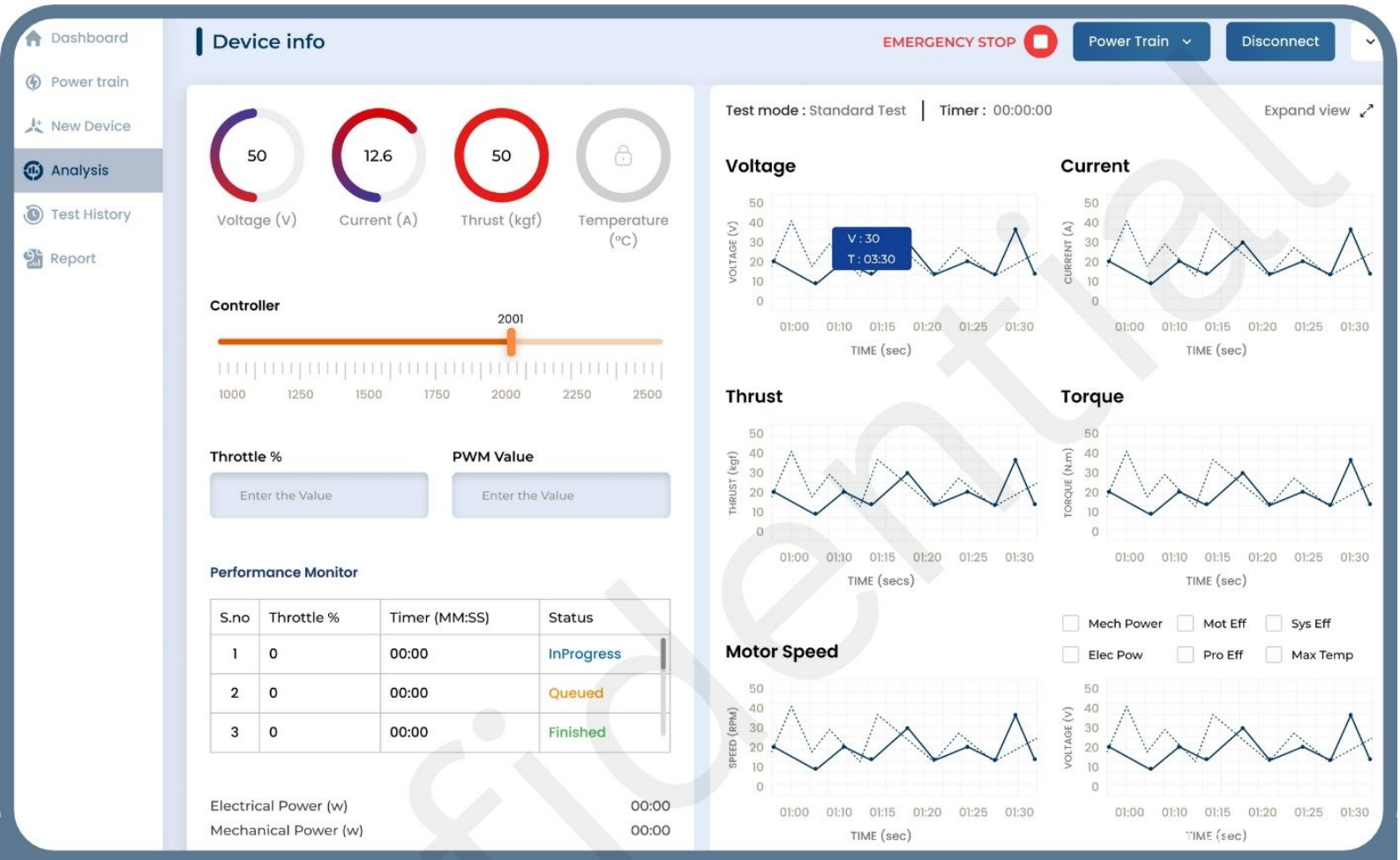
USER MANUAL



INTELLIGENT MOTOR ASSESMENT & DATA ACQUISITION SOFTWARE

RELEASE	DEVELOPED BY	VERSION
V 1.0	REUDE TECHNOLOGIES	PREMIUM
DATE: 18/05/2025		LITE/PREMIUM

PRODUCT OVERVIEW:
RotriX is an intelligent SaaS platform designed for real-time motor data assessment and smart data acquisition, purpose-built to serve two critical industries: Drones and Electric Vehicles (EVs). It acts as a plug-and-play motor analysis tool, integrating with any sensor to monitor, analyze, and report motor performance under real-world and extreme conditions.

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1 Overview

RotriX is a powerful and intuitive web-based Software as a Service (SaaS) platform developed to assess the performance of motors used in Unmanned Aerial Vehicles (UAVs) i.e., drones and electric vehicles (EVs). The platform supports real-time simulation, analysis, and validation of various motor configurations under dynamic load conditions. With its advanced test sequencing and data monitoring features, RotriX enables UAV engineers, EV developers, researchers, and enthusiasts to derive meaningful performance insights that support effective hardware selection and system optimization.

The platform integrates seamlessly with remote test beds, allowing engineers to conduct tests from any location. Its compatibility with a wide range of hardware configurations makes it a versatile tool for research labs, industrial settings, and educational institutions.

This user manual serves as a step-by-step guide, covering everything from system requirements and software setup to advanced test workflows, safety configurations, and report generation.

In this manual, you will find:

- Setup and configuration instructions
- Overview of the interface and core features
- Steps to run motor-propeller performance tests
- Tips for interpreting output data and visualizations
- Best practices for exporting and comparing test results

Whether you're selecting a motor for your next EV prototype or validating manufacturer specifications for a new drone, RotriX helps you make informed design choices backed by clear, data-driven insights from structured testing and Design of Experiments (DoE).

2 Prerequisites

To get started with RotriX, ensure the following requirements are met:

- A functional motor thrust test bench equipped with calibrated sensors for thrust, torque, battery voltage, current, motor speed and temperature measurements.
- RotriX-compatible firmware must be flashed onto the control unit (microcontroller) of the test bench to enable seamless communication between the hardware and software.
- The host computer must run Windows 11 and have administrative privileges to install and execute the 'Rotrixconnect.exe' interface program.
- Ensure a reliable internet connection is available throughout the testing process. The web interface is accessed through modern browsers like Chrome or Edge.

3 Getting Started

3.1 Signing Up

- Visit the website at https://rotrix.reude.tech
- On the login page, click the 'Sign Up' option.

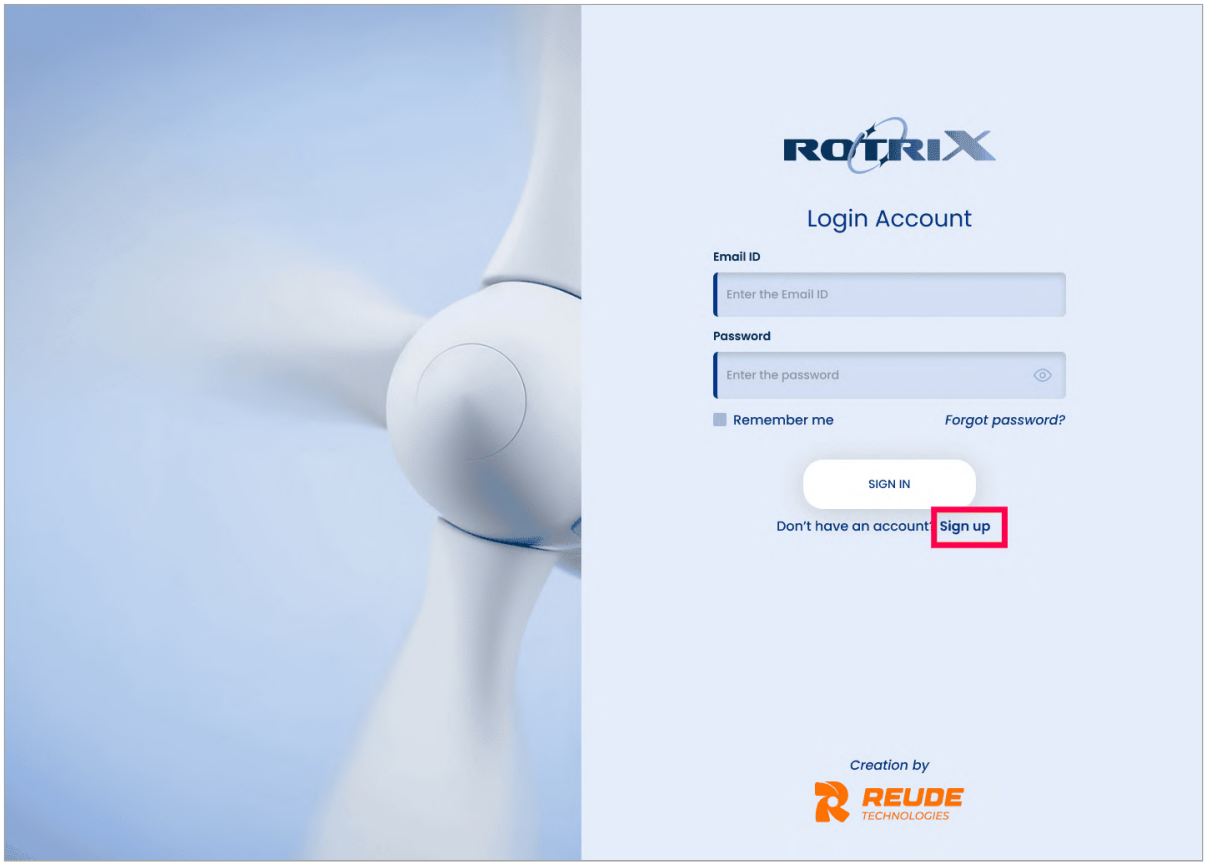

Figure 1: REUDE Login page

- In the Sign Up page, enter your details including Username, Email ID, User type (e.g., Academic Institution, Company, Individual), Organization Name, Mobile Number and Password.
- Once all the details are entered, read and agree to the terms and conditions of the software and click 'Sign Up'.

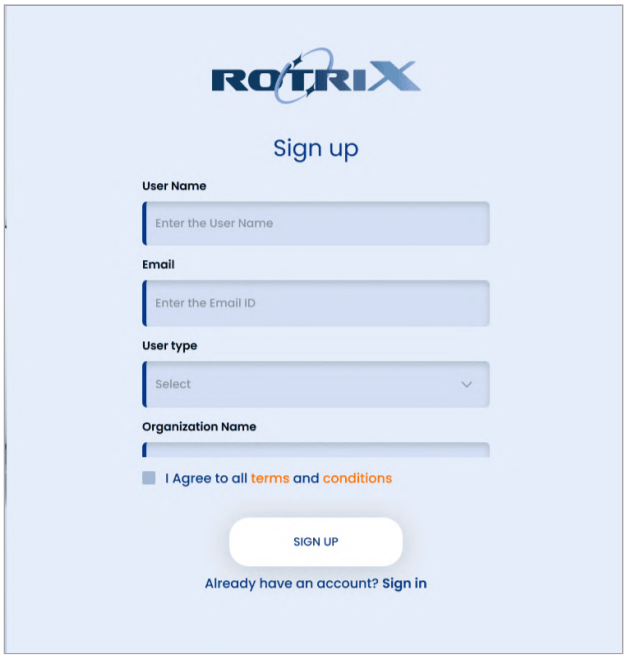

Figure 2: Sign up page

- Once signed up, a One-Time Password (OTP) verification code will be sent to your registered email ID. Enter the OTP when prompted (as in Figure 3) and click 'Continue' to activate your account.
- You have now successfully signed up for the software.

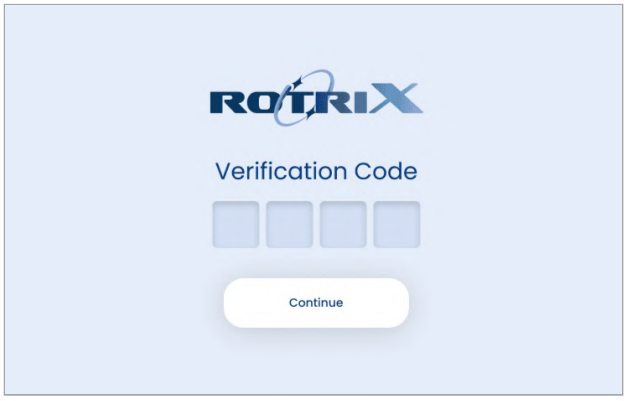

Figure 3: Verification code prompt

NOTE: Each RotriX user account requires a unique mobile number to prevent duplicate registrations. Try signing up with a different mobile number if you face issues with sign up.

3.2 Logging In

After successful signup, return to the login page (Figure 1). Use your registered Email ID and Password to access the RotriX platform. This login ensures a secure session and allows personalized access to devices, powertrains, and test results.

3.3 Dashboard Overview

The Dashboard serves as the central resource hub of the RotriX platform, providing users with an overview of the software and its features. Key features include:

- A Quick start guide to navigate users through the platform's functionalities
- A link to download the desktop EXE file for enabling hardware-software interfacing
- User manual for detailed information on all features.
- Access to RotriX Subscription Plans & Pricing
- Governing Terms & Conditions
- RotriX and motor testing-related FAQs

Additionally, a Feedback section is available where users can share their experience, report issues, or suggest new features.

