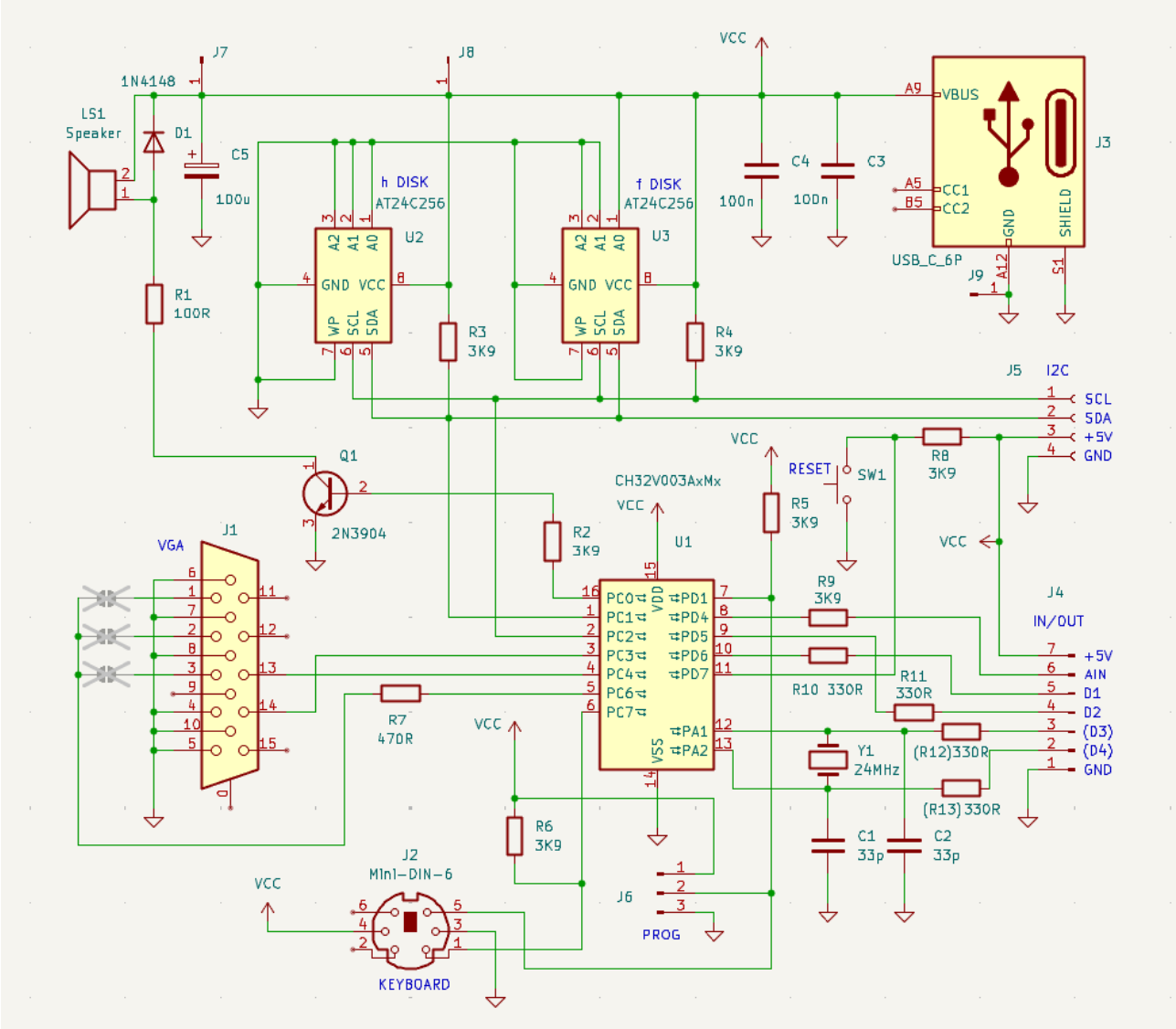
Hardware TinyBasRV ver. 1.0

Parameters:

Supply voltage:	5 V
Current consumption:	100 mA max
Inputs and outputs:	2 (or 4) digital + 1 analog input
Expansion modules:	expander with PCF8575

The TinyBasRV microcomputer is a simple circuit that allows a beginner hobby electrician to build his own easy-to-use and programmable computer. To use it, you just need to connect a +5V power supply, a computer keyboard with a PS2 connector and a monitor with input from a VGA card. All computer components are located on one side of a two-layer printed circuit board measuring 65 x 70 mm. The circuit can be divided into several parts and further modified by the user according to the needs and availability of components. The complete circuit diagram is shown in the following figure.



