- "THE PHOTO COLLECTION"
- "THE TV PRODUCT RACK"



At the start of each game, these items are scattered randomly across the eight landing pads. After each round, you will receive a brief summary showing which artifact you've found and which pads you have already visited.

The game ends once you have successfully collected all eight artifacts or when you run out of fuel. You can also end the program at any time with the "Menu/Next" switch. A power cycle quickly restarts the game.

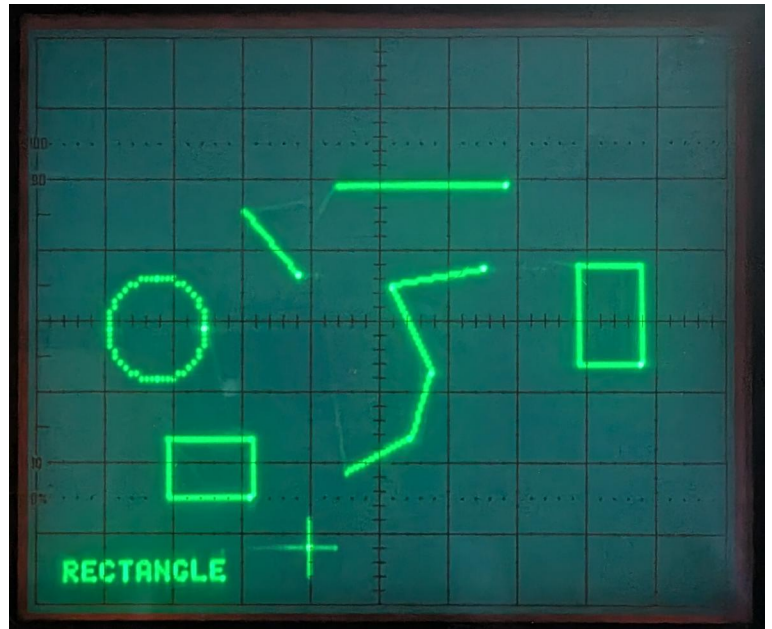


8. Graphic Editor

The built-in graphic editor can be used to design your own custom graphic, which then can be displayed in the demo mode of the board.

The “Menu/Next” switch cycles through the editing options and the “Select” switch executes the selected tool. The position of the drawing cursor is controlled by a connected analog joystick or two potentiometers.

The graphic is automatically saved to the ATmega328P processor's EEPROM. So it survives a power cycle.



The tools are:

- | | |
|----------------------|---|
| Line | With the line tool, you can draw straight lines by setting the two points for the starting and ending coordinates. |
| Line Segments | With the line segments tool, you can draw a continuous path by setting multiple points which are connected by straight lines. |
| Rectangle | With the rectangle tool, you can quickly draw boxes by simply setting two points for the opposite diagonal corners. |
| Circle | With this tool, you can draw circles by setting the center point and a second point for the radius. |
| Undo | With the undo function, you can revert the last action. It removes the previous point, rectangle, or circle. |
| Clear All | Erases the complete graphic. |
| Exit | Exits the editor and returns to the main menu |

9. Program & Board Settings

The settings entry in the main menu is hidden in normal operation mode. To enable it power up the board while holding both the “Menu/Next” and the “Select” switch down at the same time.

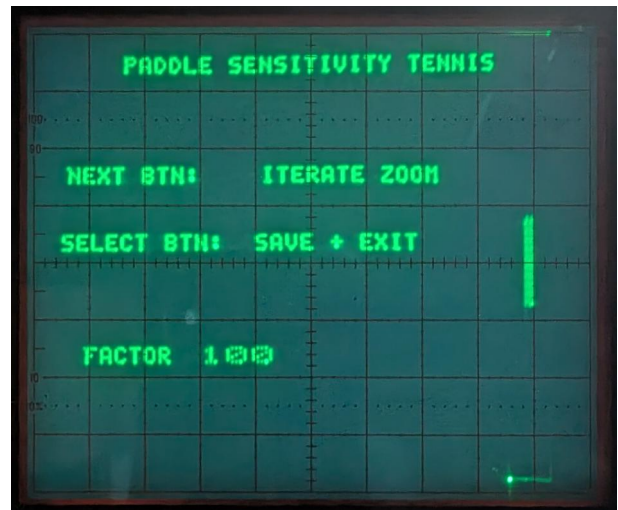
9.1. Paddle Sensitivity Tennis

Here you can change the sensitivity level of the potentiometers for the tennis games.

The “Menu/Next” switch cycles through the available levels. A paddle from the tennis game is displayed to test the settings in real time.

Press the “Select” switch to save your choice to the ATmega328P processor's EEPROM and exit the menu.

You can choose from these sensitivity levels: 200, 150, 125, 100, 50, 25, and 15. 100 is the factory default value.



9.2. Joystick Sensitivity Graphics Editor

Here you can change the sensitivity level of the potentiometers for the graphics editor.

The “Menu/Next” switch cycles through the available levels. The cross from the graphics editor is displayed to test the settings in real time.

