Documentation: Roller Blinds Automatic Control system	
Date:	22.02.2026
Author:	Aksamit Michał

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1. Purpose of work.

The purpose of this work is to show user experience with automatic control systems, especially using Real Time Operating System (RTOS). This is important to note that the subject of this work should be able to be used in real-world applications. The Roller blinds automatic control is usable in that scenario. Additionally, because of motors (moving, dynamic elements) RTOS system would be great for application. It is reliable, deterministic and safe to use.

2. Scope of work.

There will be a few points found in this work, done in sequence:

- Requirements.
- Electronic diagram with chosen elements.
- Mechanics and construction.
- Block diagram of program.

3. Requirements.

The project has multiple requirements needed to run without issues, including:

- DC Motors with worm gear (needed for self-lock, if not working) having enough torque (estimate 10 kgcm) and encoders, powered with 5-12 V
- DC Motor controller with direction control, cheap, powered with 5-12 V (If 12, then output power option of 5V for powering main controller) and small size
- 2 Switches for manual steering and e-stop button
- Electrical box for modules
- Cables (6x0.5/0.35) and pitch 2.54 mm, male and female connectors
- 3 LED Diodes
- Microcontroller (5 V) with multicore and technical support for RTOS (FreeRTOS), wi-fi and small size
- 3D printed parts for connecting motors with roller slides and to hang motors on the window
- 12 VDC power supply

Because of its DIY project purpose it is important to note that selected parts should be as cheap as possible just to not generate additional costs.

3.1 The Comparison table.

Name	Description	Price
Microcontroller		
ESP32 WiFi + BT 4.2 - platform with module ESP-WROOM-32 compatible with ESP32-DevKit	> Supply voltage: 5 V - with microUSB > Microcontroller Dual Core Tensilica LX6 240 MHz > The SRAM 520 KB > Flash memory: 4 MB > Built-in wi-fi module 802.11 BGN HT40 Wi-fi security: WEP, WPA/WPA2 PSK/Enterprise, AES / SHA2 / Elliptical Curve Cryptography / RSA-4096 > Built-in Bluetooth BLE > Integrated Hall sensor and touch interface > 30 GPIO leads, including: 3x UART 3x SPI 2x I2C (2x I2S) 12 - channel >ADC converter 2 - channel DAC converter	€11.50

	> The PWM outputs > Interface of SD card > Dimensions: 55 x 28 x 8 mm	
DFRobot FireBeetle ESP8266 IoT WiFi	> Supply voltage: 3.3V / 5V > Supports USB charging > Microcontroller: 32-bit Tensilica L106 Frequency: 800 MHz > SRAM: 50KB > Flash: 16Mbit > Low current consumption: 46 uA > Wi-fi: 802.11 b / g / n / > Leads: Digital x 10 Analog x 1 SPI x 1 I2C x 1 IR x 1 I2S x 1 > Supports MicroPython, Arduino IDE and RTOS > Dimensions: 24 x 53 mm	€8.00
NUCLEO-WL55JC1	> Ultra-low-power MCU, 256Kbyte flash memory and 64Kbyte SRAM > 3 user LEDs, 3 user buttons and 1 reset push-button > 32.768KHz LSE crystal oscillator, 32MHz HSE on-board oscillator > USB with Micro-B, MIPI® debug connector > ST morpho extension pin headers for full access to all STM32WL I/Os > ARDUINO® Uno V3 expansion connector, delivered with SMA antenna > Fully open hardware platform > Flexible power-supply options: ST-LINK, USB VBUS, or external sources	€40.00
Motor Controller		
L298N - two-channel motor controller - 12V/2A	> Supply voltage: 12 VDC > Supply voltage of the logic part: 5 VDC > Built-in voltage regulator 5 V to power the logic part with the possibility of disconnection via jumper > Maximum output current: 2 A per channel > Module to control two DC motors or one stepper motor > Direct control and fast,free braking-stop options > The outputs for the motors and the power inputs was displayed on the screw connectors ARK > The input pins of the logic part are available on the goldpin connectors - 2.54 mm pitch	€4.50