Along with the Dashboard page, you can find a navigation panel located on the left side of the interface providing access to key sections of the software:

- Powertrain – Create and configure custom powertrains
- New Device – Add devices based on hardware types and selected subscription plans
- Analysis – Core module for testing, data collection, and real-time monitoring
- Test History – View and manage records of previously conducted tests
- Report – Generate and download detailed test reports for documentation or review

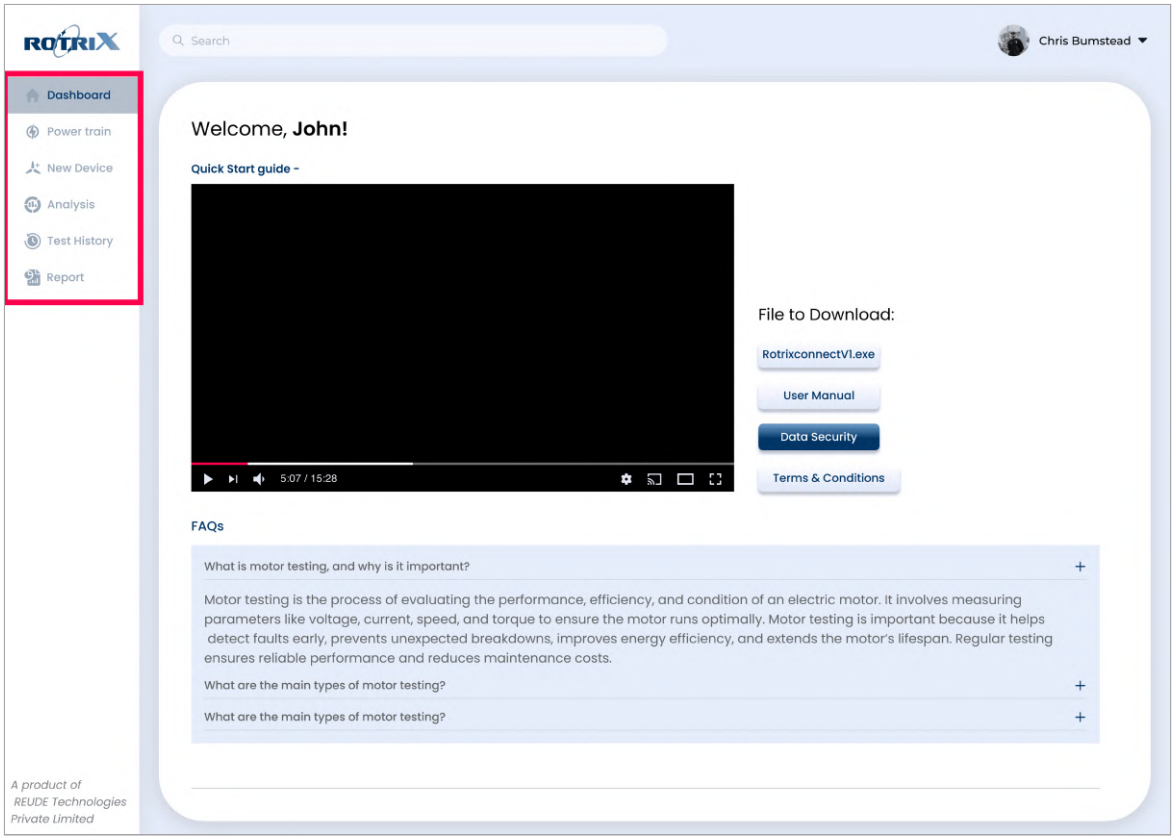

Figure 4: RotriX Dashboard

4 RotriX Desktop EXE Installation

- Upon login, download the EXE file, 'Rotrixconnect.exe', from the Dashboard page under 'Files to Download'.

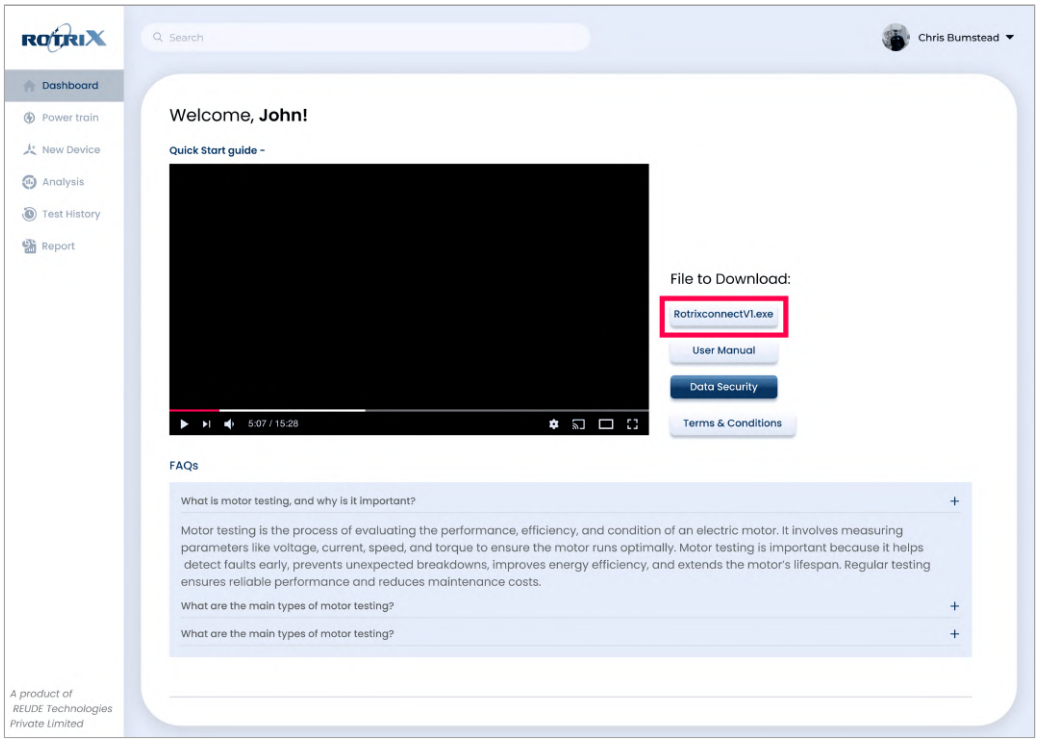

Figure 5: RotriX EXE file location

- Install the software on the computer connected to the test bed.
- This desktop EXE file has to be launched before starting a test, and logged in using your registered credentials include Email ID and Password in order to establish a secure link between your local hardware and the RotriX web-based testing interface.

5 Device Management

5.1 Creating and Registering a New Device

As a new user, the first step in using the RotriX software is to create a new device. This step is essential for onboarding and registering devices, ensuring that the test hardware is properly authenticated and linked to the RotriX database. During this step, users can choose device-specific attributes, select an appropriate subscription plan based on the required features, and specify the hardware type to ensure full compatibility with your test setup and requirements.

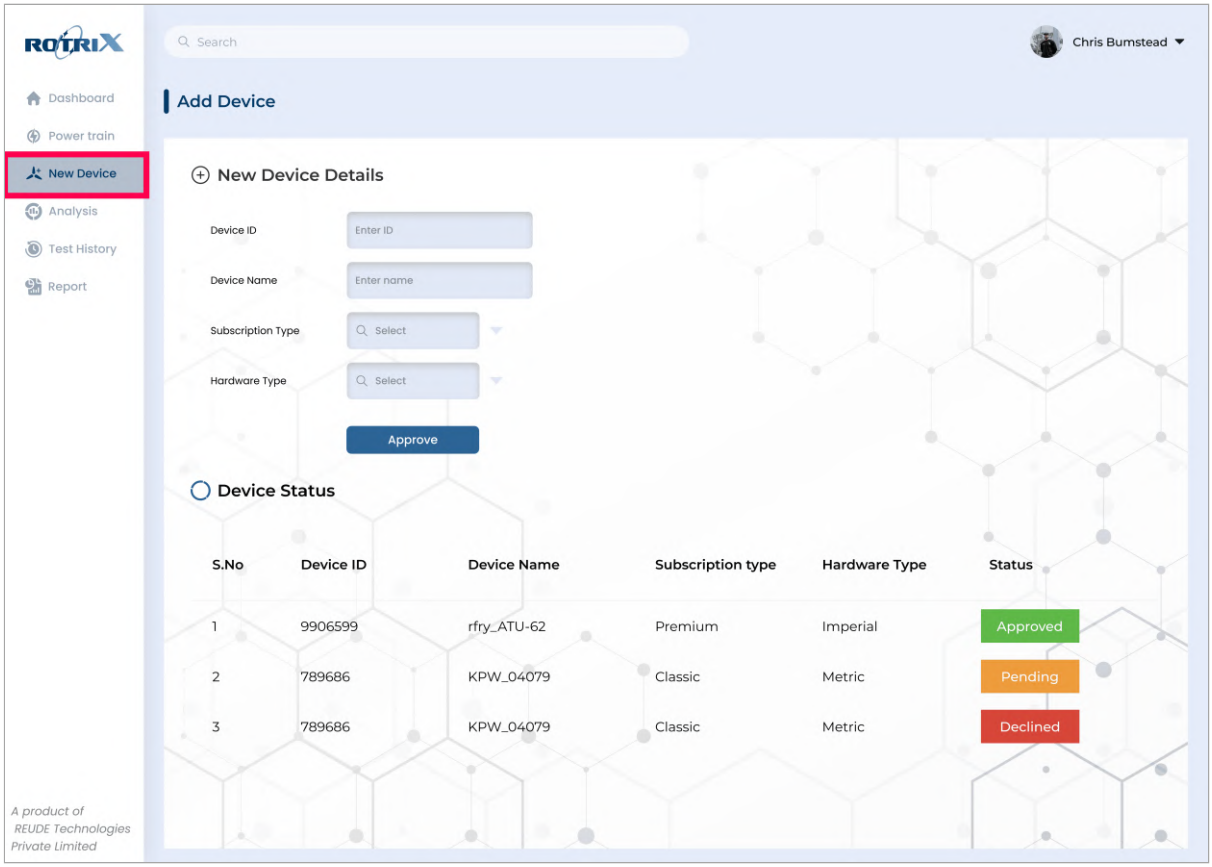

Figure 6: New Device page

- Navigate to the ‘New Device’ page in the navigation panel. On this page, you will be prompted to enter the following information:
  - Device ID – Provide a unique, user-defined identifier for your device. This ID will be used to match the device with its corresponding firmware during data transfer, ensuring a secure and authenticated connection.
  - Device Name – Provide a custom, user-friendly name for your device
  - Subscription Type – Select your active subscription plan from the dropdown menu. For detailed information on available plans, refer to the document accessible via the ‘Price/Plan’ icon on the Dashboard page.

- Hardware Type –Choose the hardware configuration that best matches your test setup. A description of supported hardware types, based on your subscription, is also available in the document linked through the ‘Price/Plan’ icon on the Dashboard page.

- After filling in the details, click the ‘Approve’ button to submit your device for registration. The approval process is managed by the RotriX Support team. Approval process with be handled by the RotriX support team within 24 hours on working days.

You can track the approval status in real-time under the 'Device Status' section. This panel also allows you to manage all your registered devices, including the ability to edit device details or delete outdated configurations as needed.

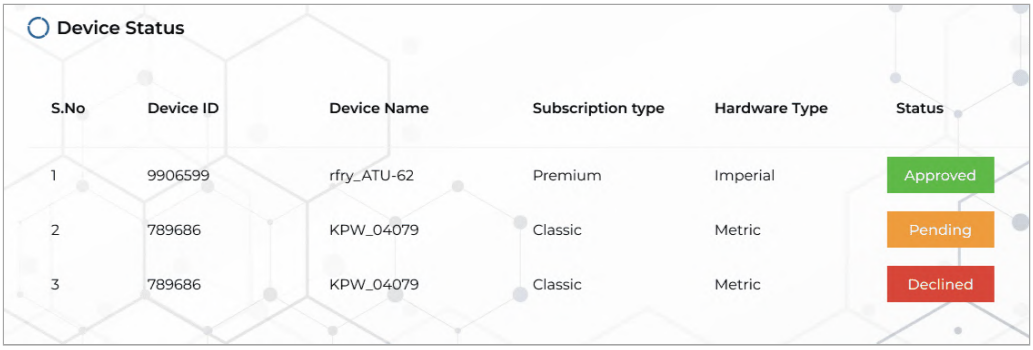

Figure 7: Device Status

6 Powertrain Configuration

6.1 Overview of the Powertrain Page

The **Powertrain** page is the core interface for configuring and managing motor-propeller test setups. It allows users to create detailed powertrain configurations, which include combinations of motors, propellers, Electronic Speed Controllers (ESCs), and batteries. This module provides a centralized overview of all configured powertrains, enabling users to conveniently manage, edit, or remove setups as required.

At the center of the page, a list displays all the configured powertrains. Clicking on a specific powertrain provides detailed insights into its configuration, with options to edit or delete it as needed. At the top of the page, an overall summary section presents categorized test results—such as the total number of powertrains created, total tests conducted, and pass/fail counts across all tests. This overview helps users quickly assess testing progress and identify system-wide performance trends.