Computer core

The components necessary for the computer to function are integrated circuits U1 and U2 (respectively U3), resistors R3 to R7, capacitors C3 to C5, and connectors J1 and J2. This represents the minimum number of components that must be mounted on the printed circuit board.
The 32-bit RISC-V processor U1 receives commands from the keyboard connected to connector J2. Resistors R5 and R6 maintain a quiescent level of log. 1 on the keyboard bus. The output for the user is the information displayed on the VGA display. The actual video signal is generated on pin PC6. Its level is adjusted to the required level via a divider consisting of resistor R7 and the monitor input resistor. Vertical and horizontal image synchronization is generated on pins PC3 and PC4. The monitor connection is provided by a three-row D-SUB connector J1.
The processor has the program data stored in the serial EEPROM memory U2 (or U3). Communication with it takes place over the I2C bus, which again needs resistors R3 and R4 to maintain the quiescent level at log. 1. The memory U2, referred as "DISK h", has all address inputs A0 to A2 connected to log. 0 and thus has the address set to 0. The memory, like the processor, is SMD and is permanently soldered to the board.
The remaining components, i.e. capacitors C3 to C5, are for blocking the supply voltage.

Computer power supply

The computer requires a stabilized +5V supply voltage. This can be connected directly to the printed circuit board using wires in the holes next to the capacitor C5 (J8 is +, J9 is GND). It is also possible to power the computer from a power adapter with a USB type C connector. The board has contact areas for soldering a 6-pin type C power connector.

Optional parts:

Accurate time base

The U1 processor can be clocked from the internal RC oscillator. However, due to the accuracy and stability of this oscillator, the computer timing will not be accurate and this will also affect the stability of the VGA monitor image. The individual displayed lines will be visibly jittery in the horizontal direction.
For a stable image, it is better to use timing using an external 24 MHz crystal at position Y1 with capacitors C1 and C2. If a crystal is used, it is not possible to use the digital inputs/outputs D3 and D4. The processor pins will be blocked by the time base. Capacitors C1 and C2 are placed in the position on the board prepared for R12 and R13. The second pin is soldered to the closer hole connected to GND. R12 and R13 are not installed.

Audio output

In order for the computer to emit various tones, it has a sound section. The basis is a miniature speaker LS1 driven by a transistor Q1. Resistor R1 limits the current flowing through the speaker and R2 determines the current to the base of the transistor. Diode D1 is protective and serves to suppress voltage peaks that would arise when the current through the speaker is turned off.

RESET circuit

If the computer stops responding to user commands, it can be reset to its initial state using the RESET button. Resistor R8 maintains a quiescent level of log. 1 on the processor reset input. After pressing the SW1 button, the level is changed to log. 0 and the computer is RESET.

Expandable memory

In addition to the U2 memory, there is also a slot on the board for another serial EEPROM memory

U3. This time, the type in the classic DIL8 pinout design is chosen so that it can be inserted and removed from the socket. The memory has a preset address of 1 (address input A0 is at logic 1) and represents a "floppy" DISK f. The memory can be used in the same way as DISK h. It is therefore possible to install a socket on the board for future use of a second memory. This is suitable if you want to expand the size of the computer's program memory or for the possibility of transferring programs between different TinyBasRV computers.

