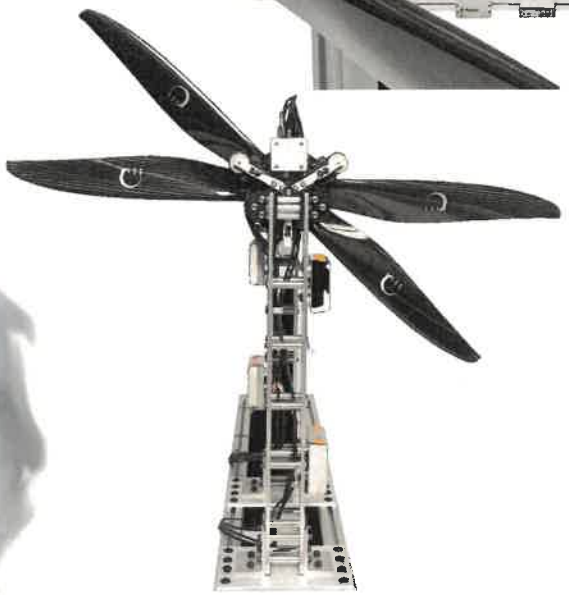
División Investigación

Sidilab + TYTO ROBOTICS

Propeller Testing
Drone Testing
Brushless Motor Testing
Motor Heat Testing
Drone Maintenance
and Quality Testing
Propeller
Wind Tunnel
Testing



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TYTO ROBOTICS

Flight Stand 15 Datasheet
Document ID: FSF015
V2.0 2022-10-07

Flight Stand 15

High-precision professional test stand

Introduction

The Flight Stand 15 test stand allows you to precisely characterize and evaluate the performance of your motors and propellers by measuring thrust, torque, RPM, current, voltage, temperature, airspeed*, propeller efficiency and motor efficiency.

This test stand is the result of five years of experience developing propulsion testing systems and refining our equipment based on feedback from thousands of clients.

Description

Several versions of the Flight Stand 15 (FS15) are available:

- **FS15 Standard:** has our essential performance characteristics for static tests over our standard range of values
- **FS15 Pro:** has enhanced performance characteristics for designers wanting to perform dynamic tests over a wider range of values with the highest possible accuracy. Supports higher sampling rate and two extra general purpose analog inputs.
- **FS15 Dual motor (available in Standard or Pro):** Two powertrains tested simultaneously in one of three configurations: back-to-back, face-to-face, or offset (below).

- **Multi-powertrain version:** designed for distributed electric propulsion (DEP) testing - record the performance of up to 4 powertrains simultaneously*

* Optional feature planned to be released at the end of 2022

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TYTO ROBOTICS

Flight Stand 15 Datasheet
Document ID: FSF015
V2.0 2022-10-07

Technical Specifications

	Specification	Standard	Pro
Basic Information	Storage temp & humidity	23°C, 20% to 80% suggested	23°C, 20% to 80% suggested
	Operating temp & humidity	0°C to 40°C, 20% to 80% suggested	0°C to 40°C, 20% to 80% suggested
	Dimensions	28" x 12" x 6"	28" x 12" x 6"
	Input power / Output power	90 - 264 VAC, 1 A input adapts into 9 V, 2 A	90 - 264 VAC, 1 A input adapts into 9 V, 2 A
Measurement Information	Sampling rate	50 Hz	**1,000 Hz**
	Thrust calibration	Internal standard (26 points, push & pull)	**ASTM E74 standard (211 points, push & pull)**
	Torque calibration	Internal standard (30 points, CW & CCW)	**ASTM E2428 (213 points, CW & CCW)**
	Crosstalk calibration	Yes with 48 points	**Yes with 1056 points**
Recommended Test Range	Thrust	-15 to -5, or 5 to 15 kgf	**-15 to -3, or 3 to 15 kgf**
	Angular speed	400 to 30 000 RPM	400 to 30 000 RPM
	Resonant frequencies	Mode 1: 25.91 Hz Mode 2: 26.29 Hz Mode 3: 128.91 Hz [for a motor + propeller mass of 0.8 kg]	Mode 1: 25.91 Hz Mode 2: 26.29 Hz Mode 3: 128.91 Hz [for a motor + propeller mass of 0.8 kg]
	Propeller diameter	16" to 40"	**12" to 40"**
Voltage and Current	Voltage range	0 V to 180 V max	0 V to 180 V max
	Voltage resolution	0.001 V	0.001 V
	Voltage accuracy	1% measured value from 5 V to 180 V	1% measured value from 5 V to 180 V
	Current range	0 to 150 A	0 to 150 A
	Current resolution	0.001 A	0.001 A
	Current accuracy	1% from 5 A to 150 A	1% from 5 A to 150 A
Thrust	Range	±150 N	±150 N
	Resolution	0.05 N	**0.002 N**
	Accuracy	± 1.5 N	**±0.5% of measured value, with lower limit of ±20 N (± 0.1 to ± 0.75 N)**
	Temperature effect	±1.5 N per 10 degree Celsius	**±0.4 N per 10 degree Celsius**
Torque	Range	±8 Nm	±8 Nm
	Resolution	0.005 Nm	**0.001 Nm**
	Accuracy	± 0.1 Nm	**±0.75% of measured value, with lower limit of 1.2 Nm (± 0.01 to ± 0.06 Nm)**
	Temperature effect	±0.5 Nm per 10 degree Celsius	±0.15 Nm per 10 degree Celsius
RPM Sensor	Range	0 to 30 000 RPM	0 to 30 000 RPM
	Operating environment	Indoor	Indoor
	Accuracy	±1 RPM	±1 RPM
Temperature	PT100	-30 °C to 100 °C, ±2 °C	-30 °C to 100 °C, ±2 °C
General analog inputs	Range	N/A	**2 inputs of ±10 V differential.**
	Resolution	N/A	**0.001 V**
	Accuracy	N/A	**±0.5% of measured value ±0.1 V**
	Supply pin	N/A	**5 V ± 0.1 V 30 mA max**