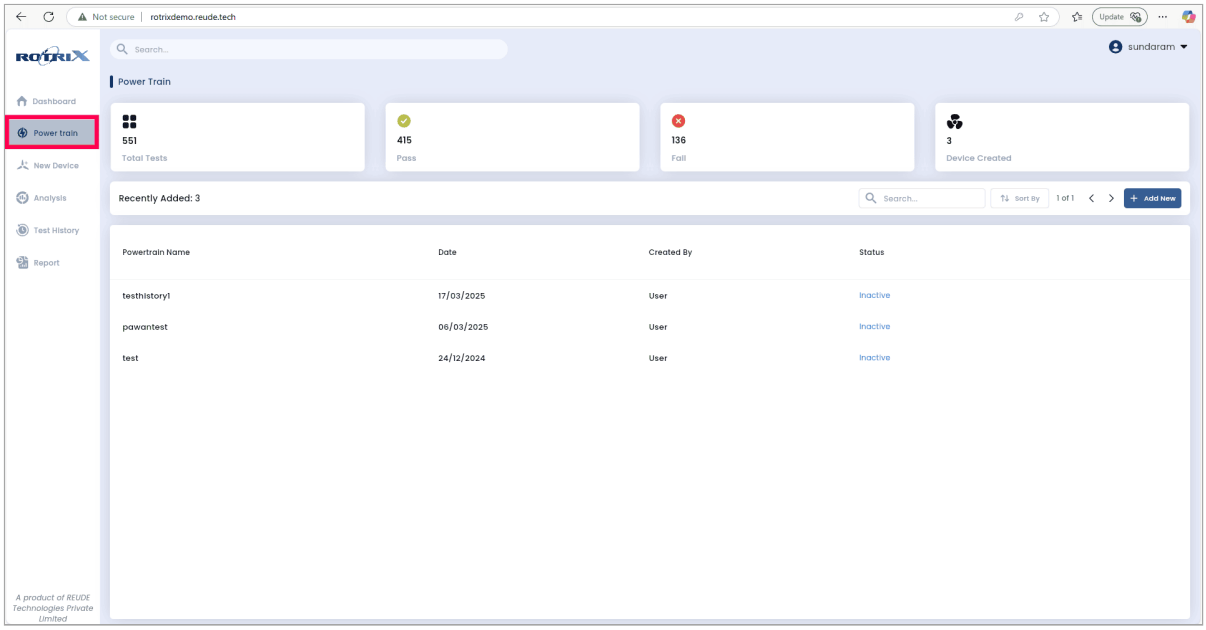

Figure 8: Powertrain page

6.2 Configuring powertrain (Assigning Motor, Propeller, ESC, and Power Source)

- To create a new powertrain, click the 'Add New' button

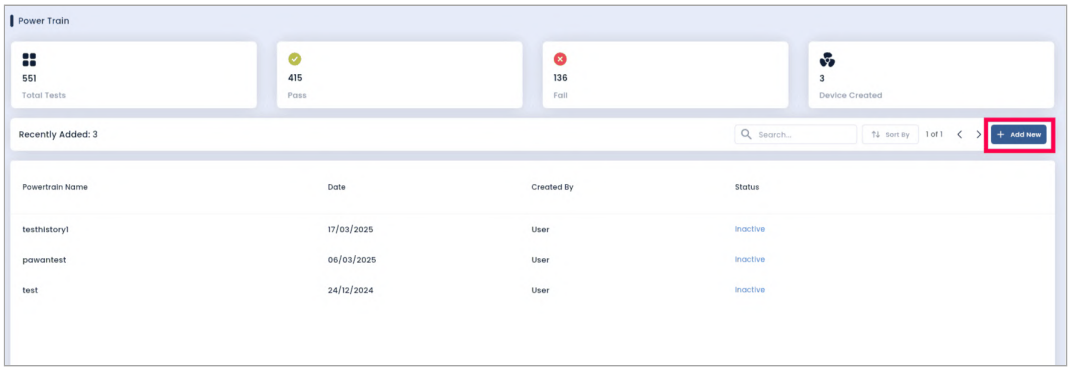

Figure 9: Powertrain creation

- A setup panel will open on the right side of the screen, where you can input the specifications for your motor, propeller, ESC, and battery, along with the safety limits for your device.

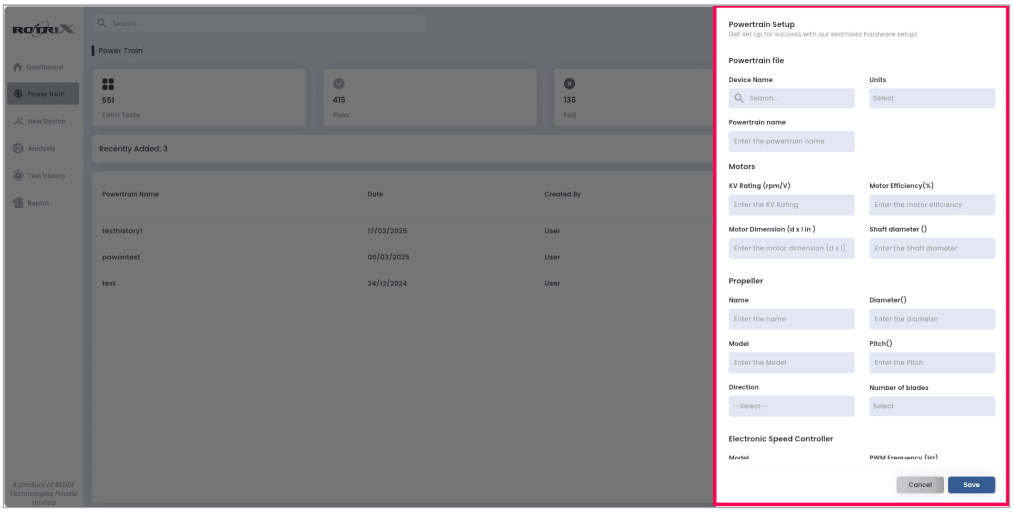

Figure 10: Powertrain setup

6.3 Setup Options

6.3.1 Powertrain-Device mapping

Within the setup panel, under the Powertrain file section, in the 'Device Name' field select the device to which this powertrain should be linked.

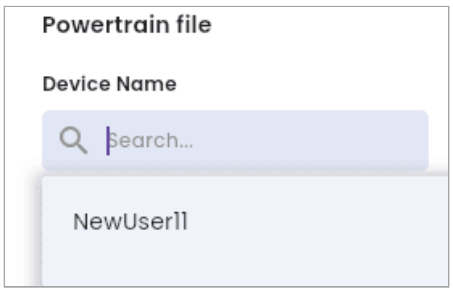

Figure 11: Powertrain-Device mapping

6.3.2 Units of measurement

You can choose your preferred unit system—metric or imperial—depending on your project requirements.

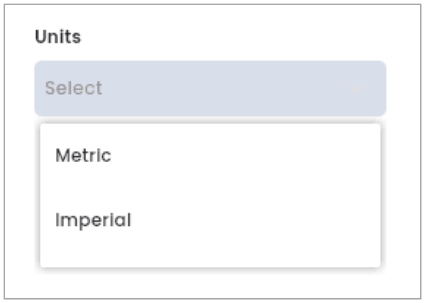

Figure 12: Units of measurement

6.3.3 Safety limits

During setup, you can define safety thresholds for your device to ensure safe testing and protect hardware. These include:

- Threshold Voltage: The minimum voltage level at which a warning prompt appears, allowing the user to either continue or stop testing.
- Cut-off Voltage: The critical minimum voltage level. Once reached, the test is automatically terminated by the software.
- Max Torque: The upper torque limit for the motor.
- Max Current: The maximum allowable current drawn by the motor.
- Max RPM: The maximum rotational speed of the motor in RPM.
- Max Temperature: The maximum safe operating temperature for the motor.

These safety parameters are continuously monitored during testing. If any threshold is crossed, the software will alert the user via visual indicators or warning pop-ups.

Once all configurations are completed, click the ‘Save’ button to finalize and store the new powertrain setup.

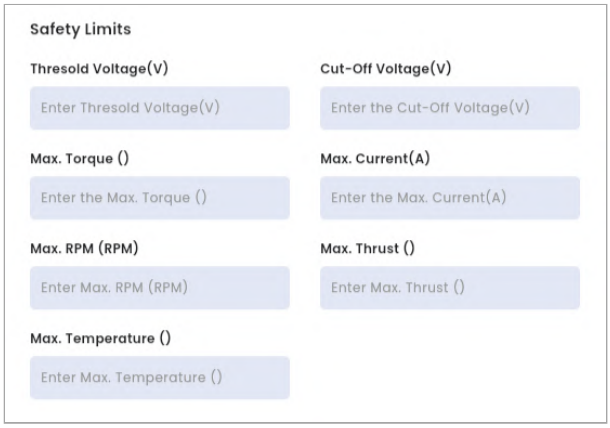

Figure 13: Safety limits setup

7 Motor Test Modes

RotriX offers a versatile motor testing environment that supports both ***automated control*** and ***on-the-fly control*** of powertrain configurations. This dual-mode approach allows users to either define structured test sequences or dynamically control motor input values during live testing ensuring flexibility across development, validation, and research workflows.

Motor tests in RotriX are executed by supplying a series of throttle percentage values to the motor over defined time intervals. These values correspond to pulse-width modulation (PWM) signals transmitted to the Electronic Speed Controller (ESC), which in turn regulates the motor's behavior. Understanding the following terminologies is essential for configuring and interpreting motor tests accurately.

ESC PWM Range: This refers to the minimum and maximum PWM values (in microseconds) accepted by the ESC to control throttle. For example, a typical ESC might accept PWM signals ranging from 1000 µs (0% throttle) to 2000 µs (100% throttle). These limits are configurable during the powertrain setup and directly affect how throttle percentages are interpreted by the system.

Throttle Percentage: A normalized percentage value (0–100%) that represents the relative position within the ESC's defined PWM range.

Motor Runtime: The duration (in seconds) for which the motor maintains a specific throttle percentage during testing. This parameter determines how long the motor will be driven at each test point.

7.1 Point-Based Automatic Control Test

The Automatic Control mode is designed for systematic evaluation of motor behavior under user-defined or standard input sequences. This feature enables the creation of repeatable test profiles that can be executed multiple times to validate consistency, study transient response, or assess thermal stability. Users can configure tests in two ways:

7.1.1 Standard Tests

A predefined set of throttle percentage values—ranging from 0% to 100%—is provided, each with a fixed runtime. You can select specific steps from this set to construct a basic test sequence. This mode is ideal for quick validation and bench-marking.

7.1.2 Custom Tests

This mode offers complete flexibility, allowing you to define a personalized sequence of throttle percentage values and assign custom runtime duration for each point. It is particularly useful for simulating real-world usage patterns or stress testing powertrains under non-linear load conditions.

7.2 Free control test

The Free Control mode is designed for real-time, manual control of motor throttle during a test session. Unlike the automatic modes, this mode allows you to actively adjust the throttle percentage on the fly - either increasing or decreasing the input in response to live performance feedback. While throttle inputs are dynamic in this mode, the runtime for each throttle percentage remains fixed. This ensures that all data captured is bounded within a consistent time frame, even though the throttle control is continuously variable.

Free Control provides maximum flexibility for exploratory testing, calibration, or quick validation of motor response under changing loads.

8 Data Acquisition

The Analysis page in RotriX is where real-time motor control, monitoring, and data acquisition are performed. It allows users to execute test modes described in the previous section by interfacing with both firmware and hardware components. This page is central to evaluating powertrain performance through live data visualization and test control.

The layout of the Analysis page is divided into three key panels:

- The top panel provides controls to connect with the hardware, select powertrains, start or stop tests, and trigger emergency stops.
- The left panel offers manual motor control via a throttle slider, real-time safety limit indicators, and key parameter displays.
- The ***right panel*** is dedicated to real-time graphing and visualization of motor and battery performance data.

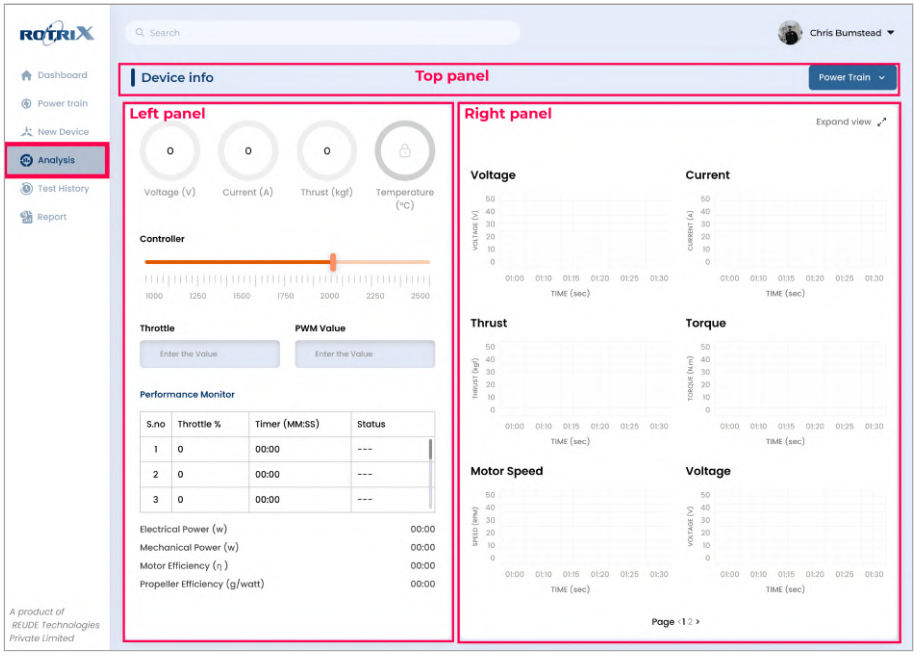

Figure 14: Analysis page

8.1 Starting the EXE

- Begin by launching the 'Rotrixconnect.exe' application from your desktop. Log in with your credentials to initialize the session.

Figure 15: RotriX EXE

- Once the COM port is successfully connected to the firmware, a prompt will appear confirming the connection (Figure 15). Click ‘OK’ to proceed.

Note: If the COM port is not detected, verify the hardware connection and confirm that the device is listed under Device Manager → Ports (COM & LPT). Ensure that drivers are properly installed and that the microcontroller is recognized by the system.

8.2 Selecting Hardware

- Navigate to the 'Analysis' page. On the top panel’s right corner, open the ‘Powertrain’ dropdown. This menu lists all the powertrains associated with the logged-in user’s device account. Select the powertrain you intend to test.