	> The board consists of all necessary for the proper operation of the controller, passive components > The system has a mounted radiator > Tile sizes: 44 x 44 x 30 mm	
DFRobot L298N - two-channel motor controller - 12V / 2A	> Voltage supply for the logical part: from 6 V to 12 V > Supply voltage for motors: 4.8 V to 46 V > Maximum current of the logical part: 36 mA > Maximum current per channel: 2 A > Maximum power: 25 W > Level of control output signals: > High state: 2.3 V = Vin = Vss > Low state: 0.3 V = Vin = 1.5 V > Operating temperature: -25°C to 130°C > Controller type: double bridge H > Dimensions: 47 x 53 mm > Weight: approx. 29 g	€13.90
Cytron MDD3A - dual-channel 16V / 3A motor controller	> Supply voltage: 4 V to 16 V > Voltage of the logical part: 1.8 V, 3.3 V, 5 V and 12 V > Current per channel: 3 A (momentary 5 A) > Number of channels: DC motor: 2 Stepper motor: 1 > Full NMOS H bridge for better performance without heat sinks > PWM speed control frequency up to 20 kHz > 4 buttons for quick system testing > Dimensions: 48 x 42 mm > Weight: 14,5 g	€8.00
Motors		
JGY-370 DC 12V Motor Reduction Gear Turbine Worm Self-locking Encoder Signal Feedback Motor - 10RPM	> Brand: Machifit Type: Reduction Motor > Material: Metal > Voltage: DC 12V > Weight: 167g > Power: 3W > Rated Voltage: 3 - 24V > Speed Regulation: Yes > Rotation In Both Directions: Yes > Encoder: Yes, hall with 2 sensors > Rated Torque: 12 kgcm > Current: 0.3 A (stall - 0.85A) > Rated Speed: 10 RPM > Size: Outer Dia.: 6mm > Motor: 46 x 32 mm (without shaft) Line Length: 230mm	€10.00