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Applications

Below is a non-exhaustive list of possible applications for the Flight Stand 15:

- **Real-time dynamic testing:** made possible by the FS15 Pro's 1,000 Hz sampling rate. Perform frequency and step input parameter identification.
- **Flight replay:** upload your flight controller data to the software and recreate your throttle input while your propulsion system is hooked up to the test stand.
- **Efficiency and power characterization:** measure the efficiency of your motor, propeller and overall system and compare electrical power input with mechanical power output.
- **Endurance and reliability testing:** study the endurance of your system's components using automated tests designed by you. Our user-friendly testing interface allows you to easily design and run step tests, ramp tests, flight replay tests, or any protocol you can come up with.
- **Distributed electric propulsion (DEP) testing:** test up to 4 powertrains simultaneously* for a comprehensive understanding of your multirotor's performance. Data is recorded for each individual powertrain as well as the system as a whole.

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Advantages

Here's why the Flight Stand is the best propulsion testing tool on the market:

- **Frictionless measurement:** our tools have a solid-state system for measuring thrust and torque, meaning there are no moving parts between the motor and load cells. This design significantly improves the accuracy of measurements and eliminates the need for bearings and hinges, which cause friction and are prone to misalignment.
- **ASTM Calibration:** our test stands are rigorously calibrated to ASTM standards to ensure maximum measurement precision. Thrust is calibrated with the 211-point ASTM E74 procedure and torque is calibrated with the 213-point ASTM E2428 procedure.
- **Ultra compact design:** the compact shape of the Flight Stand ensures that there is minimal airflow disturbance from the tool's hardware and wiring. This promotes more realistic measurements and testing conditions that more closely mimic flight.
- **Realistic dual motor testing:** it is possible to perform dual motor tests in 3+ configurations with the Flight Stand, each representing a different aircraft design. In the back-to-back testing configuration, the motors are separated by a distance as little as 91 mm, similar to the distance you'd have in a multicopter.
- **Superior software experience:** our software allows you to perform manual or automated tests with no programming required. We also offer a Python API and data management system with index, plots, tables, filtering and resampling capability.
- **Exceptional customer support:** our team is ready to respond to any questions you may have in a friendly and timely manner.

Award Winning

In 2022, the Flight Stand won the Regional Innovation Award from the Order of Engineers of Quebec, thanks to its ground-breaking design and capabilities.

Test with confidence with the Flight Stand 15.

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Hardware and Electronics

The Flight Stand 15 comes fully equipped with software, hardware and electronics. Here's what's included with your Flight Stand:

Flight Stand 15:

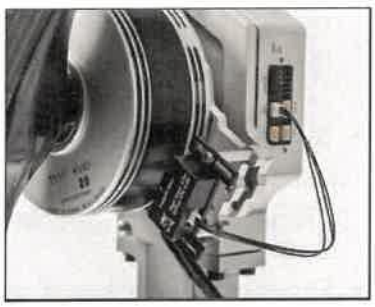
- Force Measurement Unit (15 kgf /8 Nm) (1x): measures thrust and torque
- Electric Measurement Unit (180 V - 150 A) (1x): measures current and voltage
- Tubular structure (1x): supports the FMU and propulsion system, protects wiring
- Sync Hub (1x): connects the test stand to the software
- Temperature probes (2x): records the temperature at the desired location
- Optical RPM probe (1x): provides a precise measurement of the motor's rotation speed
- Flight Stand Software

