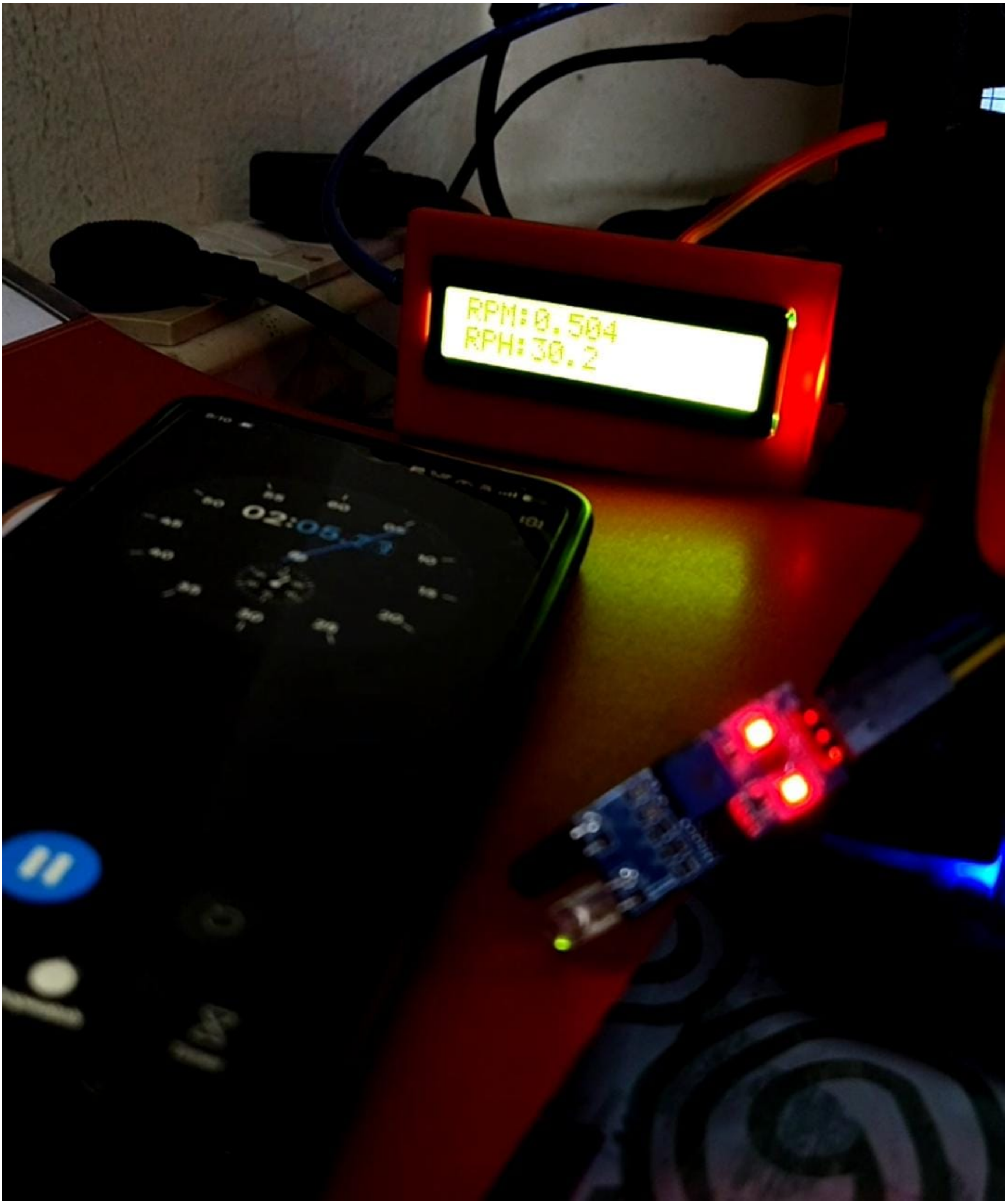
Arduino Nano Advanced Tachometer V2