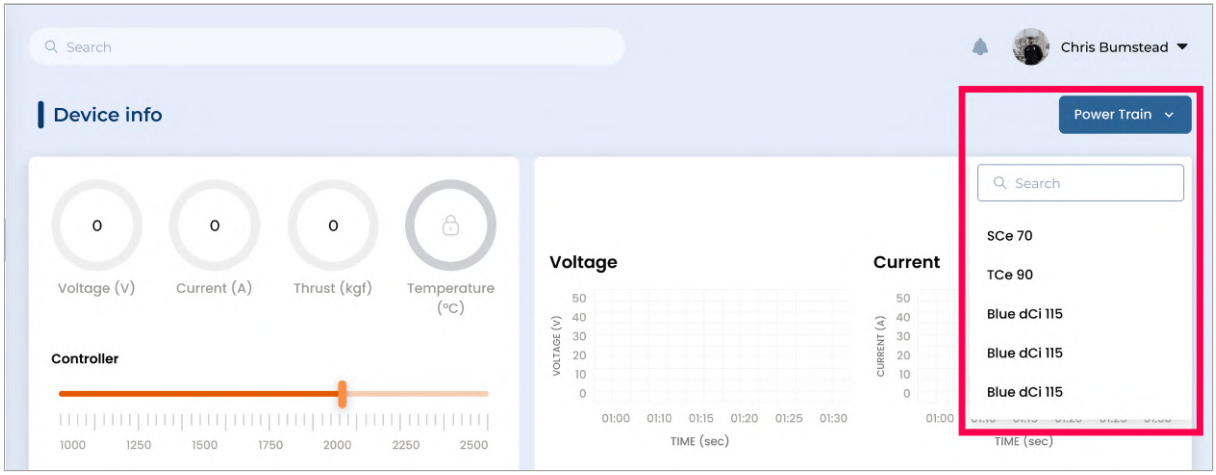

Figure 16: Powertrain selection

- Once selected, a ‘Connect’ button will appear. Click ‘Connect’ to establish communication between the software and hardware.

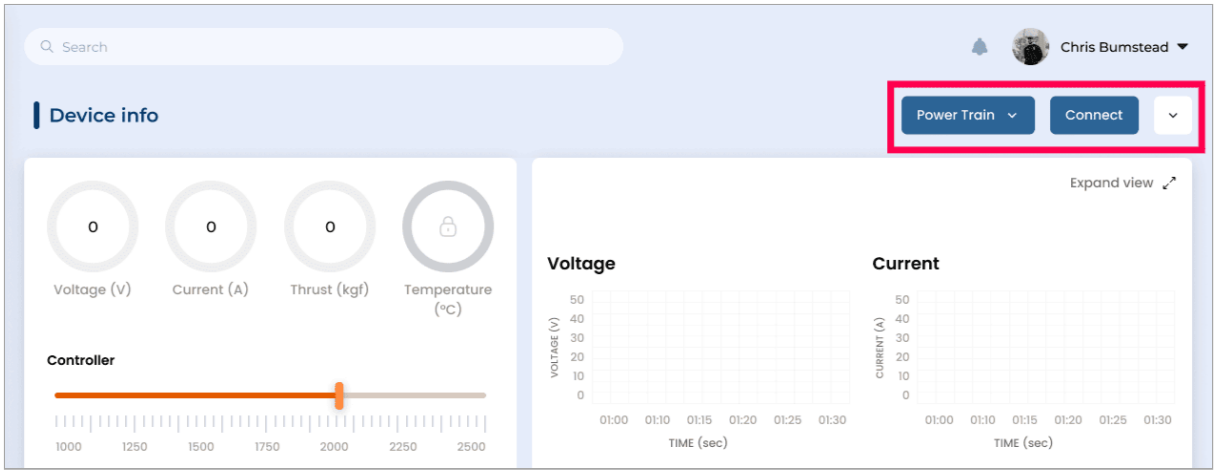

Figure 17: Firmware connection

- You'll be prompted to begin the test; click 'Yes' to proceed.

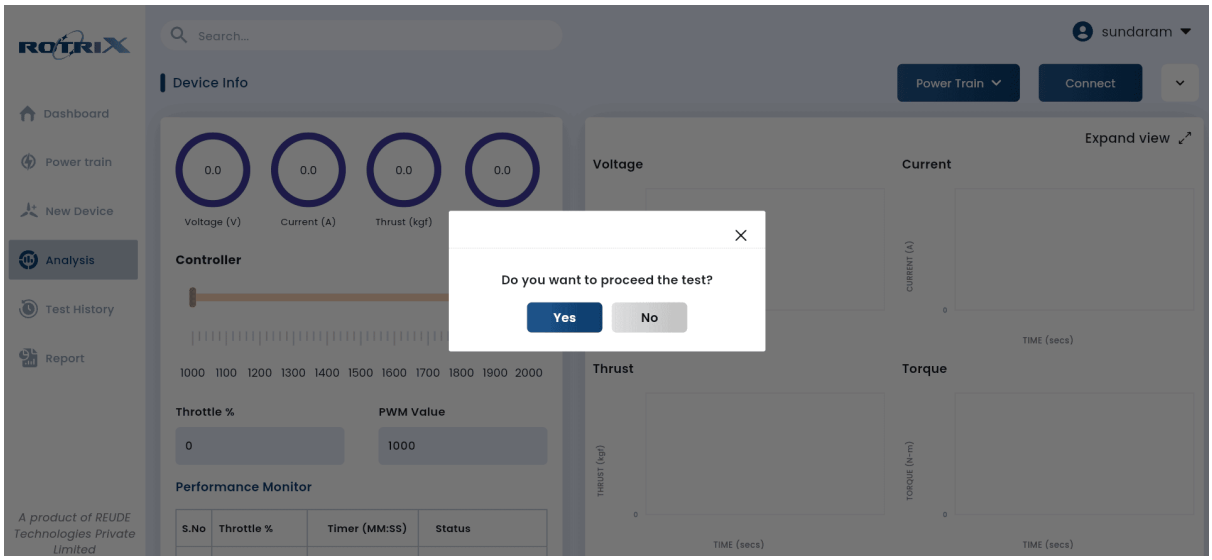

Figure 18: Test initialization

- To view detailed information about the selected powertrain, click the dropdown arrow beside the 'Connect' icon as in Figure 17.

8.3 ESC Calibration (Optional)

ESC calibration allows the software to register the ESC's minimum and maximum PWM values, as configured during powertrain setup. Although calibration is not required every time, it ensures precision in PWM control.

Important: Before calibration, disconnect the battery and remove all propellers for safety.

To calibrate:

- When prompted, click 'Yes' to begin ESC calibration.

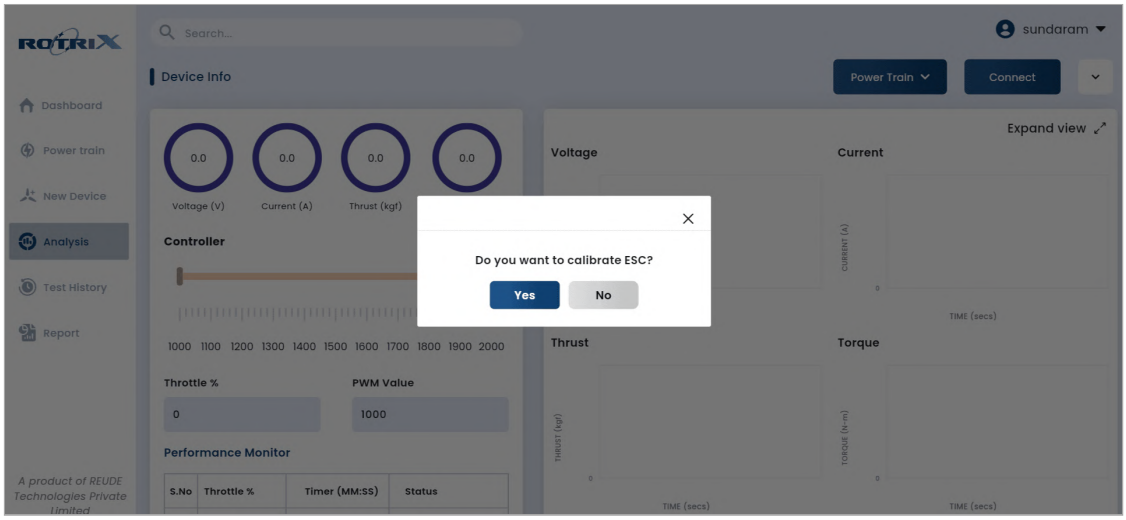

Figure 19: ESC calibration prompt 1

- Follow the on-screen instructions to disconnect the battery and remove the propeller. Click ‘OK’ to initiate calibration.

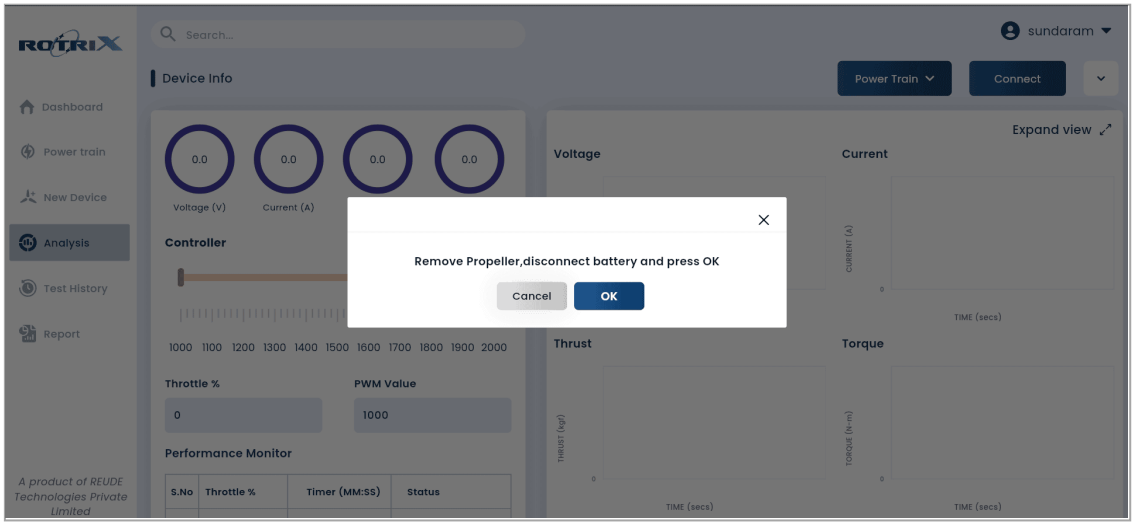

Figure 20: ESC calibration prompt 2

- When prompted again, reconnect the battery within 30 seconds and press ‘OK’.

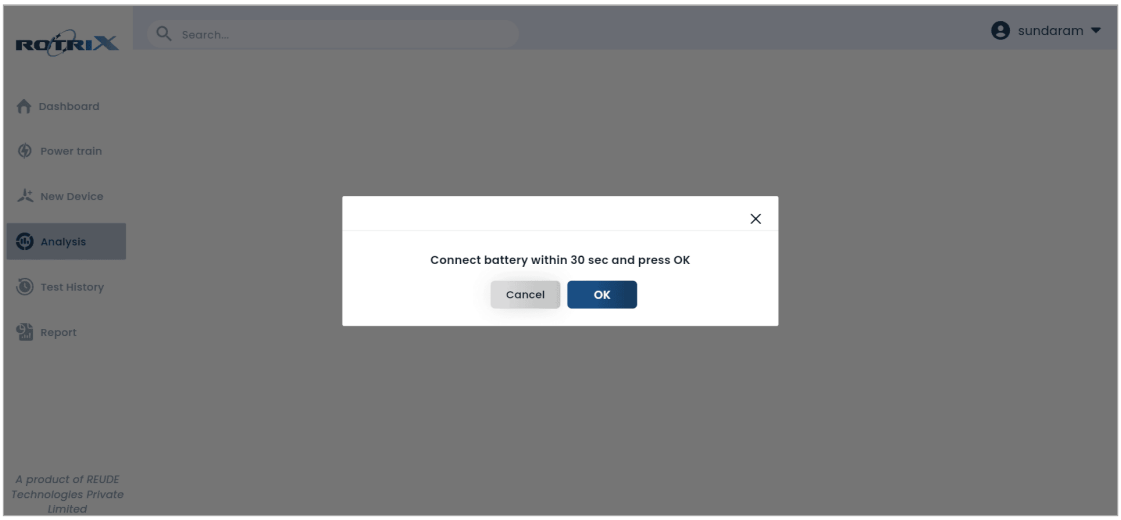

Figure 21: ESC calibration prompt 3

- Wait for the calibration to complete. A success message will confirm the process is finished.