Flight Stand 15 Dual Motor:

- 2x everything listed under Flight Stand 15 (except sync hub - only 1 needed for 2 FMUs)
- Dual motor fixture kit: ground rails and hardware for securing Flight Stands

Tubular Structure (Pro)

Electrical Measurement Unit (Pro)



Optical RPM Probe

Sync Hub

Force Measurement Unit with Motor Mounting Plate

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Software

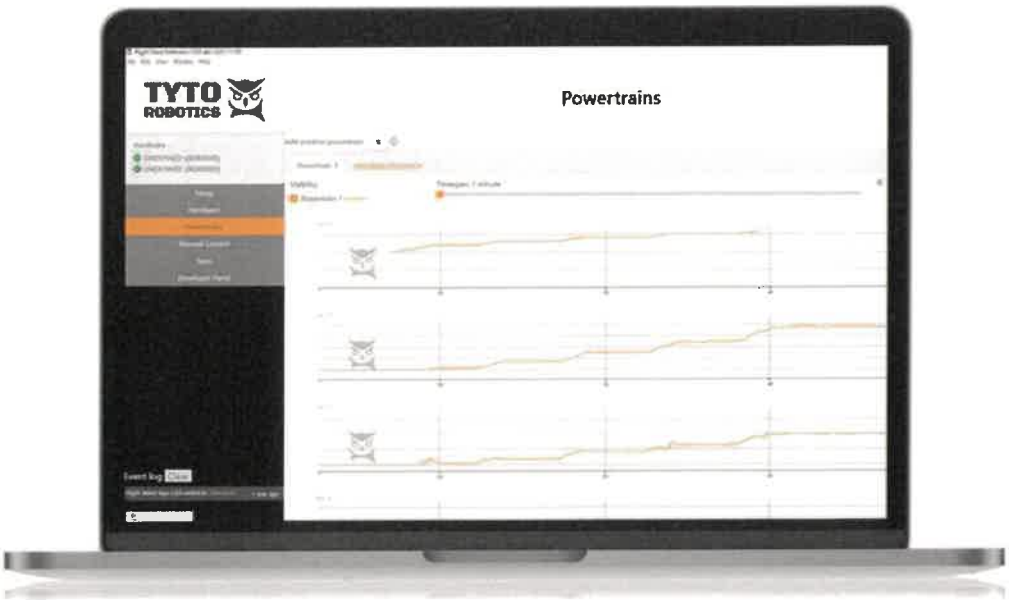
The Flight Stand Software is used to control your test stand and record your data. If you prefer to manually control your tests, you can enter throttle values in a front-end table. If you prefer to automate your tests, you can create a script directly in the UI or use the Python API to control the entire software. The protocols supported include:

ESC:
Standard PWM: 50, 100, 200, 300, 400, 490 Hz
Dshot: 150, 300, 600
Oneshot: 42, 125
Multishot

Servos:
Standard PWM: 50, 100, 200, 300, 400, 490 Hz

With the Flight Stand Software you can:

- Control the test stand manually and view live data as it is recorded
- Automate tests with an easy-to-use interface that requires no programming
- Control the whole system from a Python API
- Upload .CSV files from your flight controller to perform flight replay tests
- Save tests directly in the software and/or export them as .CSV files
- Re-sample data for smaller files and adjust sensor noise filtering
- Map and test up to four powertrains simultaneously (DEP testing)