I2C bus expansion

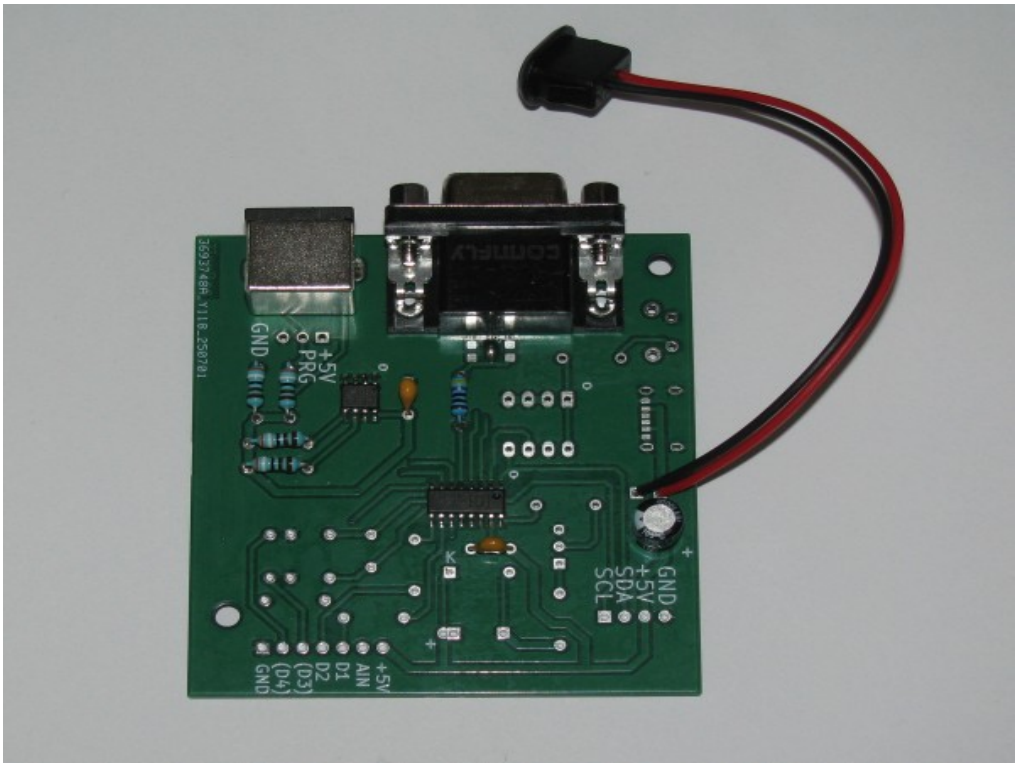
The computer has relatively few inputs and outputs in case the user wants to control larger peripherals. In this case, the I2C bus can be used, through which the memories communicate. If you install a 4-pin connector in position J5, you can connect a PCF8575 expander board to it. This will increase the number of digital inputs/outputs by 16. Be careful **when connecting external circuits to the I2C bus and always do it in the off state.** The bus transfers data between the processor and memories and a disturbing signal can damage the written program.