Press the “Select” switch to save your choice to the ATmega328P processor's EEPROM and exit the menu.

You can choose from these sensitivity levels: 100, 50 and 25. 25 is the factory default value.



9.3. Input Device Lunar Lander

Here you can select the input device for the Lunar Lander game.

You can choose between:

Two independent potentiometers

Choose this option when you're controlling the firmware with two independent potentiometers.



Joystick with combined X/Y axis

Choose this option if you've connected one or two analog joysticks.

When playing with two potentiometers, one potentiometer controls the thrust and the other controls the rotation of the lander. When playing with a joystick, both the direction and thrust level follow the movement of the joystick.

Press the "Select" switch to save your choice to the ATmega328P processor's EEPROM and exit the menu.

9.4. Factory Reset

Performs a factory reset of the board.

Use the “Menu/Select” switch to iterate through the options.

The “Select” switch executes your choice and returns to the settings menu.



No	Nothing is changed.
Yes, but keep user graphics	The potentiometer sensitivity settings are restored to factory defaults. The user graphics are not touched
Yes and erase user graphics	The potentiometer sensitivity settings are restored to factory defaults. The user graphics are also erased.

10. The About Dialog

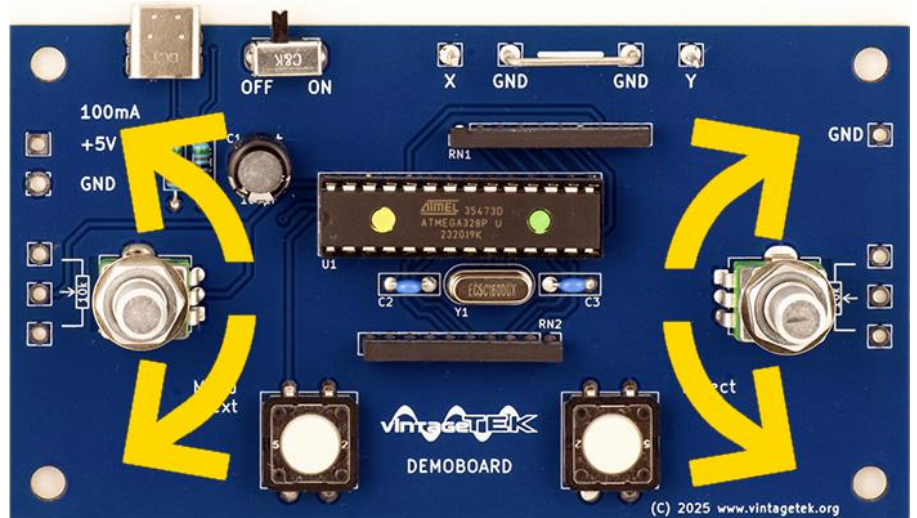


11. Using on-board Potentiometers

Change the input device setting to “**Two independent potentiometers**” for this hardware setup (See chapter 9.3).

11.1. Tennis

Each potentiometer controls a paddle. The arrows indicate the direction the paddle will move.

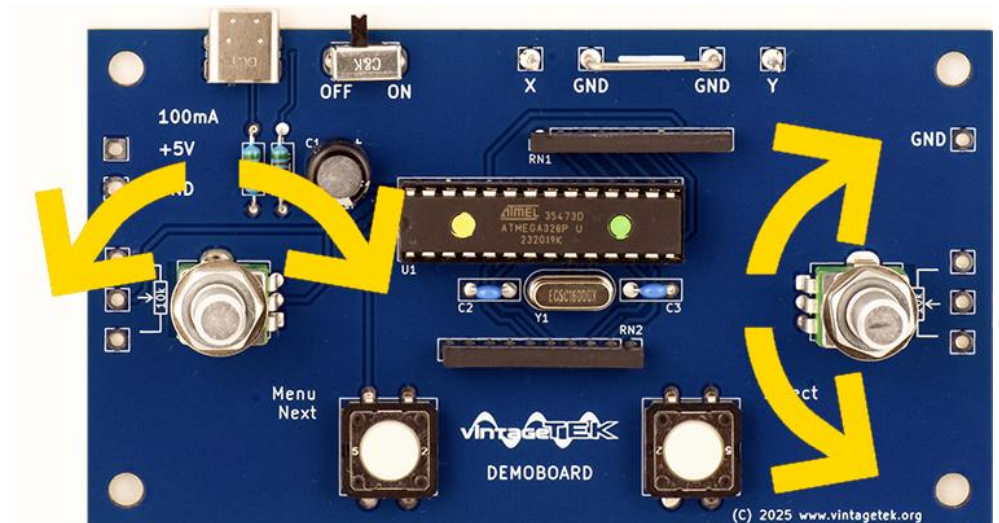


11.2. Lunar Lander

The left potentiometer controls the direction of the lander and the right potentiometer controls the thrust of the main engine.