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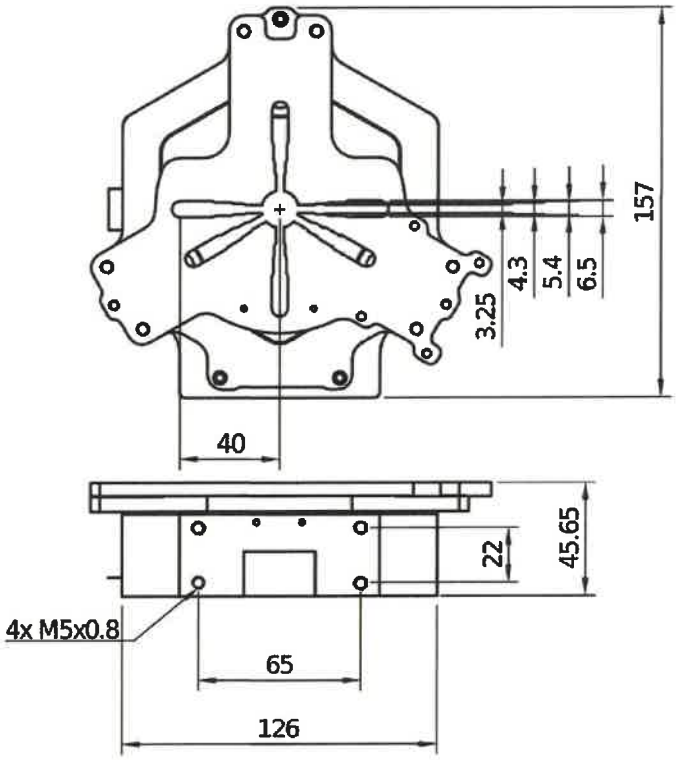
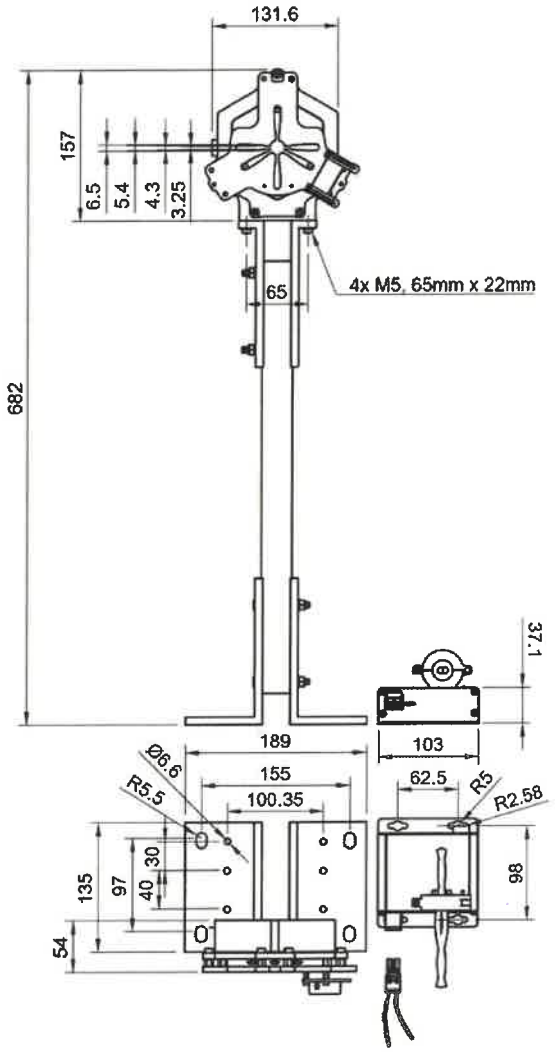
Technical Drawings

Force Measurement Unit:



Stand Components:



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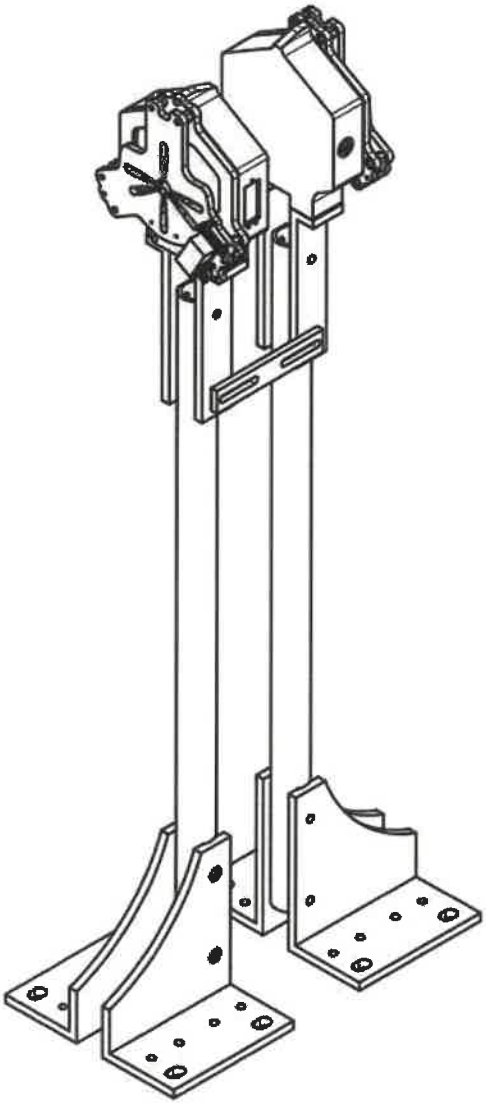
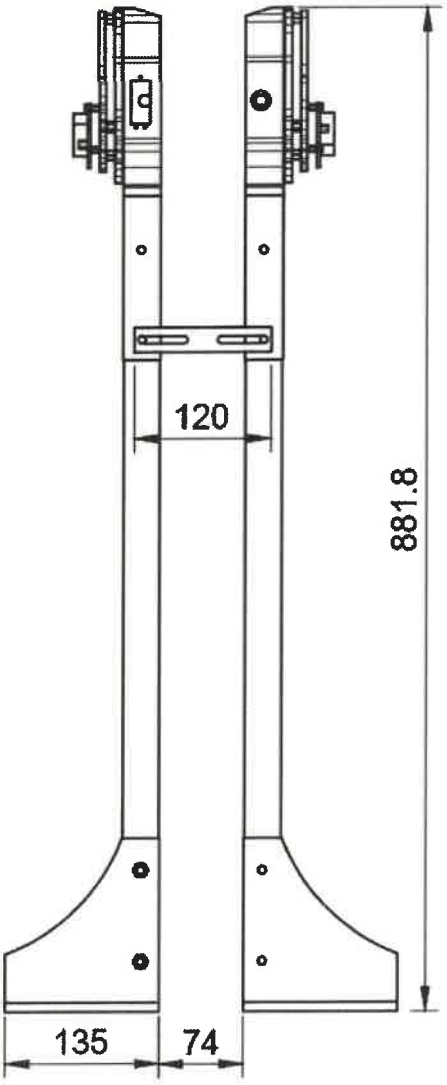
Technical Drawings - Dual Motor Configurations