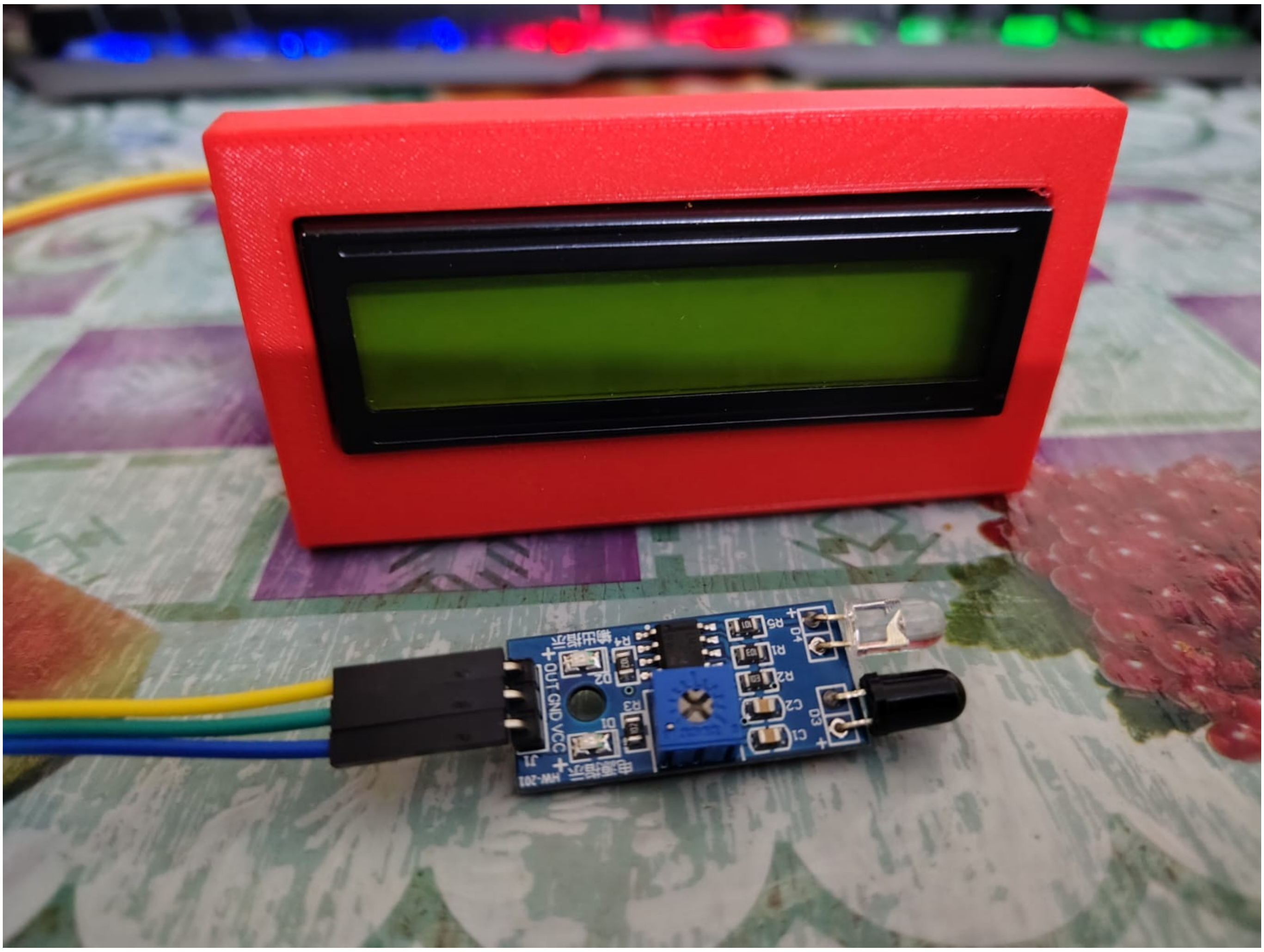
Arduino Nano tachometer with 3D-printed case and LCD display