11.3. Graphics Editor

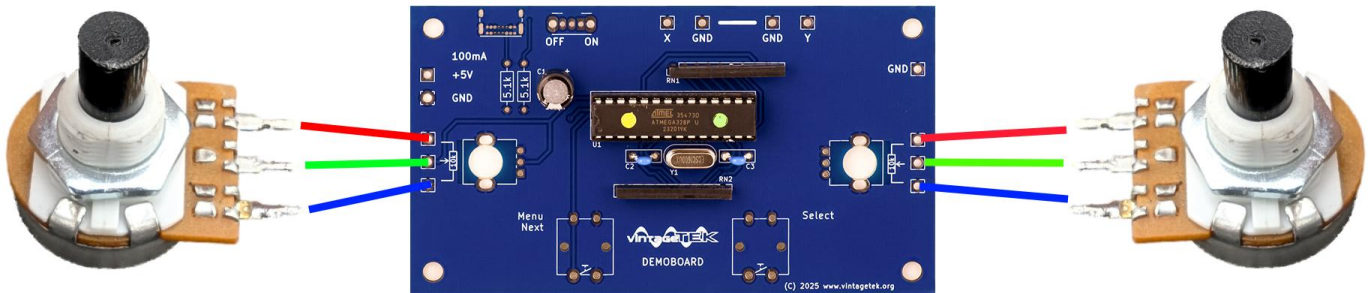
The left potentiometer controls the X and the right potentiometer the Y position of the drawing cursor.



12. Using external Potentiometers

Change the input device setting to **“Two independent potentiometers”** for this hardware setup (See chapter 9.3).

The image below shows how to connect the two potentiometers to the input pads of the board. The potentiometers need to have a **linear** characteristic and a nominal value of 5k or 10k.



The external potentiometers behave the same as the on-board ones. See chapter 11.

13. Using Joysticks

Change the input device setting to “**Joystick with combined X/Y axis**” for this hardware setup (See chapter 9.3).

This page will explain how to use the joysticks for the various parts of the firmware. The following pages will explain how to connect the joysticks to the board.

13.1. Tennis & Graphic Editor

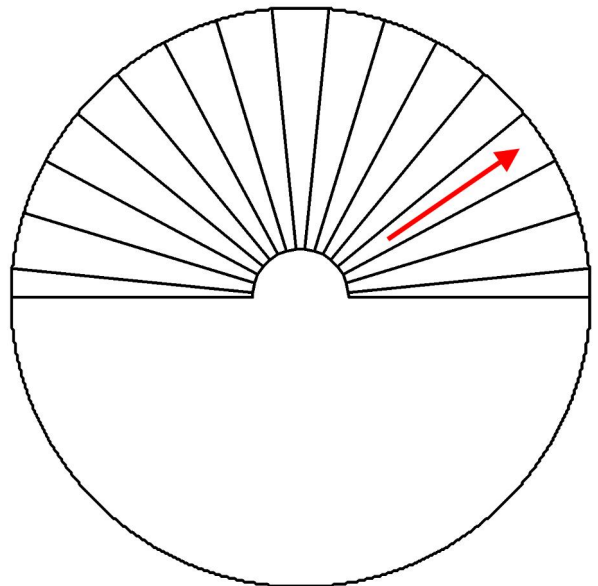
Using a joystick for the tennis games and the graphic editor is straight forward – the paddles and the cursor will follow the movement of the joystick.

13.2. Lunar Lander

Controlling the lander relies on the fact that we’re using **joysticks with a spring to return to center** mechanism. This ensures immediate stabilization of the lander whenever the stick is released.