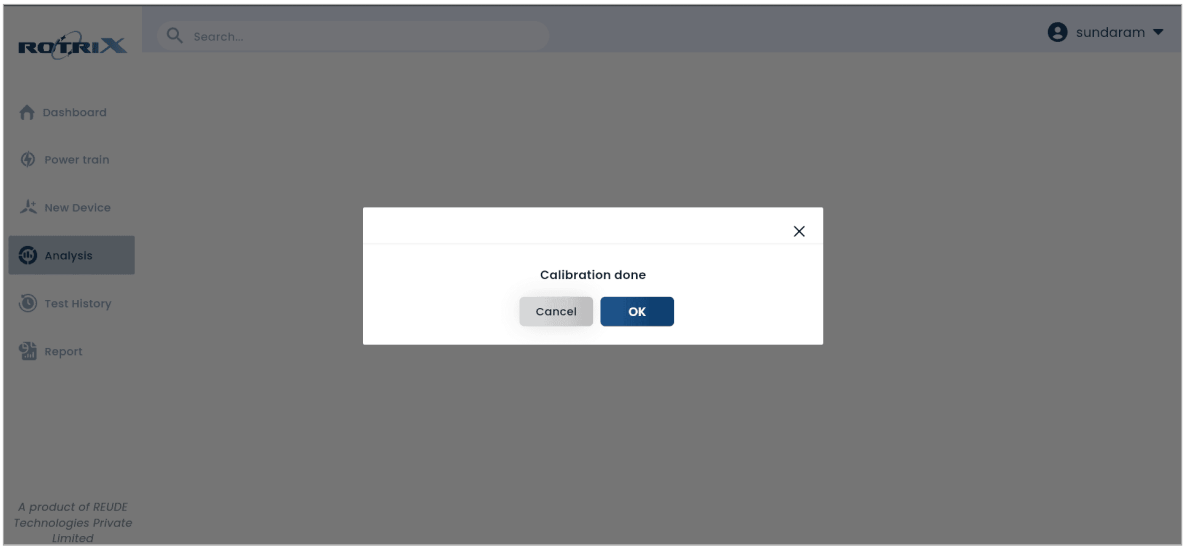

Figure 22: ESC calibration prompt 4

8.4 Selecting Test Mode

- After calibration (or skipping it), the next step is to choose your preferred test mode. Click ‘Connect’ again, and when prompted about ESC calibration, select ‘No’. A new pop-up will appear with available test modes:
  - Free Control
  - Point-Based Control

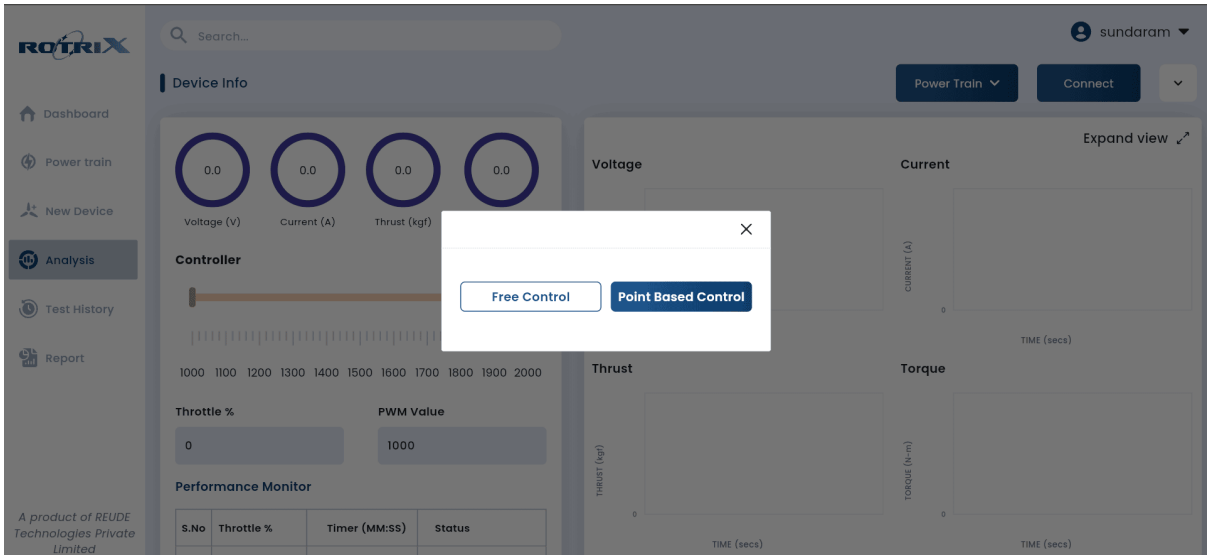

Figure 23: Test mode selection

8.4.1 Standard test (Point-Based Control)

- Select ‘Point-Based Control’, followed by ‘Standard Test’ option. This mode provides a sequence of predefined throttle percentage steps (0% to 100%, in 10% increments), each with a fixed runtime of 10 seconds.

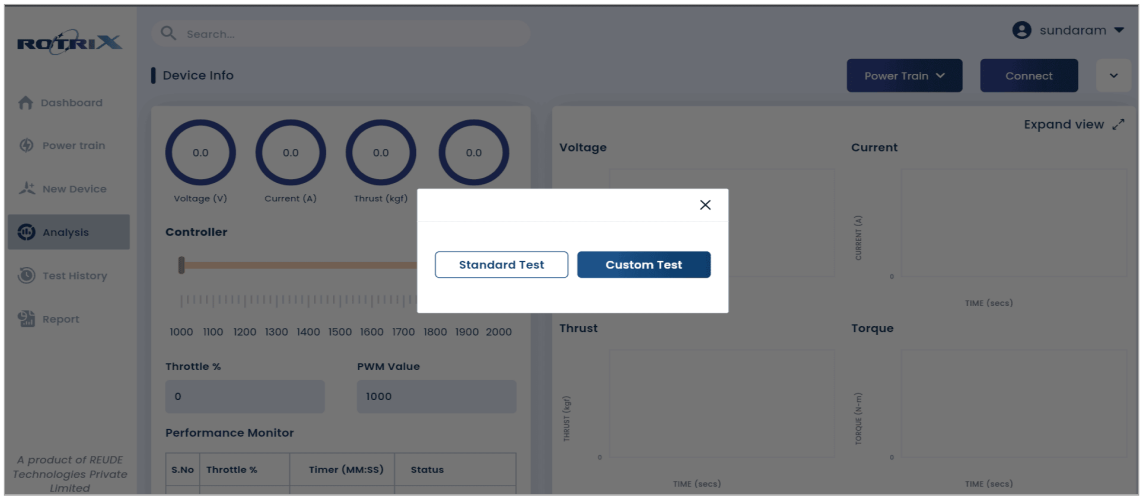

Figure 24: Point-based mode selection

- Choose the throttle steps you wish to include and click ‘OK’. The test will automatically start, running the motor through each step in sequence and stopping once completed.

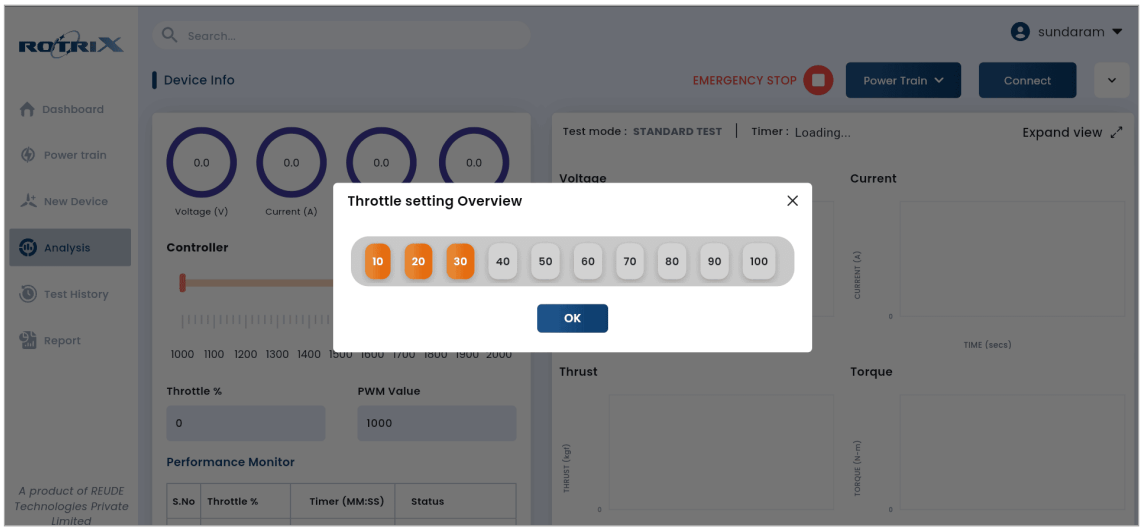

Figure 25: Standard Test sequence selection

- In case of an emergency, click the ‘Emergency Stop’ button on the top panel to immediately terminate the test.

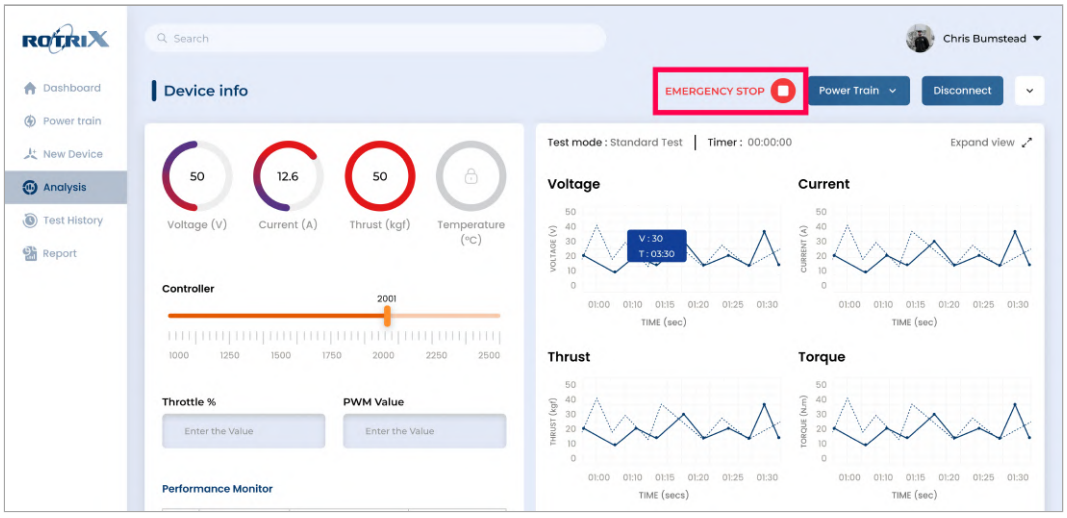

Figure 26: Emergency Stop option

8.4.2 Custom test (Point-Based Control)

- After selecting ‘Point-Based Control’, choose ‘Custom Test’ when prompted as in Figure 23. This mode allows you to create a custom throttle sequence with user-defined runtime.
- Enter the desired throttle percentage in the ‘Enter Throttle % Steps’ field, and set the duration for each step in the ‘Set Timer’ field. Use the ‘+’ icon to add more steps.

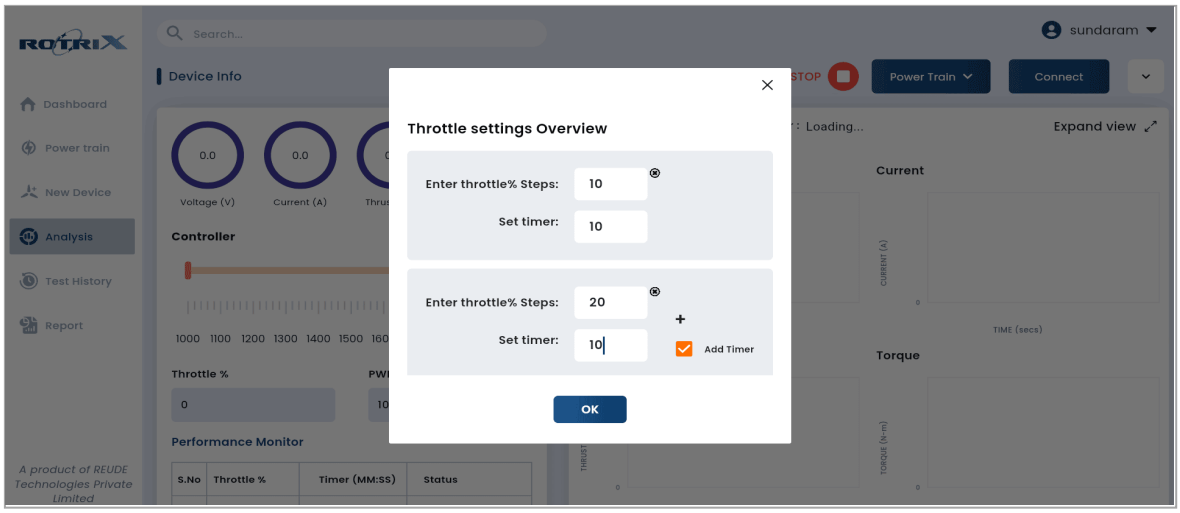

Figure 27: Custom test sequence creation

- Click ‘OK’ to start the test. The motor will follow the defined sequence and automatically stop once the final step is executed. Users can use ‘Emergency Stop’ if the test needs to be halted at any point.

8.4.3 Free Control

- To use Free Control mode, select 'Free Control' option when prompted during test mode selection as in Figure 23. This mode enables real-time manual control of the motor throttle throughout a fixed-duration test session.

You can control the motor in two ways:

- ESC PWM Slider: Use the ‘Controller’ slider on the left panel to adjust the ESC PWM signal within the defined min–max range set during powertrain configuration.
- Throttle Percentage Input: Enter a specific throttle percentage directly into the ‘Throttle %’ field on the left panel.

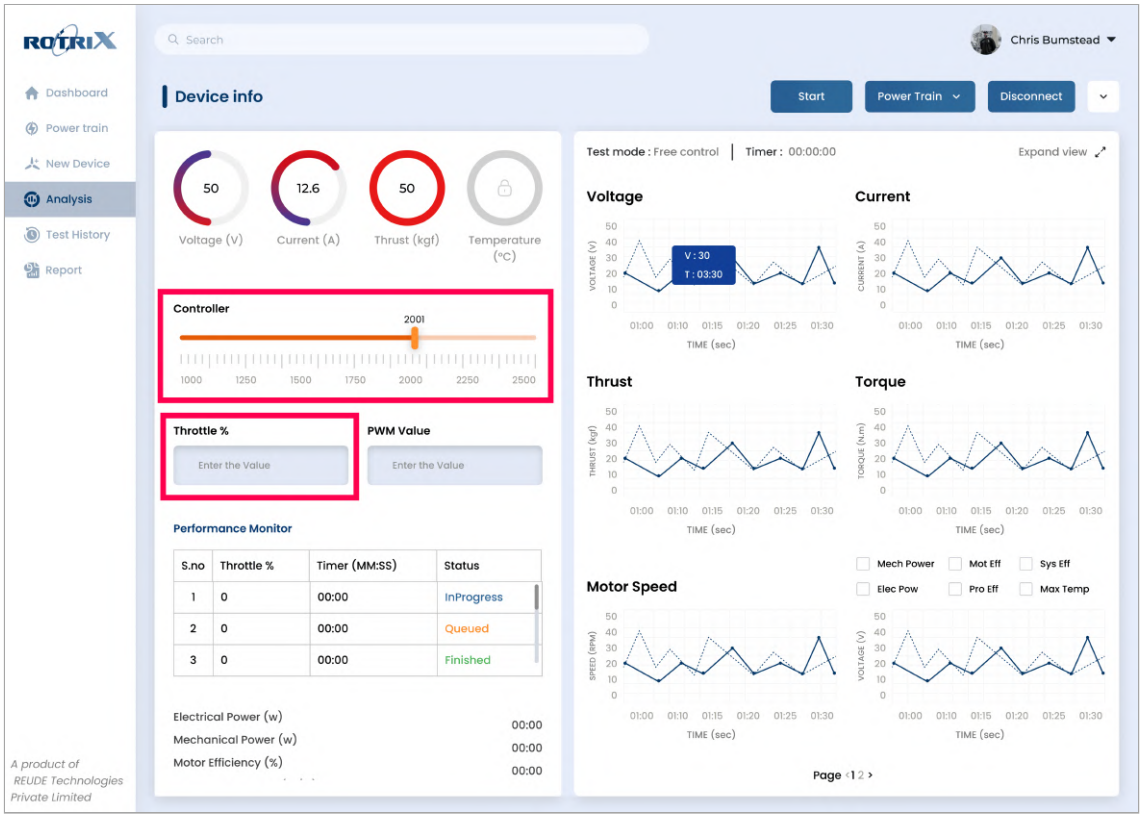

Figure 28: Free Control test input modes

- After selecting your input throttle %, click the ‘Start’ button on the top panel to begin the test.