Overview

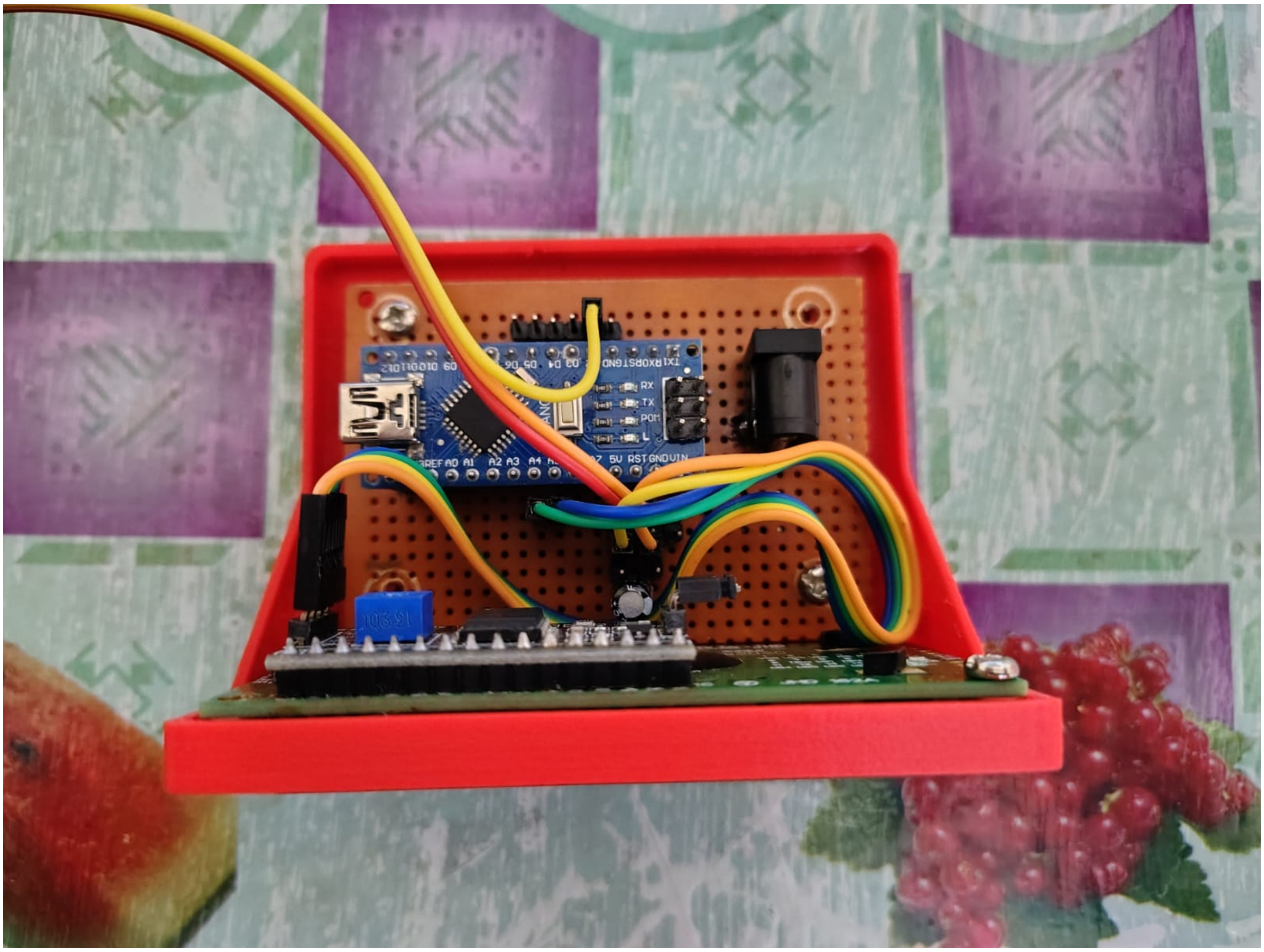
This project is a robust, configurable digital tachometer using an Arduino Nano, a TCRT5000 IR reflective sensor, and a 16x2 I2C LCD display housed in a custom 3D-printed case. It measures RPM (revolutions per minute), RPH (revolutions per hour), and total revolutions of a rotating object with black strips/markers. The system features high precision, floating-point display, and advanced debouncing for reliable measurements in various environments.