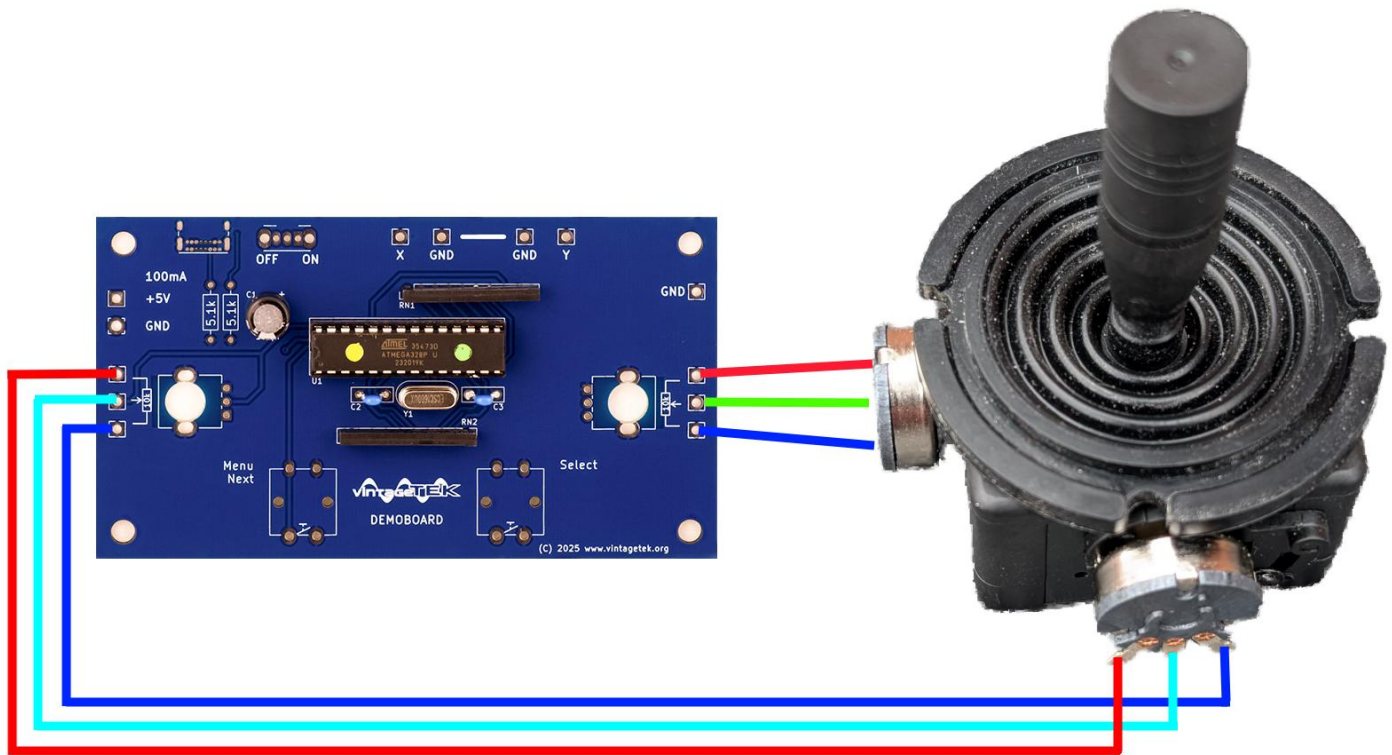
When the joystick is resting in the center position, the lander remains upright with zero thrust. There is a small dead zone around the center position to compensate for hardware tolerances or drift.

The upper hemisphere surrounding the center zone is divided into 17 flight sectors. Pushing the joysticks into one of these sectors sets the flight vector & thrust.



13.3. Single external joystick

Change the input device setting to “**Joystick with combined X/Y axis**” for this hardware setup (See chapter 9.3).



The image above shows the principle of controlling the lunar lander game with one single external joystick. The right input port of the board controls the thrust of the lunar lander and the left input port controls the rotation. This wiring diagram is for reference only. Exact wiring depends on the joystick model and its mounting orientation.

You need an analog joystick with a “Spring to return to center” mechanism and a nominal resistance value of 5k or 10k. The resistance characteristic needs to be linear. **The spring mechanism is mandatory** for controlling the lunar lander.

Note that this configuration only works for the lunar lander game, the graphics editor and the single-player tennis variants. **You can't play the 2-player tennis games with this configuration.** See the next chapter for a more advanced solution.