Inputs and outputs

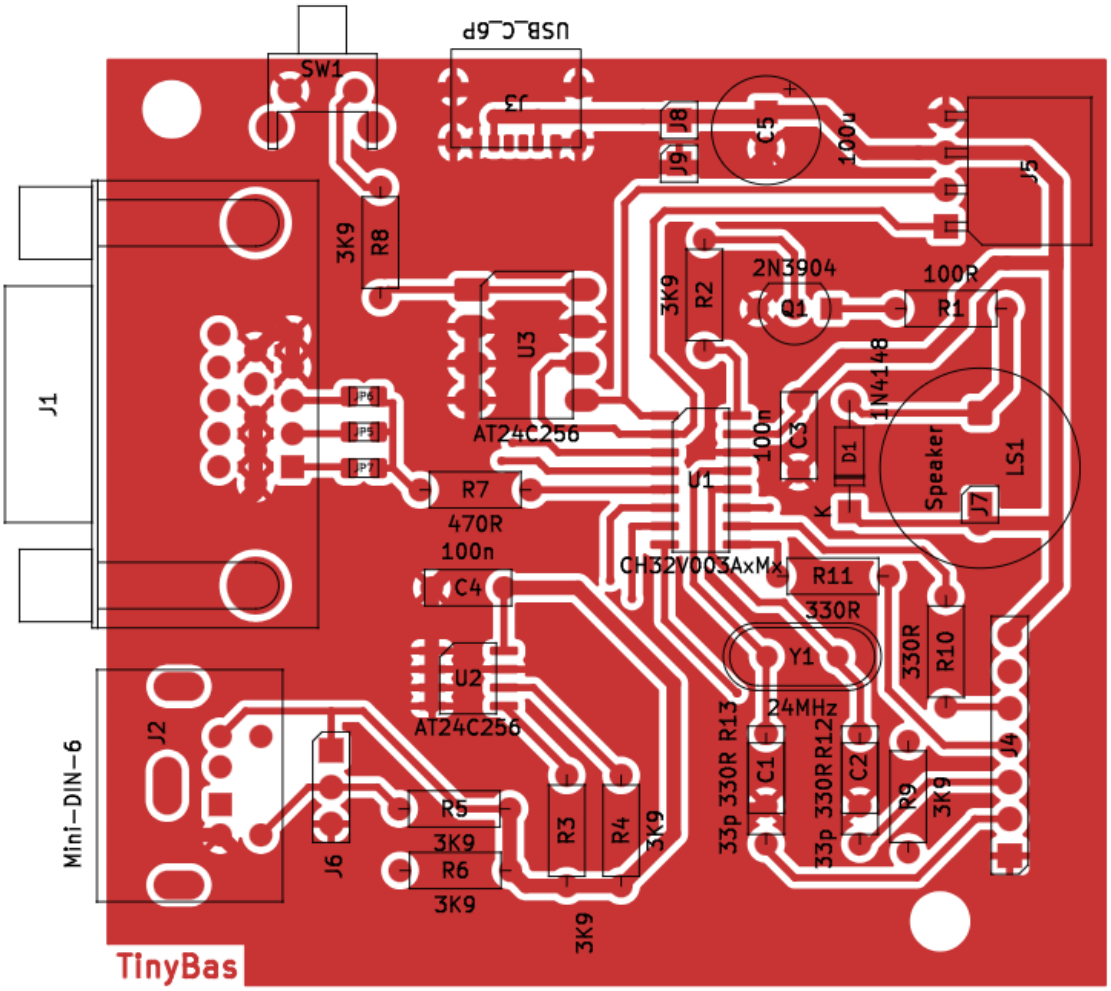
The user can have several inputs and outputs on the J4 connector to control various devices. One input AIN is analog and allows measuring voltages from 0 to 5V. Other inputs/outputs are digital and can be 2 if a crystal is used, or 4 without a crystal. If a specific pin is input or output, it is determined by the program. All inputs/outputs are ready for mounting protective resistors R9 to R11 (or R13). When choosing a crystal time base, inputs/outputs D3 and D4 cannot be used. Resistors R12 and R13 must not be mounted, because capacitors C1 and C2 are expected to be placed in one of their holes.

Building a computer

All computer components are mounted on one side of a double-sided printed circuit board. It is only necessary to place the components marked above as the core of the computer on the board and ensure its power supply.



The picture shows a minimal version of a microcomputer. The remaining elements are optional.