Project Images

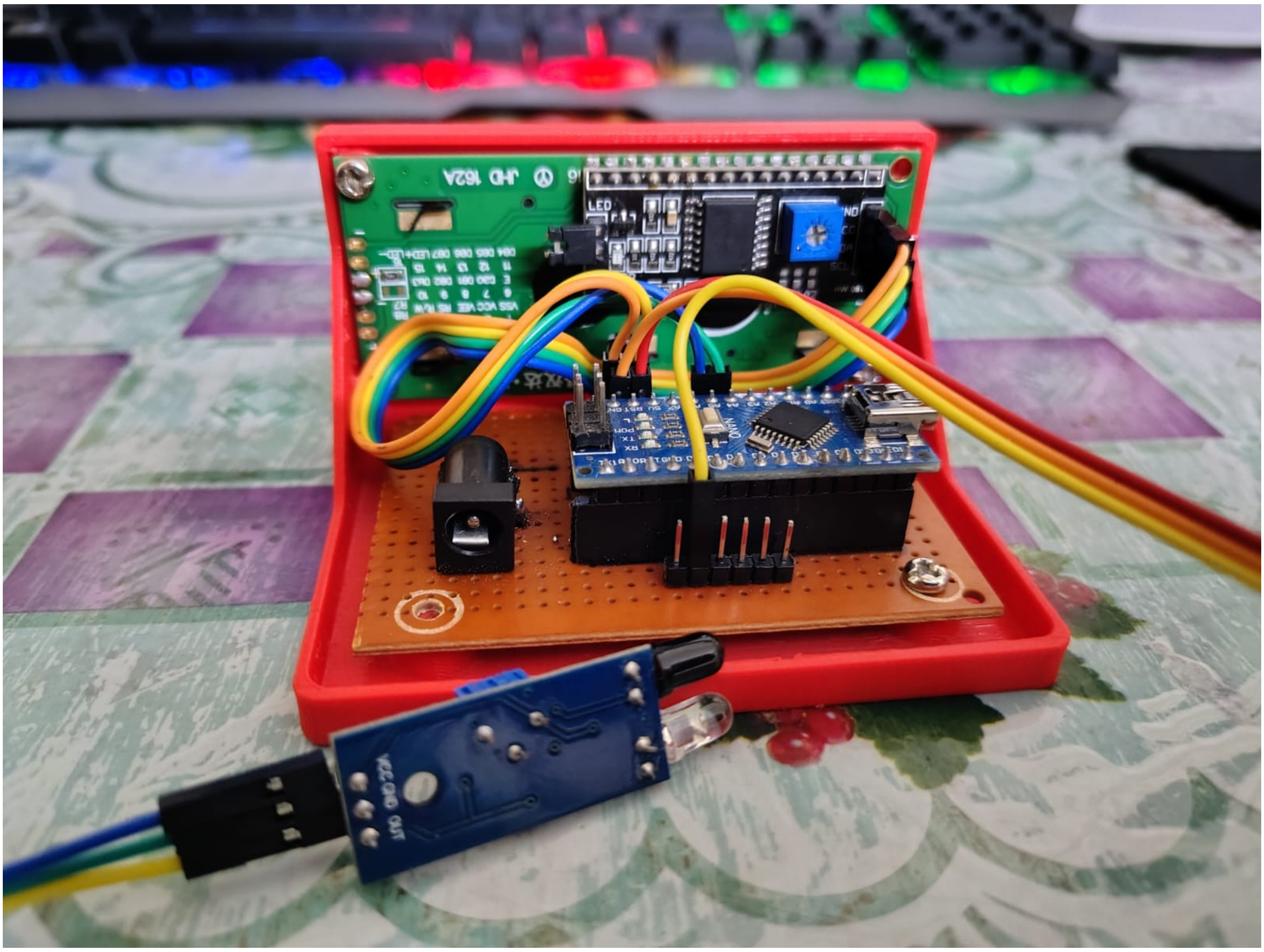
Assembled Device



Front view showing the LCD display and compact red case

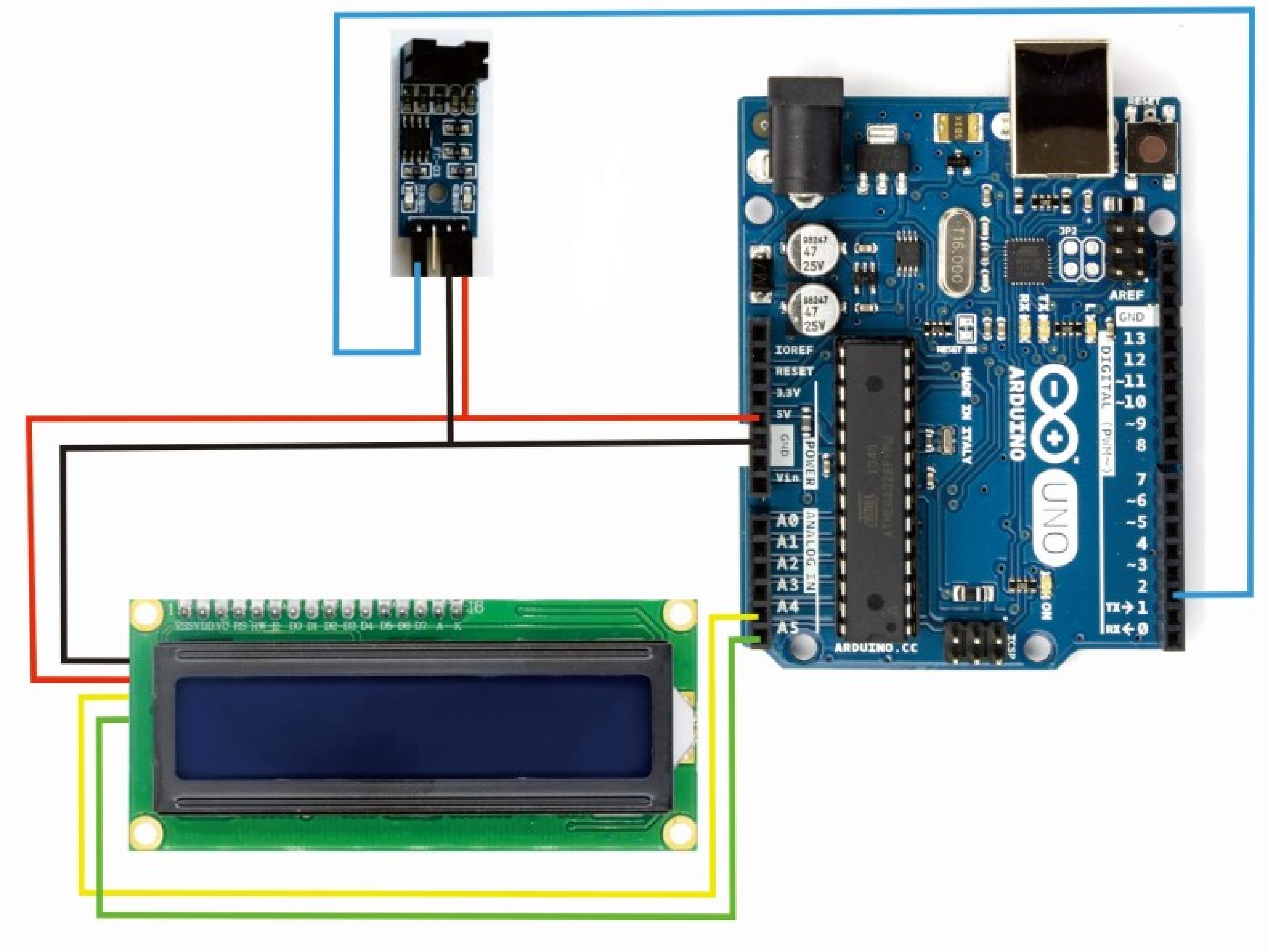


Internal view showing Arduino Nano, IR sensor, mount and wiring



Side view showing the breadboard layout and connections

Wiring



Wiring is same for Arduino nano

Key Features

- **High Precision Measurements**: Uses floating-point calculations for accurate RPM readings with decimal places
- **Configurable Pulse Detection**: Set the number of markers/strips on your wheel for accurate measurement
- **Advanced Smoothing**: Configurable `RPM_SMOOTHING` factor for stable, noise-immune readings
- **Metal-Optimized Debouncing**: `DEBOUNCE_MICROS` setting prevents false readings from reflective metal surfaces
- **Interrupt-Driven Detection**: Hardware interrupts for precise pulse timing without blocking main loop
- **Pulse Timeout Protection**: Automatically resets to zero after specified inactivity period
- **Total Revolution Tracking**: Cumulative rotation counter
- **Custom 3D-Printed Enclosure**: Professional-looking protective case with easy access
- **Direct 5V Power Supply**: Simplified power delivery with capacitive filtering

3D Printed Case Files

STL Files Included

- **`Tachometer_Case.stl`** - Open case for the tachometer project where lcd display and the arduino nano on perfboard is mounted.