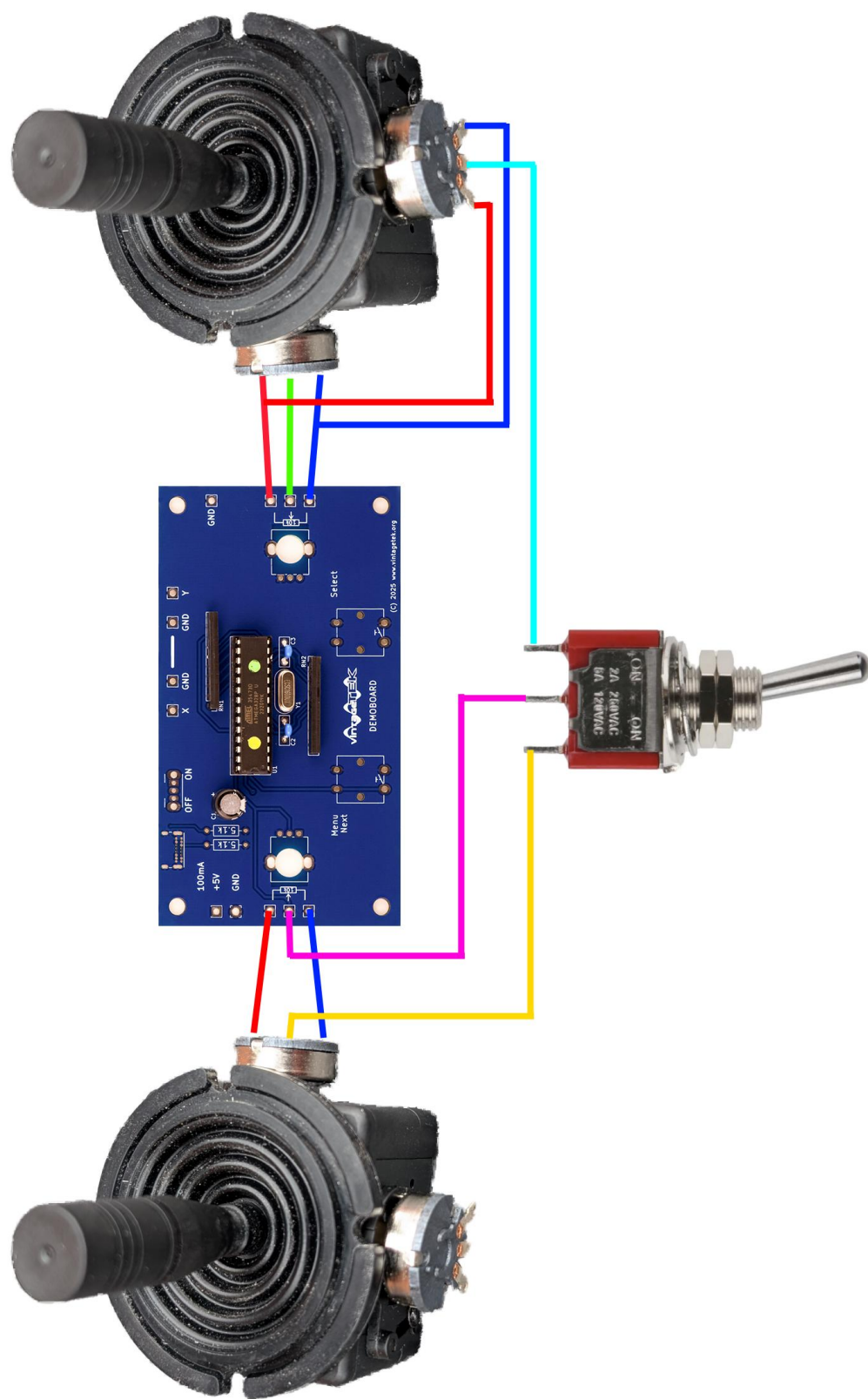
13.4. Two external joysticks + switch

Change the input device setting to “**Joystick with combined X/Y axis**” for this hardware setup (See chapter 9.3).

The wiring diagram on the following page shows a solution for controlling the Demo Board with two joysticks. An additional switch allows you to toggle between two-joystick control for the tennis games and single-joystick control for Lunar Lander and the Graphics Editor.

You need analog joysticks with a “Spring to return to center” mechanism and a nominal resistance value of 5k or 10k. The resistance characteristic needs to be linear. **The spring mechanism is mandatory** for controlling the lunar lander.

Basic wiring for two external joysticks and a switch



This wiring diagram is for reference only. The exact wiring depends on the joystick model and its mounting orientation.

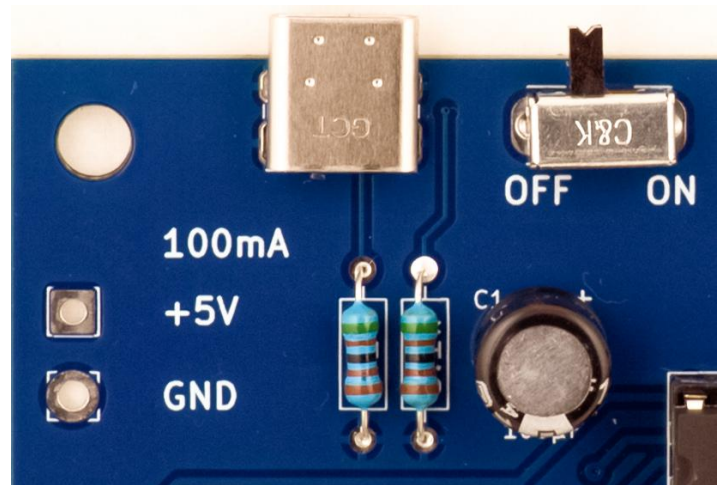
14. USB connector and power switch

It is possible to power the Demo Board from an external USB power supply.

You can connect the leads from the power supply directly to the +5V and GND pads. It's also possible to solder a 2-pin terminal block to the pads to allow for a detachable connection.

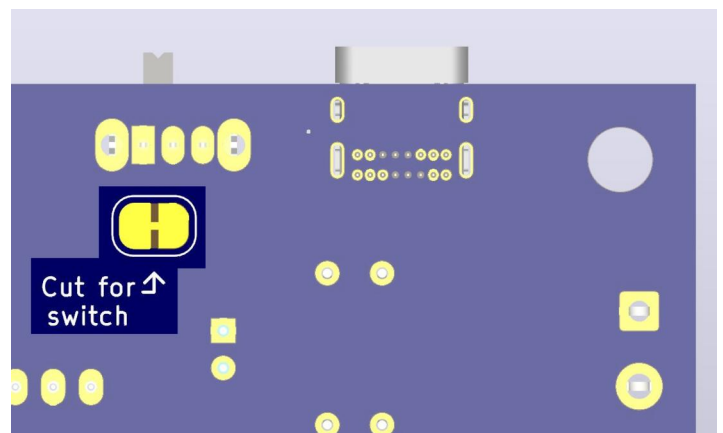
Another option is to add a USB-C connector with two 5.1k pull-down resistors.