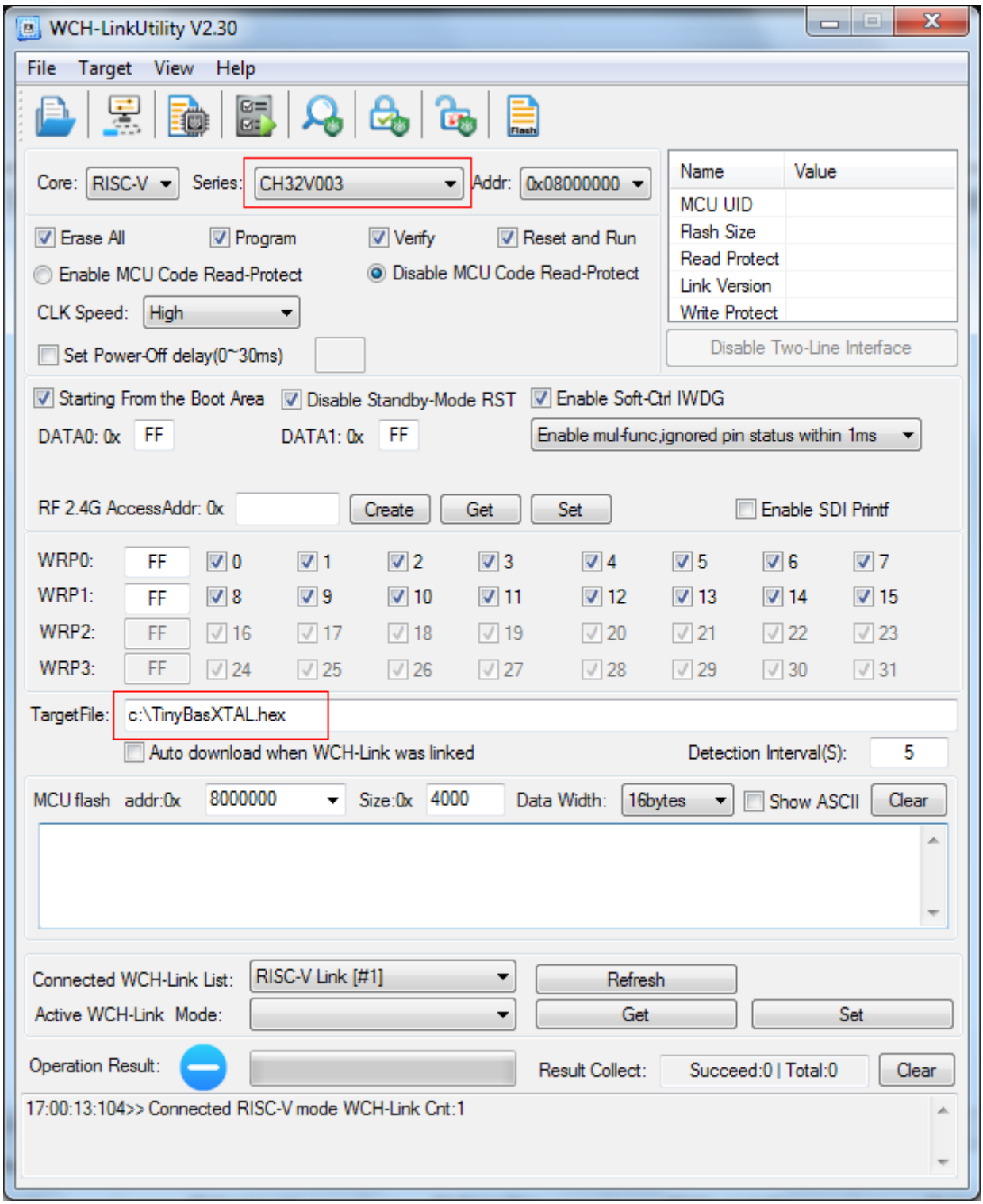


Recommended assembly procedure

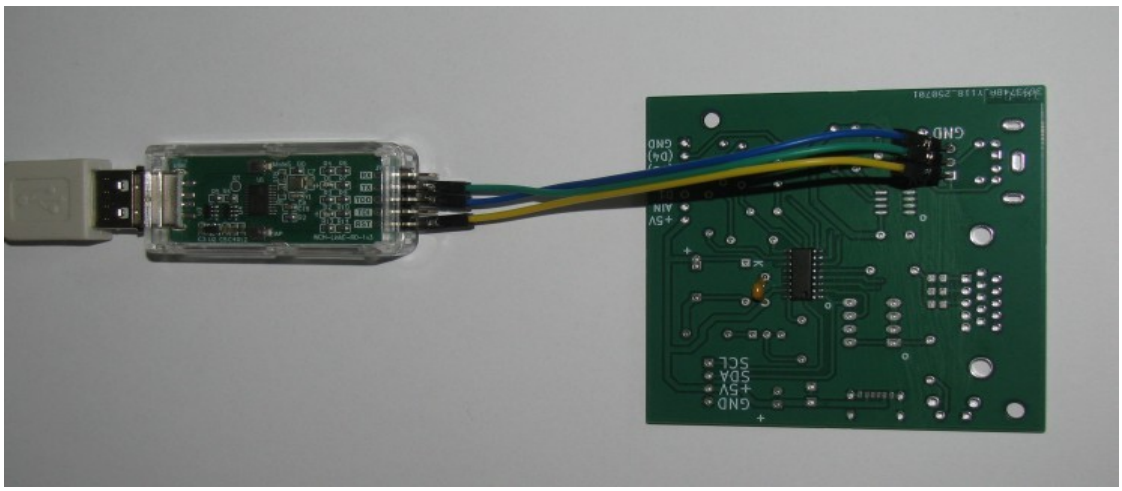
When building a microcomputer, it is advisable to start by soldering the U1 processor and the C3 capacitor to the board. Then, you can use the WCH-LinkUtility program to program Tiny BASIC into the computer's memory. To write the program into the memory, you need the WCHLinkE programmer (**Caution! A programmer without an "E" will not work!**). The WCH-LinkUtility program can be found on the website of the CH32V003 processor manufacturer and is freely downloadable. In the program window, you usually just need to select the correct processor type and enter the HEX file with the programming data.