Print Settings

Parameter	Value	Notes
Layer Height	0.2mm	For good surface finish
Infill	20-25%	Sufficient strength
Perimeters	3-4	Strong walls
Support	Only for overhangs	Minimal supports needed
Material	PLA or PLA+	Easy to print, durable
Print Speed	50-80mm/s	Quality over speed
Nozzle Temperature	210°C (PLA+)	Adjust for your filament
Bed Temperature	60°C	Good adhesion

Case Features

- **LCD Window**: Precision-cut opening for 16x2 display
- **Arduino Mounts**: Secure mounting points for Arduino Nano
- **IR Sensor Bracket**: Adjustable positioning for optimal detection
- **Cable Management**: Built-in channels for clean wiring
- **Power Jack Access**: Easy access to DC power connector
- **Ventilation**: Air vents for heat dissipation
- **Professional Finish**: Smooth surfaces with minimal post-processing needed

Hardware Requirements

Electronic Components

- Arduino Nano (or compatible)
- TCRT5000 IR reflective sensor module
- 16x2 I2C LCD (address 0x27 or 0x3F)
- 22µF 50V electrolytic capacitor
- 5V DC power adapter (2A recommended)
- DC barrel jack (5.5mm x 2.1mm)
- Perfboard or PCB
- Header pins and jumper wires

Hardware Components

- M3 screws (various lengths: 6mm, 12mm, 16mm)
- M3 nuts
- Heat shrink tubing
- Reflective tape or markers for target object

Library Requirements

Wire (Built-in)

No installation required - included with Arduino IDE.

LiquidCrystal_I2C (External)

Option A: Arduino Library Manager

1. Open Arduino IDE
2. Go to **Sketch → Include Library → Manage Libraries...**
3. Search for "LiquidCrystal I2C"
4. Install "LiquidCrystal I2C by Frank de Brabander"

Option B: Manual Installation

1. Download from GitHub
2. **Sketch → Include Library → Add .ZIP Library...**
3. Select downloaded ZIP file

Wiring Diagram

Component	Arduino Nano Pin	Wire Color	Notes
TCRT5000			
VCC	5V	Red	Power supply
GND	GND	Black	Ground
OUT	D2 (INT0)	Blue	Digital output, interrupt
I2C LCD			
VCC	5V	Red	Power supply
GND	GND	Black	Ground
SDA	A4	Green	I2C data line
SCL	A5	Yellow	I2C clock line
Power Supply			
+5V	5V	Red	Direct to 5V pin
GND	GND	Black	Direct to GND pin
Capacitor			
Positive	5V	Red	22µF electrolytic
Negative	GND	Black	Observe polarity!

⚠ IMPORTANT POWER SUPPLY WARNINGS

- **Never connect USB and 5V power simultaneously!** This can damage your Arduino

- **Check capacitor polarity** - Wrong polarity can cause failure or explosion
- **Use regulated 5V supply** - Input voltage tolerance: 4.8V - 5.2V
- **Current capacity** - Minimum 1A, 2A recommended for stable operation

Software Configuration

User-Configurable Constants

```
const uint8_t STRIPS_PER_REVOLUTION = 4;       // Number of black strips/markers
const unsigned long DEBOUNCE_MICROS = 250000;  // 250ms debounce for metal surfaces
const float RPM_SMOOTHING = 0.92;              // Heavy smoothing (0.0-1.0)
const unsigned long PULSE_TIMEOUT = 120000000; // 2 minutes timeout (microseconds)
const uint16_t DISPLAY_UPDATE_INTERVAL = 5000; // 5 seconds display refresh
```

Configuration Examples

For a wheel with 6 reflective strips:

```
const uint8_t STRIPS_PER_REVOLUTION = 6;
```

For more responsive readings (less stable):

```
const float RPM_SMOOTHING = 0.80;  // Less smoothing, more responsive
```

For noisy environments:

```
const unsigned long DEBOUNCE_MICROS = 500000;  // 500ms debounce
```

Assembly Instructions

Step 1: Print the Case

1. Download STL files from the project repository
2. Slice with recommended settings
3. Print the Case

Step 2: Prepare Electronics

1. **Install capacitor** - Connect 22µF capacitor between 5V and GND pins (observe polarity!)
2. **Mount Arduino** - Secure Arduino Nano to bottom case with M3 screws
3. **Install LCD** - Mount I2C LCD to top case window

Step 3: Wiring

1. Follow the wiring diagram above
2. Use colored wires for easy identification
3. Test all connections with multimeter
4. Ensure no short circuits

Step 4: Programming

1. Connect Arduino via USB
2. Select **Tools** → **Board** → **Arduino Nano**
3. Select correct **Port**
4. Upload the provided code
5. Open Serial Monitor (115200 baud) for debugging

Step 5: Final Assembly

1. Mount IR sensor to bracket
2. Position sensor for optimal detection (2-5mm from target)
3. Secure all wiring with zip ties or adhesive
4. Close case with M3 screws
5. Connect 5V power supply (NOT USB!)