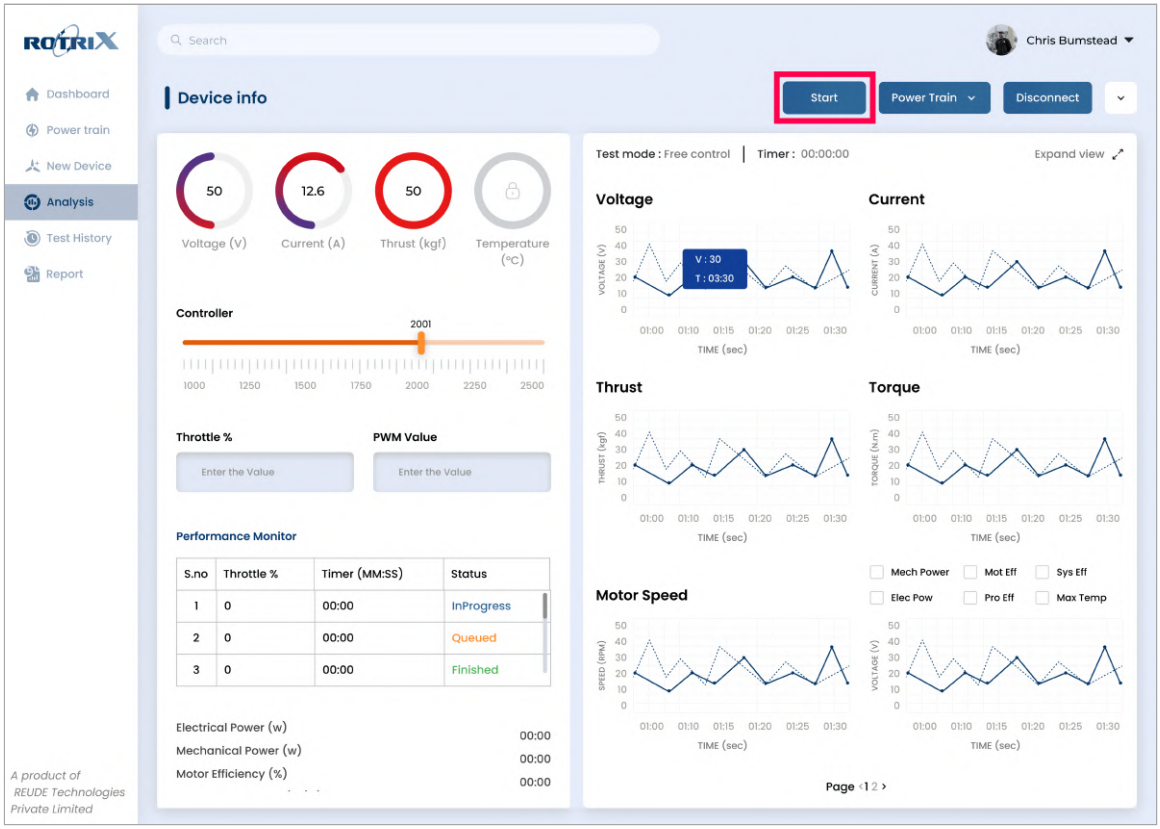

Figure 29: Free control test - Start test

- As the test runs, users can continue entering new throttle values via the slider or Throttle %

field. Once you enter a new throttle value, click 'Apply' on the top panel to send the throttle signal to ESC.

- When you're ready to end the session, click the 'Stop' button (which replaces 'Start' once testing begins).

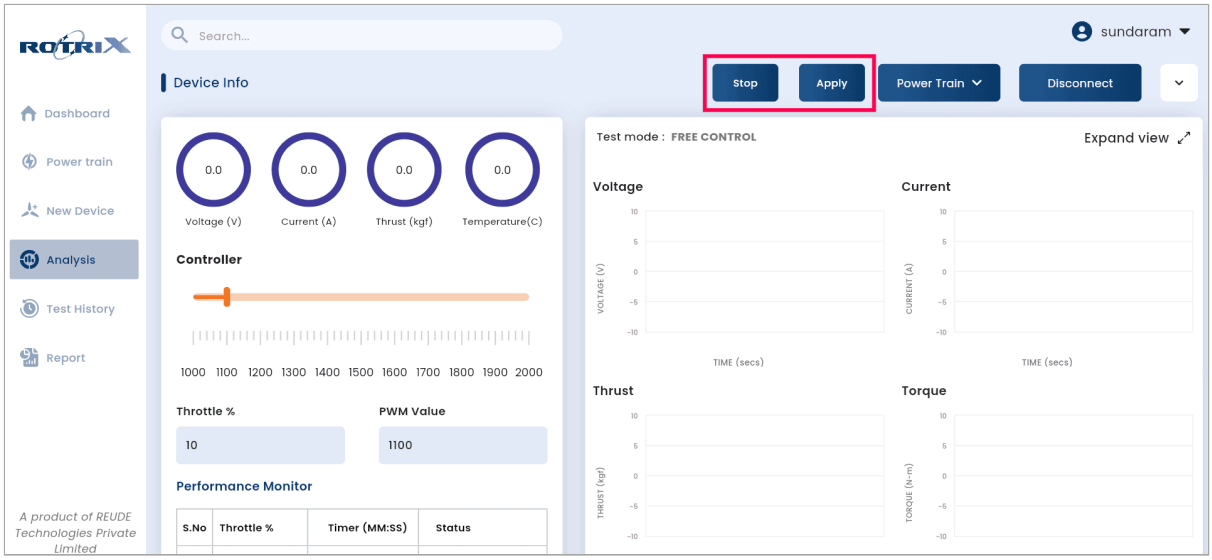

Figure 30: Free control test - Stop test

9 Data Analysis and Visualization

From basic parameter monitoring to advanced graphical inspection, the 'Analysis' page serves as the central hub for interpreting live sensor data and calculated performance metrics during testing. This section outlines the tools and visual elements available for data analysis, empowering users to make informed decisions about system behavior, efficiency, and safety.

9.1 Real-Time Parameter Monitoring

During active testing, RotriX captures a wide range of input signals and sensor data from the connected powertrain. The data obtained by the platform is organized below in clearly defined categories for easier interpretation:

Input Data:

- Throttle Percentage / ESC PWM Value – Indicates the power input sent to the ESC in real time.

Sensor Outputs:

- Electrical Measurements:
  - Voltage – Instantaneous battery voltage (V).
  - Current – Real-time current drawn by the motor (A).
- Mechanical Measurements:
  - Motor Speed – Rotational speed of the motor (Revolutions Per Minute).
  - Thrust – Generated thrust by the motor-propeller system (kgf / lbf).
  - Torque – Output torque from the motor shaft (Nm / lb-in).
- Environmental Data:
  - Temperature – Captured from up to six thermal probes placed at user-defined positions on the motor or ESC (°C) .
  - Thermal Vision – A graphical thermal map obtained from an optional thermal

camera, offering spatial heat distribution for visual diagnostics.

Calculated Parameters:

Based on real-time sensor data, RotriX continuously computes critical performance metrics:

- Electrical Power (W) – Derived from voltage × current.
- Mechanical Power (W) – Based on torque and RPM.
- Motor Efficiency (%) – Ratio of mechanical output to electrical input.
- Propeller Efficiency (gf/W) – Thrust produced per watt of electrical power.
- Overall System Efficiency (gf/W) – Overall efficiency of the powertrain.

For details on sensor interfacing and formulas used for parameter calculations, please refer to the Firmware Manual.

9.2 Performance Monitor

Located on the left panel of the Analysis page, the Performance Monitor gives a live view of active test progress and system behavior. It includes two main sections: Throttle Sequence Updates and Calculated parameters.

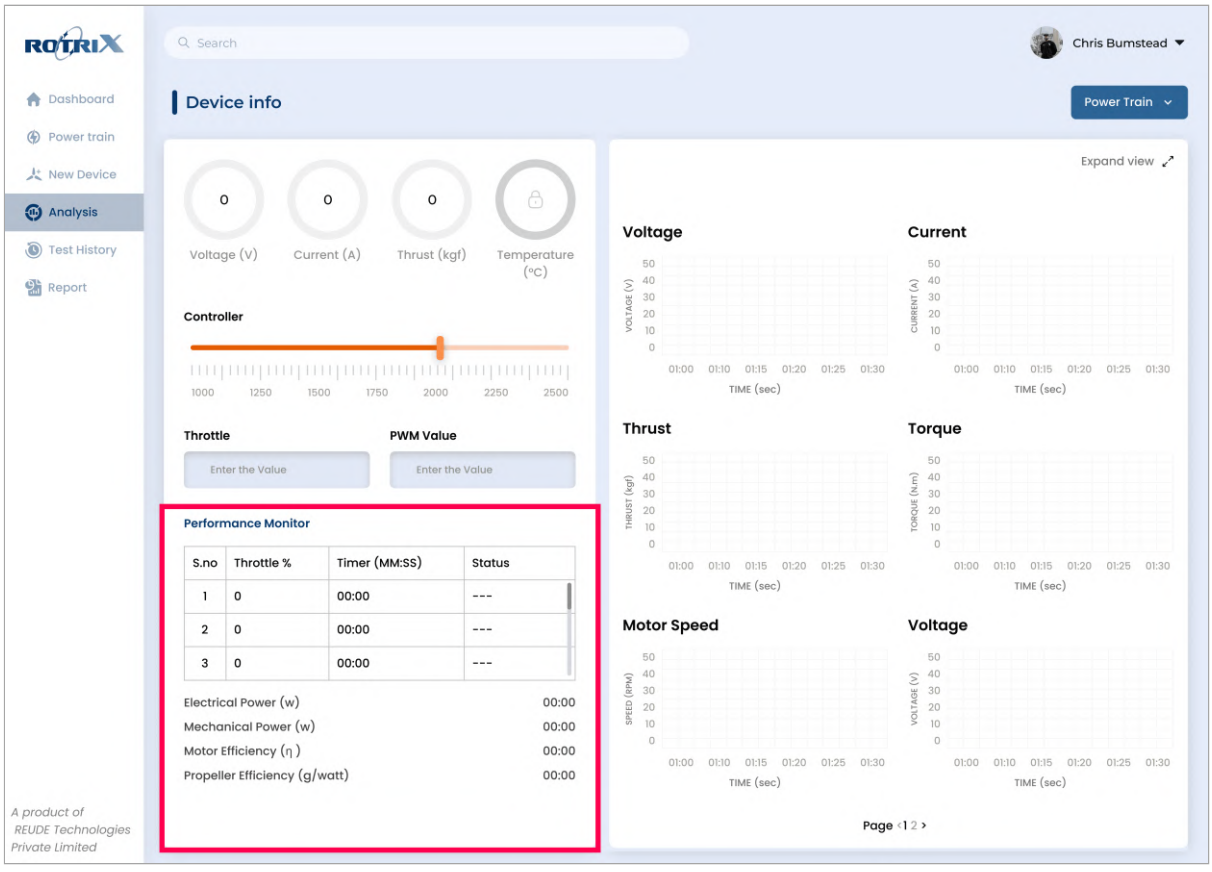

Figure 31: Performance Monitor

9.2.1 Throttle Sequence Updates

This section displays the throttle sequence being executed. Once your motor test (Standard, Custom, or Free Control) has started, the 'Throttle Input Table' will automatically begin displaying test progress.

- For Standard and Custom Tests: The table lists the throttle percentage steps that were

preconfigured before starting the test.

- For Free Control Tests: The table logs each throttle update entered during the test session.

Each throttle step is marked with a color-coded status:

- Queued – Upcoming throttle steps (Orange-colored).
- In Progress – The currently running step (Blue-colored).
- Finished – Steps that have already executed (Green-colored).

along with a timer showing the elapsed duration of each step.

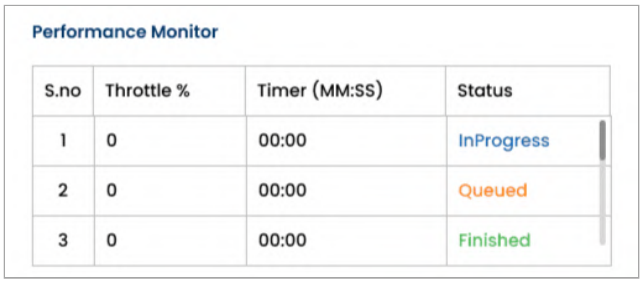

Figure 32: Throttle Input table

9.2.2 Calculated Parameters

Continuously updated as sensor data is received during tests, this section displays values for Electrical and Mechanical Power, Motor Efficiency, Propeller Efficiency, and System Efficiency in real time, giving users immediate feedback on motor performance under test conditions.

Figure 33: Calculated Parameters

9.3 Graphical Tools and Visualization

On the right panel of the 'Analysis' page, RotriX provides dynamic graphing tools to visualize motor and environmental parameters. Two visualization modes are supported for flexible exploration: Compact view and Expand view.