Please note that the board requires a **5V $\pm$ 0.25V** power supply capable of handling up to **100mA**. Make sure that your power supply meets this requirement.



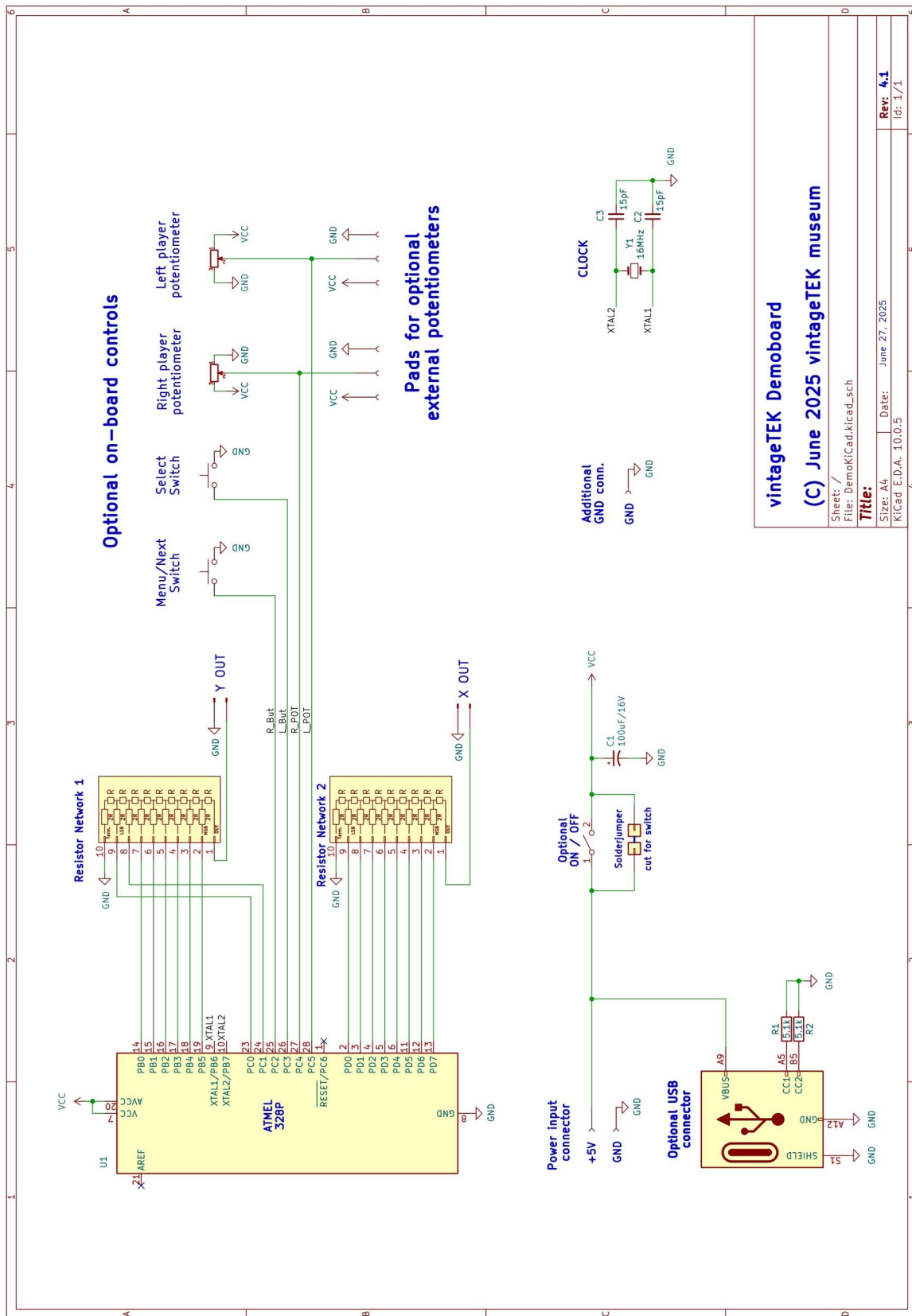
Partial view of a Demo Board with the optional USB connector, pull-down resistors and a power switch

Adding an on/off switch allows for quick power cycling. With this option you have to cut the interconnection of the solder-jumper on the rear side of the board. See the image on the right.