The WCH-LinkUtility program is also part of the MounRiver Studio programming environment. However, it is well hidden. In version 2.10, you can find it in the folder:

c:\MounRiver\MounRiver_Studio2\resources\app\resources\win32\components\WCH\Others\SWDTool\default\WCH-LinkUtility.exe

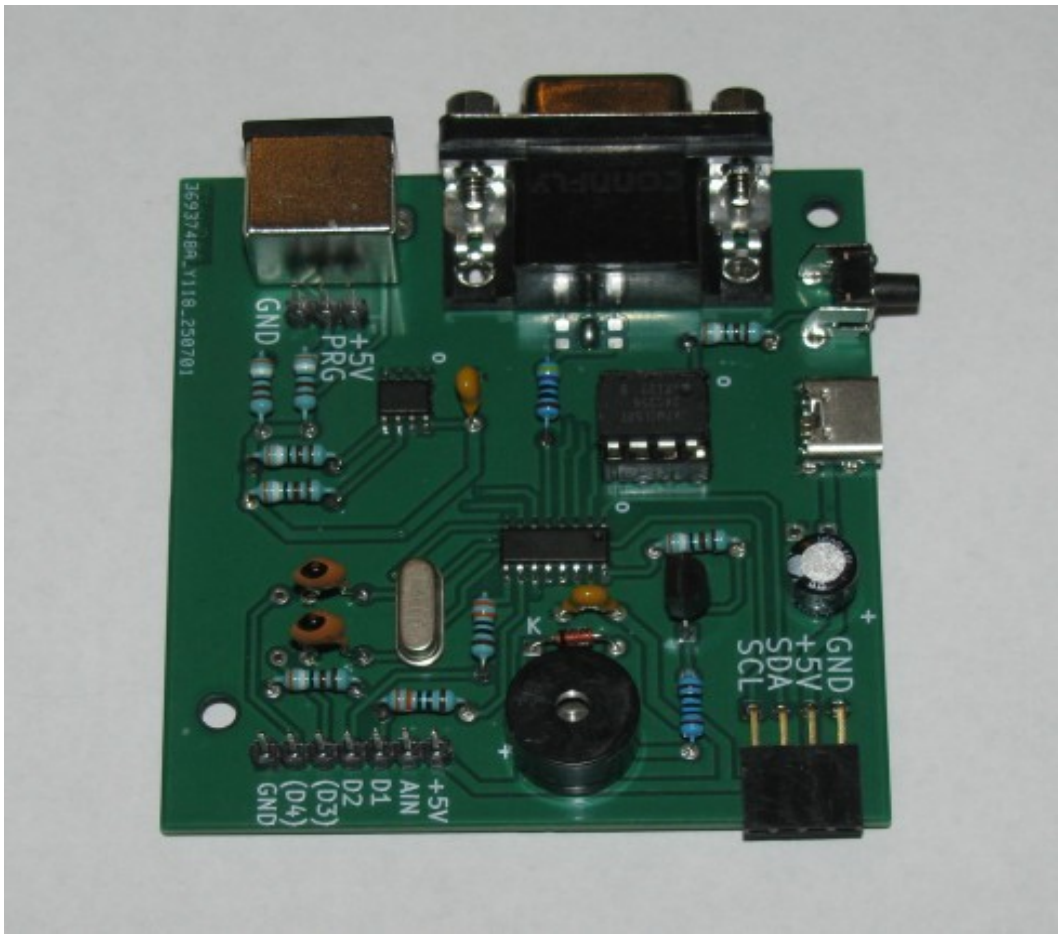


There are 2 versions of HEX files in the Bin directory. The user must decide which version to use. If the crystal is planned to be mounted on the board, select the program "...XTAL...". If the crystal will not be used, download and load the version "...RC..." into memory of CH32V003.
For programming purposes, the J6 connector is prepared on the board. If you do not plan to rewrite new versions of Tiny BASIC frequently, there is no need to install the connector. The WCHLinkE programmer can be connected with 3 wires directly to the holes for J6 on the board. The GND, SDIO and +5V signals on the programmer are connected to the board. Then just enter Target – Program.



If necessary, the processor content can be overwritten with a new version in the future. The keyboard must not be connected to connector J2 during programming!

After successfully programming the processor, we can proceed to installing other components. As mentioned above, it is necessary to install the computer core (U1, C3 to C5, R3 to R7, J1, J2 and at least one of the EEPROM memories). The remaining parts of the computer and their components are optional, they are not necessary for the basic functioning of the device.
For a complete computer, you still need to choose the color of the display on the monitor. There are 3 jumpers prepared for shorting with a drop of tin near the J1 connector. You can choose the color red, green, or blue. If you have a monochrome monitor, you need to connect the middle (green) jumper.



Parts list

Position	Type	Note
U1	CH32V003A4M6	32bit RISC-V
U2	EEPROM I2C – see below	SOIC8
U3	EEPROM I2C - see below	DIL8 + socket!
Q1	2N3904	TO92 or a similar NPN type