Users can toggle between Compact and Expand views using the ‘Compact/Expand’ icon located at the top-right corner of the right panel.

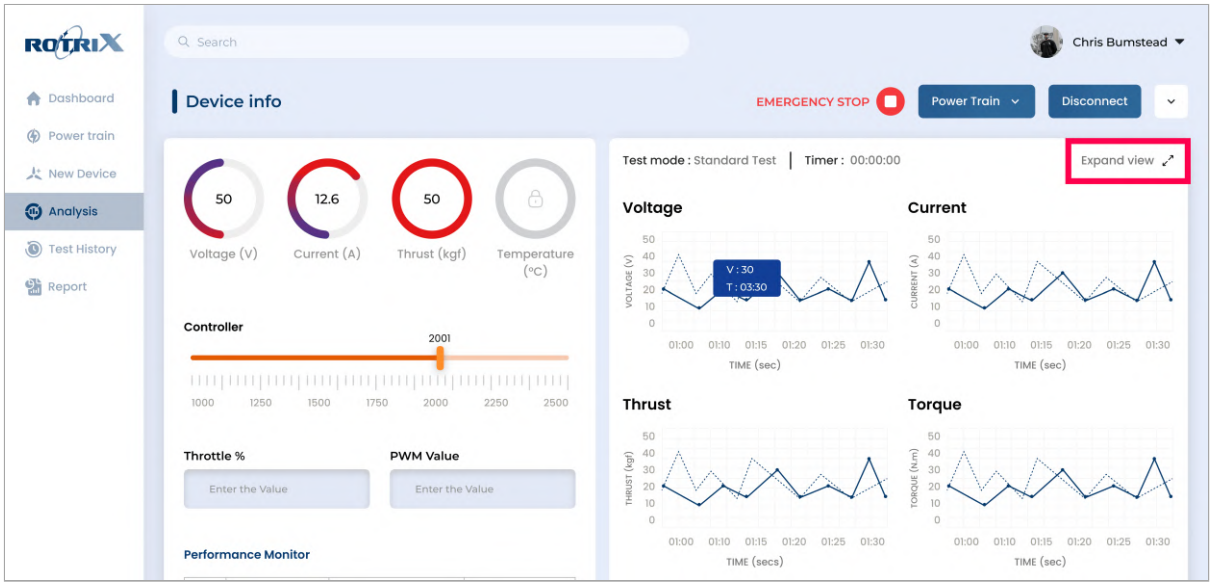

Figure 34: Graphical view - Compact / Expand toggle

9.3.1 Compact View

A multi-panel dashboard designed for simultaneous viewing of key parameters. This mode is divided into two subpages:

Page 1 - Displays five real-time scatter plots for Voltage, Current, Thrust, Torque, and RPM. A sixth graph slot is user-selectable, allowing users to choose from calculated parameters such as Electrical Power, Mechanical Power, Motor Efficiency, Propeller Efficiency, or System Efficiency.

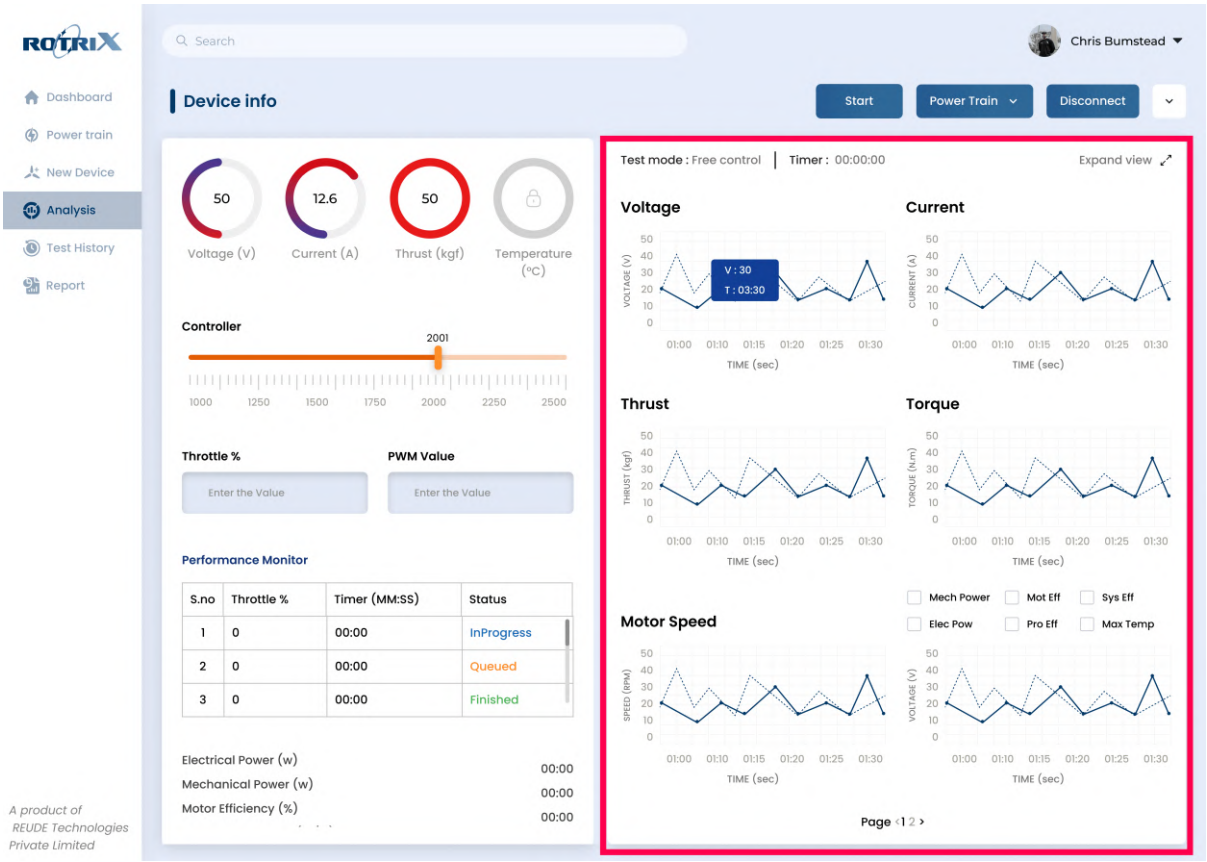

Figure 35: Compact view - Primary parameters

Page 2 - Visualizes up to six temperature readings from thermal probes. Users can toggle individual plots via legend checkboxes. Additionally, thermal camera data is rendered as a heatmap for a broader overview of motor temperature distribution, aiding in anomaly detection and identifying localized overheating.

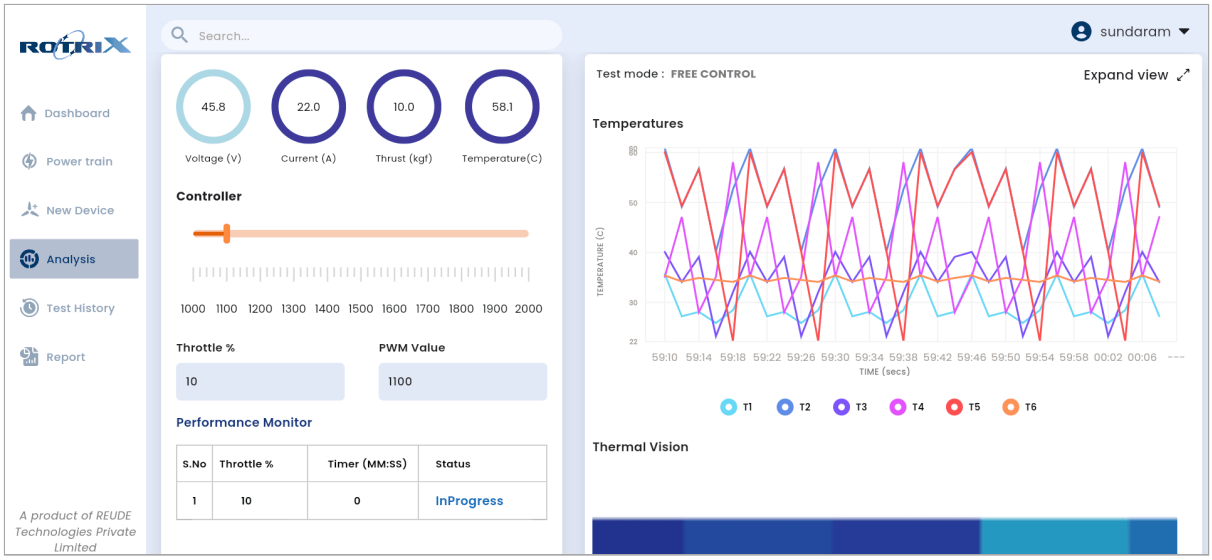

Figure 36: Compact view - Temperature monitoring

9.3.2 Expand view

A full-screen mode for in-depth analysis of individual graphs.

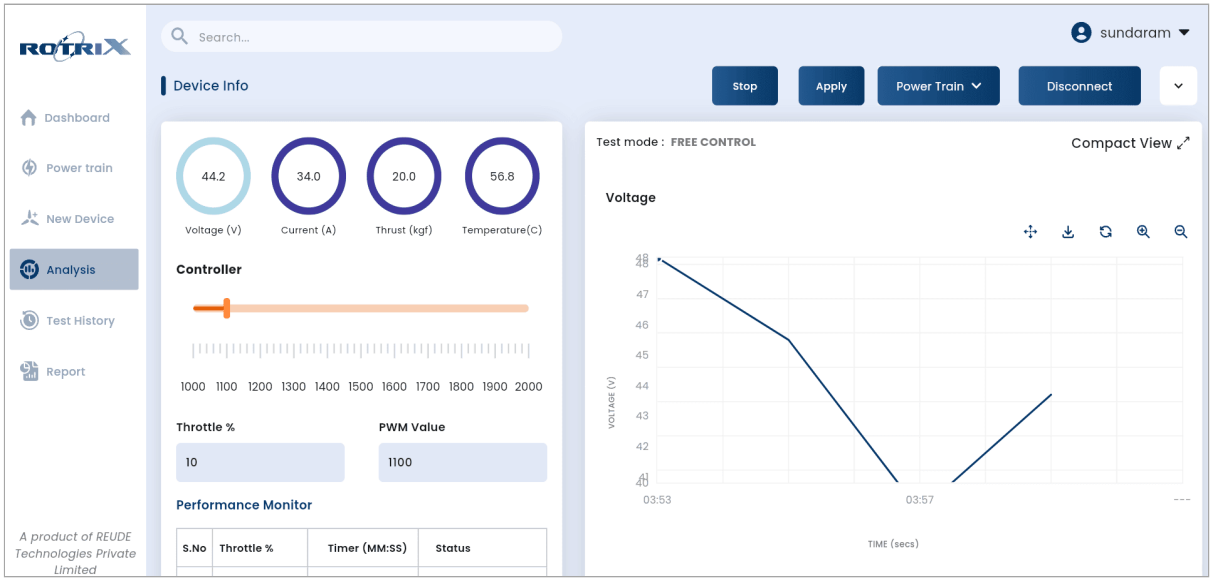

Figure 37: Expand view

Each parameter graph supports advanced features, including:

- Pan Tool – Navigate along the timeline or axes freely
- Download – Export the graph as an image
- Reset View – Restore default graph settings instantly
- Zoom In/Out – Focus on specific data ranges

Figure 38: Interactive graphical features

The graphs, in both Compact and Expand views, also include interactive features such as,

- Hovering over any graph displays the x-axis (time) and y-axis (value) of the selected data point.
- Users can scroll inside any graph to zoom in or out on the time axis, enabling closer inspection of specific events.

9.4 Safety indicators

Safety is a core element of the testing environment. The left panel of the 'Analysis' page includes four live safety indicator dials that monitor the most critical real-time parameters:

- Voltage
- Current
- Thrust
- Temperature

These dials reflect threshold values defined during powertrain configuration. When a parameter stays within the safe range, the dial remains BLUE. If a value exceeds its threshold, the indicator turns RED, alerting the user to take appropriate action.

Additionally, for voltage, two limit levels are enforced:

- Threshold Voltage – Triggers a warning prompt, allowing users to decide whether to continue or halt the test.
- Cut-Off Voltage – If reached, the test will automatically stop to prevent damage to the battery or system.

10 Data Storage and Reports

10.1 Test History

The Test History page provides a comprehensive log of all motor tests conducted on powertrains within the platform. For each test, key metadata is recorded and displayed to help users track performance, analyze historical trends, and manage testing workflows effectively.

The following metadata fields are available for every test entry:

- Test ID – A unique identifier generated each time the software connects to the firmware until disconnection.
- Product Name – The name of the product being tested.
- Device Name – The registered name of the device used during the test.
- Date – The date the test was performed.
- Test Count – The number of throttle steps executed during the test. Each step is individually logged as part of the overall sequence.
- Time – The total duration for which the test was run.
- Result – A Pass/Fail outcome manually entered by the user based on the observed test results.