Dual Motor Configurations:
(Note that many configurations are possible and at different separation distances)





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TYTO ROBOTICS

Flight Stand 50 Datasheet
Document ID: FSFI50
V2.0 2022-10-07

Flight Stand 50

High-precision professional test stand

Made in Canada

Introduction

The Flight Stand 50 test stand allows you to precisely characterize and evaluate the performance of your motors and propellers by measuring thrust, torque, RPM, current, voltage, temperature, airspeed*, propeller efficiency and motor efficiency.

This test stand is the result of five years of experience developing propulsion testing systems and refining our equipment based on feedback from thousands of clients.

Description

Several versions of the Flight Stand 50 (FS50) are available:

- **FS50 Standard:** has our essential performance characteristics for static tests over our standard range of values
- **FS50 Pro:** has enhanced performance characteristics for designers wanting to perform dynamic tests over a wider range of values with the highest possible accuracy. Supports higher sampling rate and two extra general purpose analog inputs.
- **FS50 dual motor (available in Standard or Pro):** Two powertrains tested simultaneously in one of three configurations: back-to-back, face-to-face, or offset (below).

- **Multi-powertrain version:** designed for distributed electric propulsion (DEP) testing - record the performance of up to 4 powertrains simultaneously*

* Optional feature planned to be released at the end of 2022

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TYTO ROBOTICS

Flight Stand 50 Datasheet
Document ID: FSFI50
V2.0 2022-10-07

Technical Specifications

	Specification	Standard	Pro
Basic Information	Storage temp & humidity	23°C, 20% to 80% suggested	23°C, 20% to 80% suggested
	Operating temp & humidity	0°C to 40°C, 20% to 80% suggested	0°C to 40°C, 20% to 80% suggested
	Dimensions	28" x 12" x 6"	28" x 12" x 6"
	Input power / Output power	90 - 264 VAC, 1 A input adapts into 9 V, 2 A	90 - 264 VAC, 1 A input adapts into 9 V, 2 A
Measurement Information	Sampling rate	50 Hz	**1,000 Hz**
	Thrust calibration	Internal standard (26 points, push & pull)	**ASTM E74 standard (211 points, push & pull)**
	Torque calibration	Internal standard (30 points, CW & CCW)	**ASTM E2428 (213 points, CW & CCW)**
	Crosstalk calibration	Yes with 48 points	**Yes with 1056 points**
Recommended Test Range	Thrust	-50 to -15, or 15 to 50 kgf	**-50 to -10, or 10 to 50 kgf**
	Angular speed	400 to 30 000 RPM	400 to 30 000 RPM
	Resonant frequencies	Mode 1: 17.76 Hz Mode 2: 18.10 Hz Mode 3: 56.85 Hz [for a motor + propeller mass of 3 kg]	Mode 1: 17.76 Hz Mode 2: 18.10 Hz Mode 3: 56.85 Hz [for a motor + propeller mass of 3 kg]
	Propeller diameter	26" to 50"	**20" to 50"**
Voltage and Current	Voltage range	0 V to 180 V max	0 V to 180 V max
	Voltage resolution	0.001 V	0.001 V
	Voltage accuracy	1% measured value from 5 V to 180 V	1% measured value from 5 V to 180 V
	Current range	0 to 300 A	0 to 300 A
	Current resolution	0.001 A	0.001 A
	Current accuracy	1% from 25 A to 250 A	1% from 25 A to 250 A
Thrust	Range	±500 N	±500 N
	Resolution	0.2 N	**0.02 N**
	Accuracy	± 5.0 N	**±1.0% of measured value, with lower limit of ±30 N (± 0.3 to ± 5.0 N)**
	Temperature effect	±1.5 N per 10 degree Celsius	**±0.4 N per 10 degree Celsius**
Torque	Range	±30 Nm	±30 Nm
	Resolution	0.01 Nm	**0.002 Nm**
	Accuracy	±0.375 Nm	**±1.0% of measured value, with lower limit of 1.6 Nm (± 0.016 to ± 0.08 Nm)**
	Temperature effect	±0.5 Nm per 10 degree Celsius	**±0.15 Nm per 10 degree Celsius**
RPM Sensor	Range	0 to 30 000 RPM	0 to 30 000 RPM
	Operating environment	Indoor	Indoor
	Accuracy	±1 RPM	±1 RPM
Temperature	PT100	-30 °C to 100 °C, ±2 °C	-30 °C to 100 °C, ±2 °C
General analog inputs	Range	N/A	**2 inputs of ±10 V differential.**
	Resolution	N/A	**0.001 V**
	Accuracy	N/A	**±0.5% of measured value ±0.1 V**
	Supply pin	N/A	**5 V ± 0.1 V 30 mA max**