Highlighted section with the solder-jumper pads on the rear side of the Demo Board

15. Schematics



16. Bill of Materials

Standard components on the Demo Board:

Component Ids	Value	Part Number (example)
C1	100uF 16V	Panasonic EEA-GA1C101
C2, C3	15pF	TDK FG28C0G1H150JNT06
RN1, RN2	R2R 10K/20K	Bourns 4310R-R2R-103LF
U1	ATMEGA328P	ATMEGA328P-PU
X1	16MHz	ECS 160-20-4X-DU
	28-pin socket	ED281DT

Optional components for the Demo Board:

Power switch:	C&K OS102011MA1QN1
Button:	Omron B3F-4000 series
USB-C connector:	GCT USB4085
Pull-down Resistors:	5.1k
Potentiometers*:	Linear 5k or 10k. Example: ALPHA RD901 series or Alps RK09K series (RK09K1130A0H)
Joysticks*:	Analog, Spring to return to center (self reset) is mandatory. Linear 5K or 10k characteristic. Example: JH-D202X series. Carefully read the seller's product description

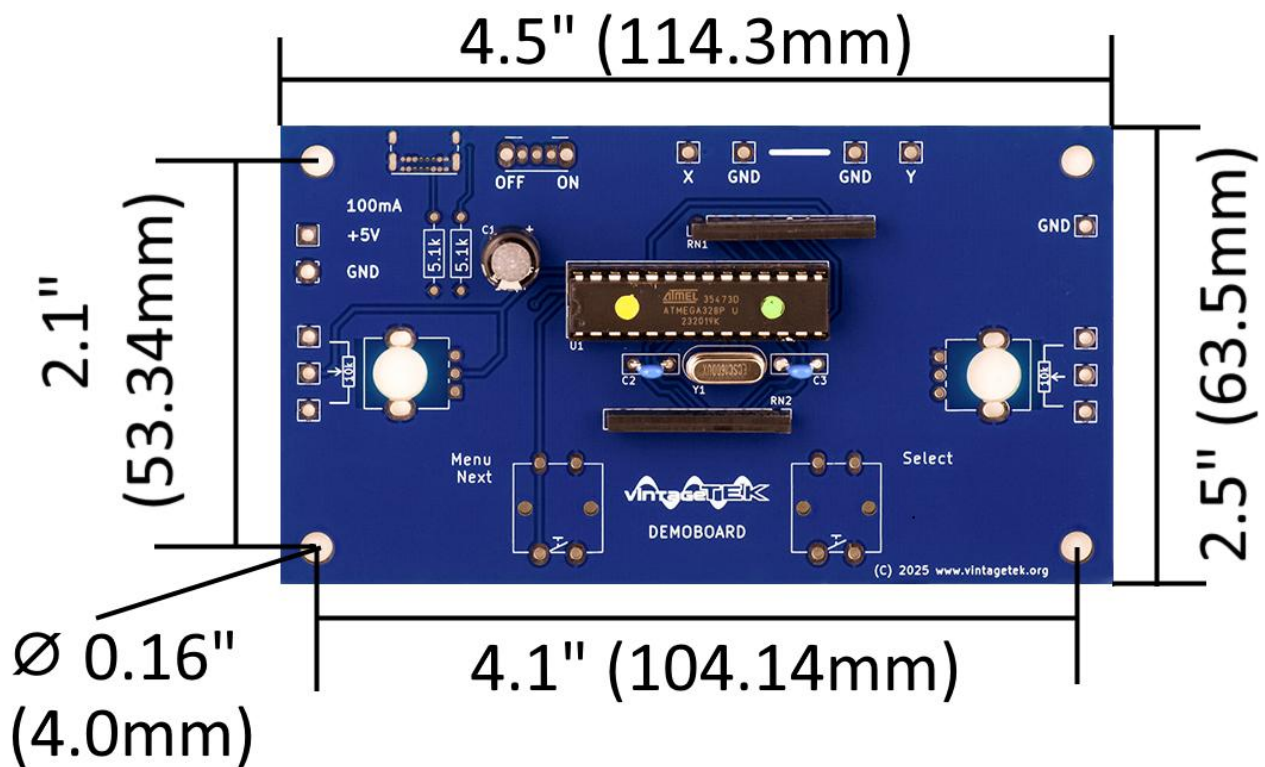
* You need either the potentiometers or the joysticks.

17. Technical data

Operating voltage: $5V \pm 0.25V$

Power consumption: $< 100mA$

Dimensions:

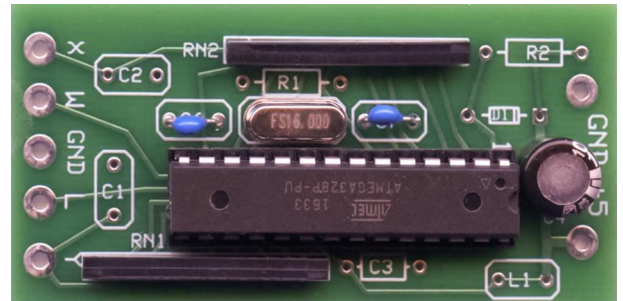


18. Retrofitting older boards.

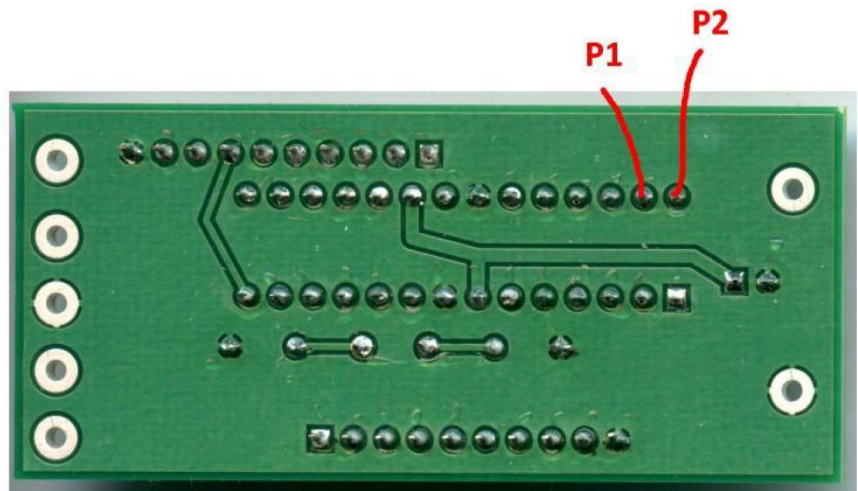
The vintageTEK museum is also selling a pre-programmed upgrade processor for those with older Demo Boards. In principle, it's possible to retrofit this processor to all generations of the board, but older boards need small modifications.

18.1. First Generation

These boards were sold before 2018. They don't have dedicated pads for connecting the potentiometers. You have to solder wires directly to the pins 27 and 28 of the processor.



Carefully remove the processor. This is most easily done by inserting a thin blade under one end of the chip and prying it up. Solder two wires on the bottom of the board to the processor pins 27 and 28 as shown in the image below. These become the connection to the wipers of the two paddle potentiometers (or joysticks). Follow the schematic diagram in chapter 15 for the rest of the wiring.



Pin 27 = P1 = right pot

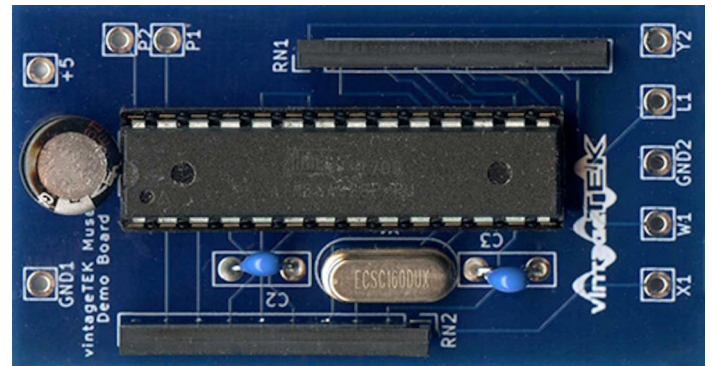
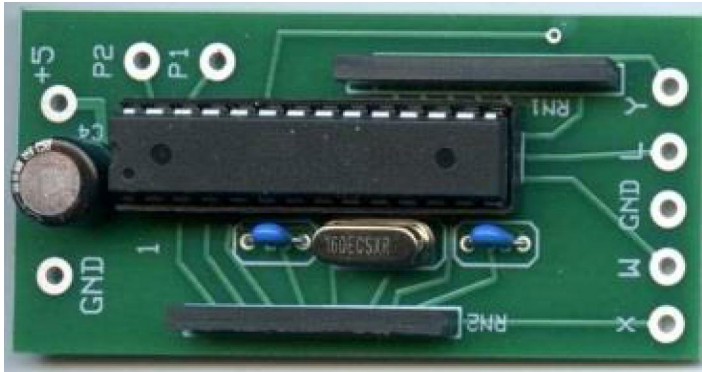
Pin 28 = P2 = left pot

Pad "L" = Select switch

Pad "W" = Menu/Next switch

Carefully insert the new processor.

18.2. Second Generation



These boards came in either green or blue and are 100% compatible. Carefully remove the processor. This is most easily done by inserting a thin blade under one end of the chip and prying it up. Then, carefully insert the new processor.

P1 = right pot

P2 = left pot

Pad "L" or "L1" = Select switch

Pad "W" or "W1" = Menu/Next switch

18.3. Boards from July 2025 and newer

This is the actual board revision. You only have to swap the processor.

19. About the vintageTEK museum



Our Charter

vintageTEK is a charitable, educational and scientific museum founded to commemorate the early history of Tektronix, Inc and its role in spawning approximately 300 high technology companies in the 'Silicon Forest' - i.e. the four county, two state metropolitan area of Portland, Oregon.

The museum and website is dedicated to displaying working Tektronix products which enabled generations of scientists, engineers, and technicians create the future and to the memory of those Tektronix employees that created this legacy. Our mission is to encourage the next generation of students to pursue careers in the fields of engineering, science, and technology by sharing this knowledge and history and supporting STEM programs in our community.

Thank you for supporting the vintageTEK Museum. Check our website at www.vintagetek.org for information about the Museum and Tektronix history.