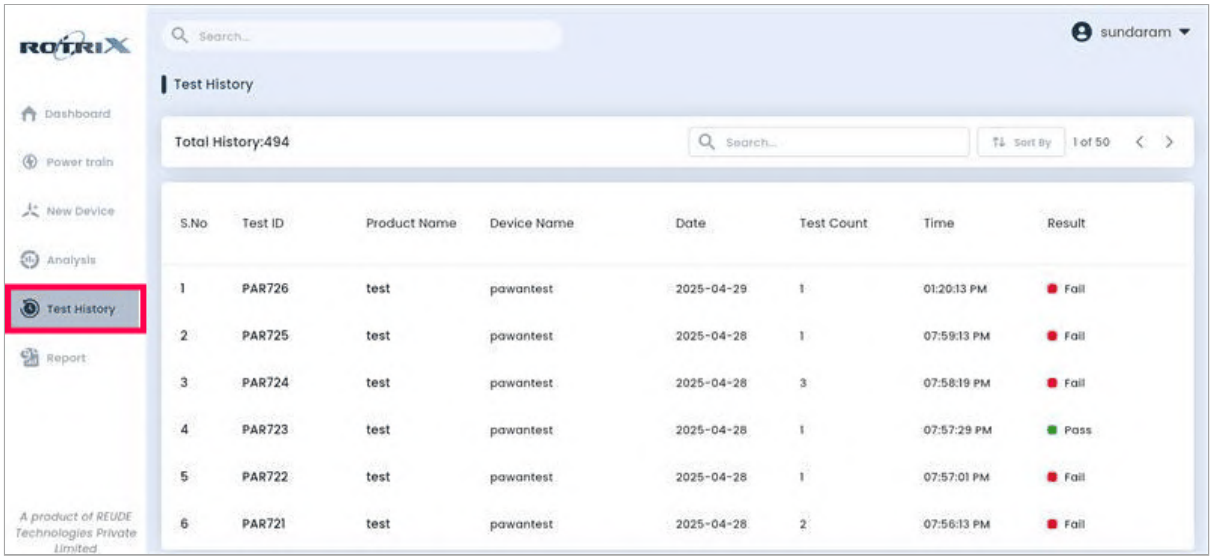

Figure 39: Test history page

By clicking on a specific test entry, users can access detailed insights such as interactive graphs, data trends, and performance metrics related to that test. This helps in comparing results over time and identifying consistent behaviors or anomalies.

To streamline data exploration, the 'Test History' page includes two useful options:

- 'Sort by' icon: Organize the test log based on test IDs.
- 'Search' icon: Use the search bar to quickly locate a specific test by entering a Test ID, device name, or product name.

These features make it easy to navigate through extensive test records and focus on the data that matters most.

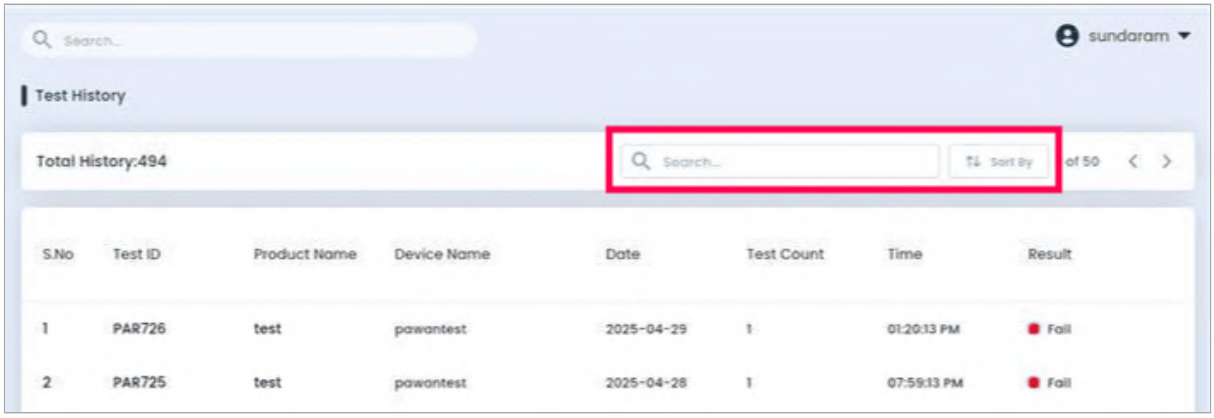

Figure 40: Test history - selection features

10.2 Report Generation

RotriX supports structured and automated generation of test reports, enabling users to archive and analyze historical performance data with ease. Reports are generated in CSV format, making them compatible with standard spreadsheet and data analysis tools for further evaluation or documentation.

To generate a report,

- Navigate to the ‘Report’ Page from the navigation panel
- Select the 'Device Type' from the dropdown menu for which the test data should be exported.
- Specify the date range within which the tests were conducted. Only tests falling within this

time window will be included in the report.

- Once the device and date range are selected, click the ‘Export’ icon. A CSV file containing the filtered test data will be generated and downloaded to your system. You may choose a destination folder to save the file.

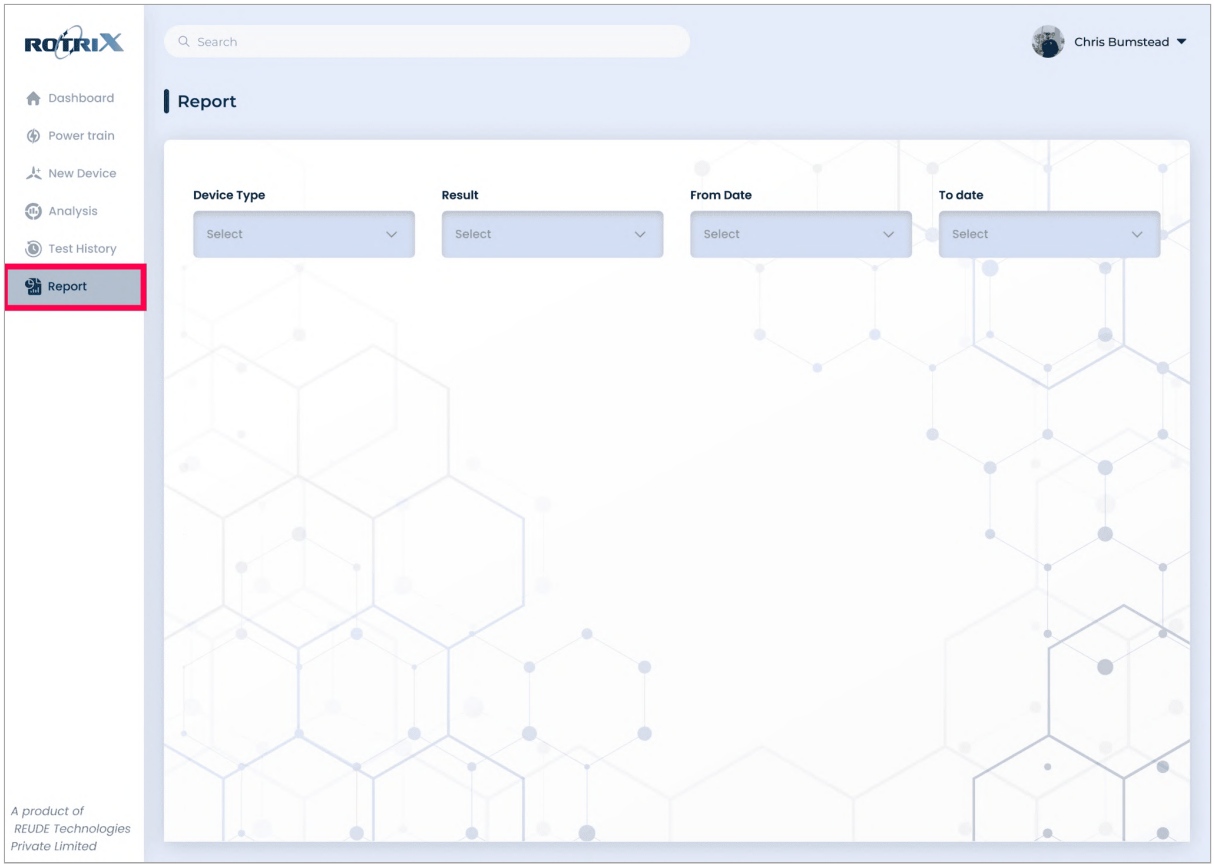

Figure 41: Report page

11 Technical Support

For detailed information on the required sensor data used in RotriX testing, as well as the data format exchanged between the software and firmware, refer to Appendix A - Firmware Development for RotriX.

Comprehensive guidelines on hardware integration, sensor specifications, and the firmware development process are available in the official RotriX Github page.

If you encounter persistent issues or require further assistance, please reach out to the REUDE Technologies Pvt. Ltd. technical support team through the following channels:

- Phone : +91 6384667822
- Email : support.rotrix@reude.tech
- WhatsApp Community : Join ROTRIX India on WhatsApp to post queries, share feedback, and engage with the user community in real time. Alternatively, you can scan the below QR code to join our WhatsApp community.

We are committed to helping you get the most out of the ROTRIX platform.

12 Appendix A - Firmware Development for RotriX

The firmware acts as the bridge between the hardware and the RotriX application, enabling the acquisition, processing, and transmission of sensor data for real-time analysis and testing. This section outlines how to develop firmware that ensures reliable data transmission and compatibility with the application.

The firmware must be designed to process sensor outputs into predefined formats and units that the software can interpret accurately. Although users may choose different sensors depending on their specific setup, the output data must conform to the standardized formats and structures detailed in the following sections to ensure seamless operation.

A reference firmware source code is available here along with a sample circuit diagram illustrating the integration of multiple sensors supported by the source code in here.

12.1 Hardware Requirements

The following hardware components are required to collect motor and environmental performance data for use with RotriX.

- Microcontroller Board (Arduino-compatible)
- Motor Test bed — Supports motor, propeller, and sensor mounting.
- Electronic Speed Controller (ESC)
- Thrust Load Cell — Measures motor thrust output.
- Torque Load Cell(s) — Measures shaft torque.
- Load Cell Amplifiers — Amplify sensor signals for processing.
- Speed Sensor — Captures motor RPM.
- Voltage and Current Sensor — Monitors electrical inputs.
- Temperature Sensors — Monitors motor/ESC temperature (up to six probes).
- Thermal camera — Optional for visual and thermal analysis.

A detailed list of suggested hardware options is available here.

Note: Users are not required to use all components listed below. Depending on the objectives of your experiment or testing scenario, you may choose a subset of sensors that best suit your requirements. The ROTRIX platform is designed to support flexible sensor configurations.

12.2 Software

Two primary software environments are required for developing and running the firmware:

- Arduino IDE — Used to develop, compile, and flash the firmware to the microcontroller.
- Python 3 — Required for backend communication between the microcontroller and the RotriX application.

Both hardware and software must be configured correctly to ensure accurate sensor readings and reliable communication.

12.3 Sensor data formats

The outputs from the sensors listed in the hardware section must be processed into specific data types and formats to match the RotriX software’s requirements. Accepted formats and units for each sensor type are provided in Table 1.

Proper adherence to these formats is essential for real-time analysis, parameter calculations, and safety monitoring within the RotriX application.

Sensor	Final values needed for software	Metric Units	Imperial units	Datatype
Thrust load cell	Current thrust measured	kgf	lb	float
Torque load cell	Current torque measured	Nm	lb-in	float
Speed sensor	Current RPM of motor	RPM	RPM	float
Voltage sensor	Current battery voltage	V	V	float
Current sensor	Battery current drawn	A	A	float
Single-point Temperature sensor (Thermocouple)	Current temperature value measured. Should be an array of size 1	℃	℉	float
Thermal camera	Current temperature array. Can be an array of sizes 32x24 (or) 320x240 (or) 640x480	℃	℉	float
Electronic Speed Controller	PWM value			float

Table 1. Final sensor data format needed for software

12.4 Output data to software

Firmware must send serial data to the RotriX application in a predefined order and format to ensure correct parsing and analysis.

Important Guidelines:

- Serial communication must operate at 115200 baud.
- Each data field must be separated by the delimiter - comma (,).
- Data must be transmitted in the exact sequence outlined in the corresponding data table.
- Fields marked with an asterisk (*) indicate parameters that are available based on the user's subscription plan.
- If a particular sensor is not present or used, a '0' value must be sent in its place.

Parameter	Values to be sent	Datatype	Size	Sample data
Device ID	User-defined identifier provided during powertrain creation	String	1	REU-MTB-001
Current PWM value	Latest PWM value sent to ESC	float	1	1100
RPM	Latest RPM value of the motor	float	1	1500
Current	Current drawn by motor, in Amps	float	1	40

Voltage	Latest voltage of the battery, in Volts	float	1	50
Thrust	Latest thrust value measured	float	1	15
Torque	Latest torque value measured	float	1	5
Thermocouple 1	Temperature measured at the Setup	float	1	28.5
Thermocouple 2*	Temperature measured at the Setup	float	1	40.2
Thermocouple 3*	Temperature measured at the Setup	float	1	32.5
Thermocouple 4*	Temperature measured at the Setup	float	1	29.3
Thermocouple 5*	Temperature measured at the Setup	float	1	46.3
Thermocouple 6*	Temperature measured at the Setup	float	1	39.8
Ambient temperature	Ambient temperature at the setup area	float	1	30
Thermal data*	An array of temperature values (image[height][width]) from a thermal camera	float	32 x 24 (or) 320x240 (or) 640x480	img[32][24]

Table 2. Data order in which data needs to be sent by firmware

A sample instance of the correctly formatted data to be sent by the firmware can be viewed here.

12.5 Input data from software

The RotriX application also sends control inputs back to the firmware via serial communication to manage motor operation and testing procedures. The firmware must be programmed to interpret and act upon the following incoming data fields:

- ESC Input Values — Control the motor throttle during tests.
- ESC Calibration Limits — Ensure motor control operates within safe PWM limits.
- Number of Propeller Blades — Used for accurate RPM calculation based on sensor input.

The input data must also follow the specified order and delimiter rules to maintain synchronization between the software and firmware.

The input data to Arduino from software will be the following data in the corresponding order,

Parameter	Values to be sent	Datatype	Size	Sample data
No.of.propeller blades	No.of propeller blades value set by user during powertrain setup in software	String	1	2
Minimum PWM value	Minimum ESC calibration value set by user during powertrain setup in software		1	1000

Maximum PWM value	Maximum ESC calibration value set by user during powertrain setup in software		1	2000
User input PWM to ESC	The latest PWM value (throttle value) set by user in the software for testing		1	1300

Table 3. Data order in which data will be sent to firmware

A sample of the data that will be sent to the firmware can also viewed here.

For detailed information on hardware implementation, sensor specifications, sample input/output data formats, please visit our official GitHub page [here].