D1	1N4148	Or a similar type
R1	100R	0207
R2 to R6, R8, R9	3K9	0207
R7	470R	0207
R10 to R13	330R	0207
C1,C2	33p	ceramic
C4,C4	100n	ceramic
C5	100u/16	electrolytic
Y1	24 MHz	THT crystal low
LS1	Miniature speaker 16Ω	Diameter 12 mm
SW1	Side microswitch	E.g. TS6606-8.0-180
J1	D-SUB 15 pin (5x3)	Female to PCB
J2	Mini DIN 6 pin	Female to PCB
J3	USB C 6 pin	E.g. USB4125
J4, J6	7 + 3 Male Header	2.54 mm straight pin header
J5	Female header 4 pins	2.54 mm for PCB 90°

Memory types and number of programs

It is possible to connect various serial I2C EEPROM memories to the computer board according to current availability and user requirements. When choosing a memory, check whether the memory manufacturer allows a supply voltage of 5V and a bus speed of 400 kHz. Different manufacturers mark their type series differently, e.g. 24LC256, 24AA256, M24512, etc. The table therefore shows the basic numerical marking, which is usually supplemented by other letter combinations.

Type	Size	Number of programs	Program designations
2432	32 Kbit / 4 KByte	1	0
2464	64 Kbit / 8 KByte	2	0,1
24128	128 Kbit / 16 KByte	4	0,1,2,3
24256	256 Kbit / 32 KByte	8	0,1,2,3,4,5,6,7
24512	512 Kbit / 64 KByte	16	0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15

The "Number of Programs" column indicates how many individual Tiny BASIC programs can be stored in memory. The last column then refers to the numerical designation of the individual programs written in memory.

If you have a serial I2C EEPROM programmer, you can use the I2C bus on connector J5. When you correctly connect the 4 wires from the connector to the socket of the EEPROM programmer, you can load the contents of the file ExampleBas.hex, which is in the EEPROM_examples folder, into the EEPROM. The file is 32 Kbytes in size, so it is suitable for 24256 and 24512 memories. If you succeed, you will get 8 sample programs in the Tiny BASIC language. For more information about the programs, see the TinyBasExamples manual.