Usage Instructions

Setup

1. **Prepare target object** - Apply reflective markers or tape at regular intervals
2. **Position sensor** - Mount IR sensor 2-5mm from rotation path
3. **Power on** - Connect 5V DC adapter (never with USB connected!)

Operation

- **LCD Display** shows real-time RPM, RPH, and total revolutions
- **Serial Monitor** provides detailed debugging information
- **Automatic timeout** resets readings if no pulses detected
- **Precision display** shows decimal values for accurate measurements

Reading the Display

```
RPM: 123.456    (Current revolutions per minute)
RPH: 7407.4     (Current revolutions per hour)
Total Revs: 456 (Cumulative revolution count)
```

Troubleshooting

Common Issues

No Display on LCD

- Check I2C address (scan with I2C scanner sketch)
- Verify wiring connections
- Check power supply voltage

Inaccurate RPM Readings

- Confirm `STRIPS_PER_REVOLUTION` matches your setup
- Check sensor distance and alignment
- Verify reflective markers are properly applied

Unstable Readings

- Increase `RPM_SMOOTHING` factor (closer to 1.0)
- Check for vibrations affecting sensor
- Shield sensor from ambient light

False Triggers

- Increase `DEBOUNCE_MICROS` value
- Improve marker contrast (black vs. reflective)
- Check sensor mounting stability

No Power/Random Resets

- Check capacitor polarity and connection
- Verify 5V supply stability and current capacity
- Ensure no loose connections

Serial Debugging

Open Serial Monitor at **115200 baud** for real-time debugging:

- Current RPM, RPH, and revolution count
- Pulse timing information
- System status messages

Advanced Customization

Performance Tuning

- **High-speed applications**: Reduce `DEBOUNCE_MICROS` to 50000 (50ms)
- **Low-speed applications**: Increase `PULSE_TIMEOUT` to 300000000 (5 minutes)
- **Noisy environments**: Increase smoothing factor to 0.95+

Display Modifications

- Change `DISPLAY_UPDATE_INTERVAL` for faster/slower refresh
- Modify code to show additional calculated values
- Add peak RPM recording functionality

Files in This Repository

```
Arduino-Tachometer-V2/
├── README.md                          # This file
├── LICENSE                            # Opensource MIT License
├── src/
│   ├── tachometer_v2.ino              # Main Arduino sketch
│   └── libraries/                     # Required libraries
├── hardware/
│   ├── 3d_models/
│   │   └── tachometer_case.stl        # Case
│   └── schematics/
│       └── wiring_diagram.png         # Connection diagram
├── images/
│   ├── Internal_Components.jpg        # Device photos
│   ├── Mount.jpg
│   ├── Tachometer_Action.jpg
│   └── Tachometer.jpg
└── docs/
    └──  assembly_guide.pdf             # Detailed assembly
```

Version History

V2.0 (Current)

- **Floating-point precision** - Decimal RPM/RPH display
- **Simplified power supply** - Direct 5V connection with capacitive filtering
- **Improved debouncing** - Configurable metal-surface debouncing
- **3D-printed case** - Professional enclosure design
- **Interrupt-driven** - Hardware interrupts for precise timing

V1.0 (Previous)

- Integer RPM display only
- Complex state machine
- EEPROM storage
- Auto-calibration system
- LM7805 voltage regulation

License

This project is released under the **MIT License**. Feel free to use, modify, and distribute for personal and commercial applications.

Support

- **Issues**: Report bugs via GitHub Issues
- **Documentation**: Check the `/docs` folder for detailed guides
- **Community**: Join our discussions for tips and improvements

Acknowledgments

- Thanks to the Arduino community for libraries and inspiration
- STL files designed for optimal printability and functionality
- Tested across multiple hardware configurations for reliability

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⚡ **Safety Reminder**: Always double-check power connections and never mix USB and external power supplies!