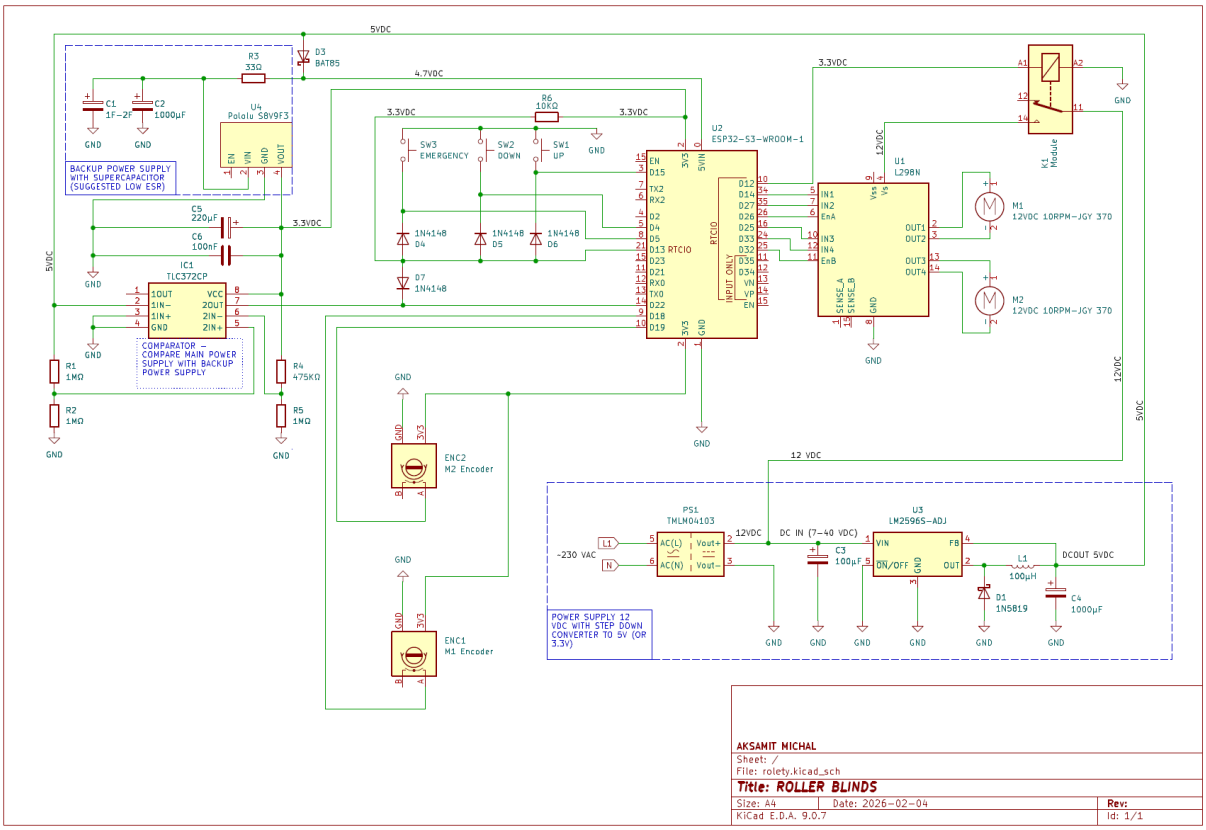
Micro DC Worm Gear Motor w/ Encoder - 12V 39RPM	> Model: 1220WG-N20VA-603-EN 12V > Gear ratio : 1/603 > No Load Current: 65 mA > No Load Speed : 39 RPM > Rated Torque : 1.8 Kg.cm > Rated Speed : 27 RPM > Rated Current : 0.15 A > Stall Current : 0.4 A > Stall Torque : > 3 Kg.cm > Encoder: hall, 7 ppr	€11.00

Table. 3.1.1

Selected items in category are marked with green glow of cell. Green marks show pros of the parts, critical cons are marked red.

4. Electronic diagram.

The purpose of this section is to describe all wiring with chosen modules from section above.



Electronic diagram 4.1

As it can be seen on above diagram (4.1) for proper installation of one device it is needed:

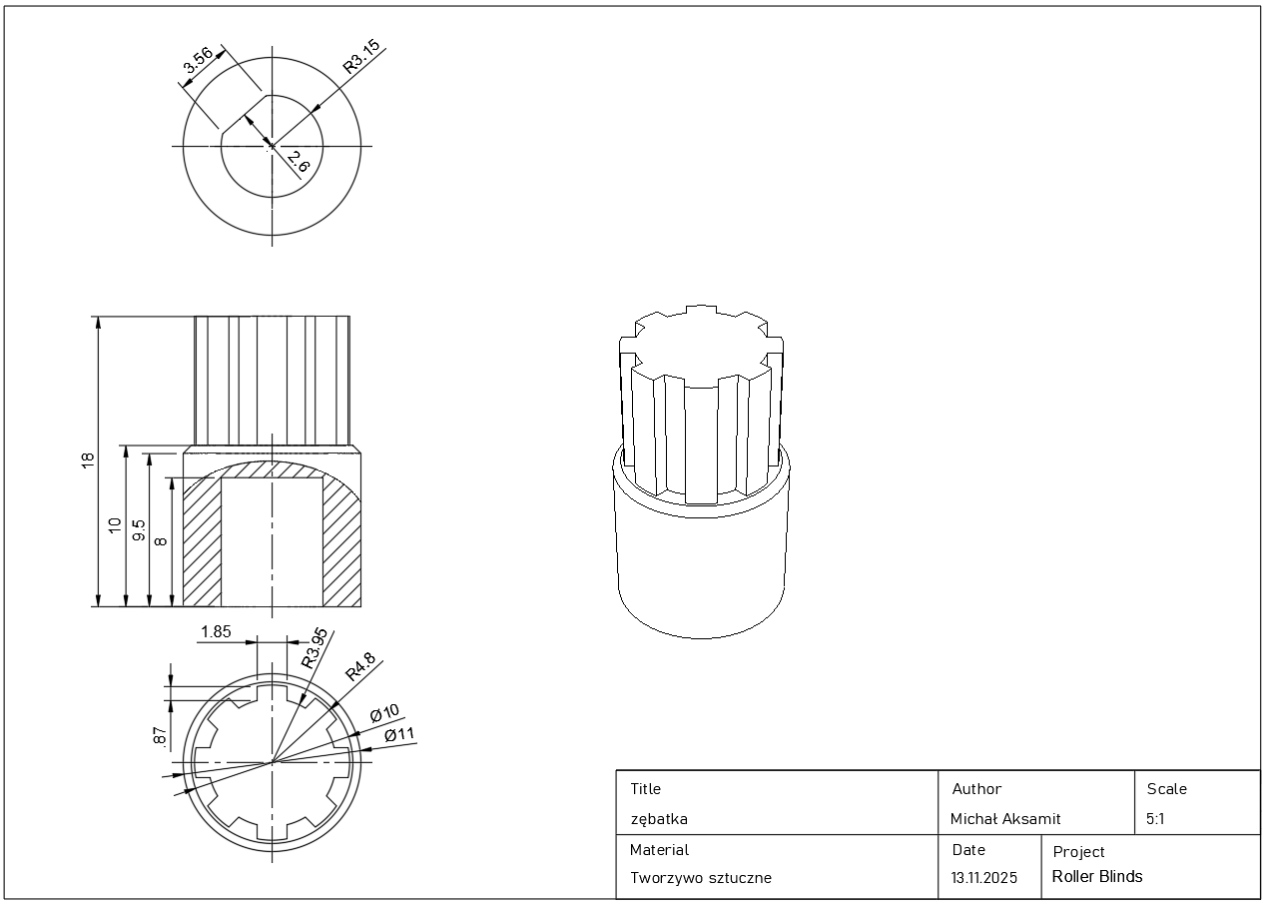
- 1 microcontroller EPS32 (U2)
- 1 motor controller L298N (U1), 1 comparator TLC372CP (IC1)
- 2 motors (M1, M2) with 2 encoders (ENC1, ENC2) installed by manufacturer
- 3 mono switches (SW1, SW2, SW3), 5 resistors, 6 capacitors, 4 diodes, 2 shottky diodes, 1 relay module with optic separation
- 1 power supply, 230 VAC to 12 VDC (PS1), 1 DC-DC converter LM2596S-ADJ (U3), 1 backup DC-DC converter Pololu S8V9F3 (U4)
- 2 wires (W1, W2) 6x0.35 mm^2 with 2,54 mm connectors (about 5 m each)
- 1 electrical box (size: 196 cm x 150cm x 30cm)

It should be notified that the device is equipped with a backup power supply. The most important element is a super capacitor (C1) which is low ESR. That capacitor is enough for 50 seconds of esp32 work during shut down and is used to save encoder data on flash. In the middle section there are 4 diodes (D4, D5, D6, D7) connected to one RTCO input of ESP32. It is used as a logical OR to wake up ESP32 from light sleep mode. The output of TLC372CP is in high state when IN+ goes to low and IN- is higher voltage than IN+ (about 2.5 V).

Electronic diagram is available as PDF in doc -> electrical diagram folder.

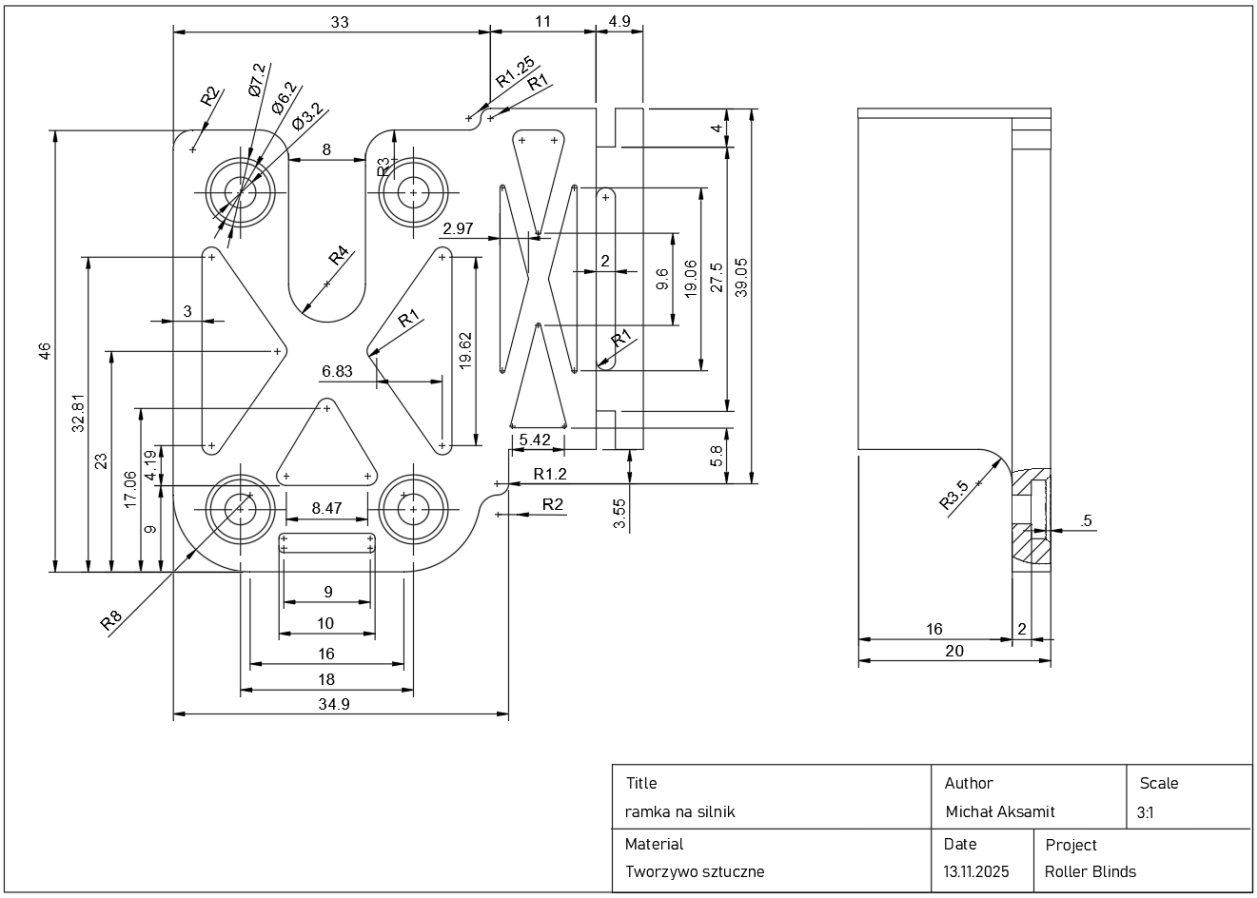
5. Mechanics and Construction.

Mechanical installation of motors connected with roller blinds on windows requires specific parts to connect all of them on one functional device. The needed parts are 3D printed with PLA filament. Technical drawings of those parts are visible below.



Technical Drawing 4.1, Gear mechanism

Gear mechanism represented in drawing above (4.1) is responsible for physical connection of motor shaft with roller blind gear.



Technical Drawing 4.2, mounting frame of motor

The mounting frame of motor (4.2) connects motor with window by four m3 screws and one additional window frame (installed in roller blinds by manufacturer) which is slipped on connector of this part (looking at right side of main view). Because of technical holes the part itself is light and material consumption of filament is maximally reduced.