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Applications

Below is a non-exhaustive list of possible applications for the Flight Stand 15:

- **Real-time dynamic testing:** made possible by the FS15 Pro's 1,000 Hz sampling rate. Perform frequency and step input parameter identification.
- **Flight replay:** upload your flight controller data to the software and recreate your throttle input while your propulsion system is hooked up to the test stand.
- **Efficiency and power characterization:** measure the efficiency of your motor, propeller and overall system and compare electrical power input with mechanical power output.
- **Endurance and reliability testing:** study the endurance of your system's components using automated tests designed by you. Our user-friendly testing interface allows you to easily design and run step tests, ramp tests, flight replay tests, or any protocol you can come up with.
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Advantages

Here's why the Flight Stand is the best propulsion testing tool on the market:

- **Frictionless measurement:** our tools have a solid-state system for measuring thrust and torque, meaning there are no moving parts between the motor and load cells. This design significantly improves the accuracy of measurements and eliminates the need for bearings and hinges, which cause friction and are prone to misalignment.
- **ASTM Calibration:** our test stands are rigorously calibrated to ASTM standards to ensure maximum measurement precision. Thrust is calibrated with the 211-point ASTM E74 procedure and torque is calibrated with the 213-point ASTM E2428 procedure.
- **Ultra compact design:** the compact shape of the Flight Stand ensures that there is minimal airflow disturbance from the tool's hardware and wiring. This promotes more realistic measurements and testing conditions that more closely mimic flight.
- **Realistic dual motor testing:** it is possible to perform dual motor tests in 3+ configurations with the Flight Stand, each representing a different aircraft design. In the back-to-back testing configuration, the motors are separated by a distance as little as 91 mm, similar to the distance you'd have in a multicopter.
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- **Exceptional customer support:** our team is ready to respond to any questions you may have in a friendly and timely manner.

Award Winning

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Test with confidence with the Flight Stand 50.

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Hardware and Electronics

The Flight Stand 50 comes fully equipped with software, hardware and electronics. Here's what's included with your Flight Stand:

Flight Stand 50:

- Force Measurement Unit (50 kgf /30 Nm) (1x): measures thrust and torque
- Electric Measurement Unit (180 V - 300 A) (1x): measures current and voltage
- Tubular structure (1x): supports the FMU and propulsion system, protects wiring
- Sync Hub (1x): connects the test stand to the software
- Temperature probes (2x): records the temperature at the desired location
- Optical RPM probe (1x): provides a precise measurement of the motor's rotation speed
- Flight Stand Software

Flight Stand 50 dual motor:

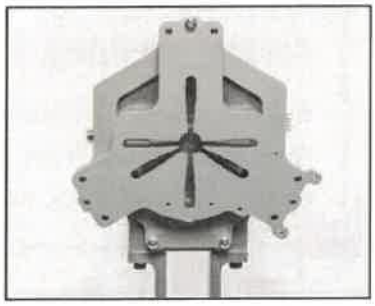
- 2x everything listed under Flight Stand 50 (except sync hub - only 1 needed for 2 FMUs)
- Dual motor fixture kit: ground rails and hardware for securing Flight Stands

Tubular Structure (Pro)

Electrical Measurement Unit (Pro)

Optical RPM Probe

Sync Hub



Force Measurement Unit with Motor Mounting Plate

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Software

The Flight Stand Software is used to control your test stand and record your data. If you prefer to manually control your tests, you can enter throttle values in a front-end table. If you prefer to automate your tests, you can create a script directly in the UI or use the Python API to control the entire software. The protocols supported include:

ESC:
Standard PWM: 50, 100, 200, 300, 400, 490 Hz
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Oneshot: 42, 125
Multishot

Servos:
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With the Flight Stand Software you can:

- Control the test stand manually and view live data as it is recorded
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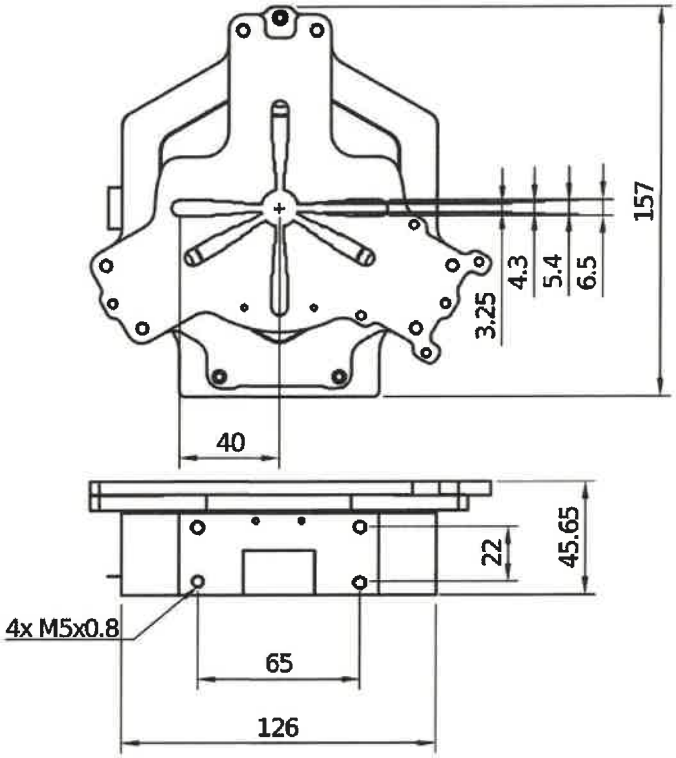
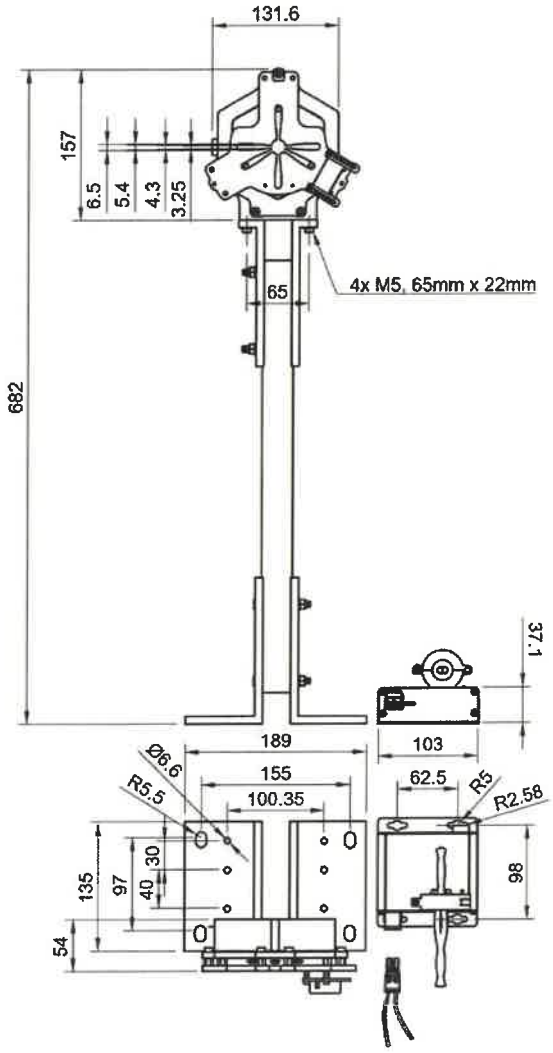
Technical Drawings

Force Measurement Unit:



Stand Components:



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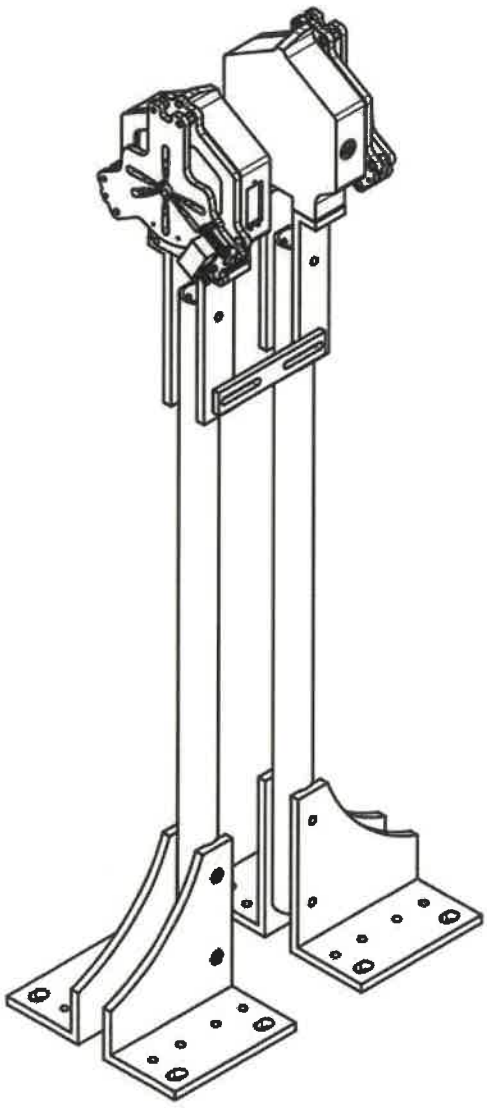
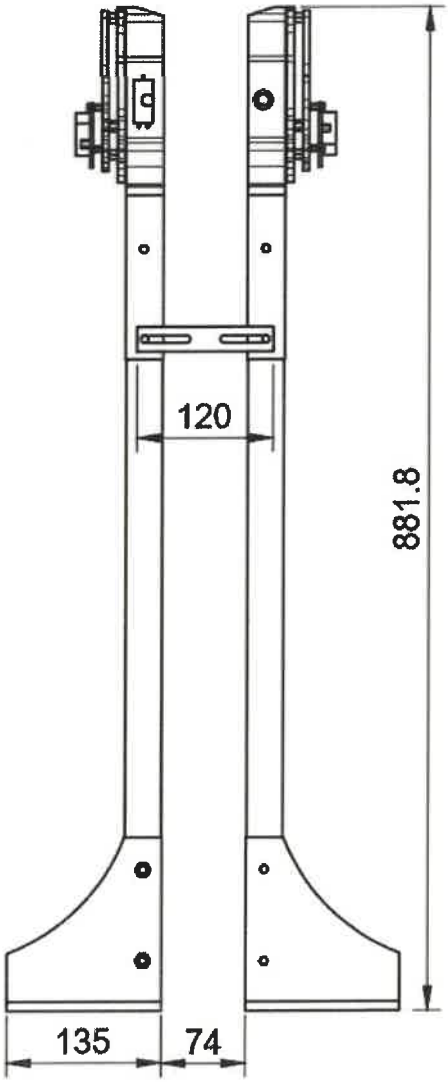
Technical Drawings - Dual Motor Configurations

Dual Motor Configurations:
(Note that many configurations are possible and at different separation distances)





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TYTO ROBOTICS

Flight Stand 150 Datasheet
Document ID: FSB150
V2.0 2022-09-28

Flight Stand 150

High-precision professional test stand

Made in Canada

Introduction

The Flight Stand 150 test stand allows you to precisely characterize and evaluate the performance of your motors and propellers by measuring thrust, torque, RPM, current, voltage, temperature, airspeed*, propeller efficiency and motor efficiency.

This test stand is the result of five years of experience developing propulsion testing systems and refining our equipment based on feedback from thousands of clients.

Description

The Flight Stand 150 is our biggest test stand to date and the only off-the-shelf test stand of its size.

It is designed to meet the needs of companies and institutions building very large drones, eVTOL aircraft, and electric airplanes.

It's impressive design and performance mirror that of our Flight Stand 15 / 50, but with a thrust measurement capacity up to 150 kgf and torque measurement up to 150 Nm.

* Optional feature planned to be released at the end of 2022

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Technical Specifications

	Specification	Value
Basic Information	Storage temp & humidity	23°C, 20% to 80% suggested
	Operating temp & humidity	0°C to 40°C, 20% to 80% suggested
	Power adapter input power / output power	90 - 264 VAC, 1 A input adapts into 9 V, 2 A
Measurement Information	Sampling rate	1,000 Hz
	Thrust calibration	ASTM E74 standard (339 points, push & pull)
	Torque calibration	Internal standard (204 points, CW & CCW)
	Crosstalk calibration	Yes with 1044 points
Recommended Test Range	Thrust	-150 to -25, or 25 to 150 kgf
	Maximum angular speed	30 000 RPM
	Propeller diameter	30" to 80"
Voltage and Current	Voltage range	0 V to 180 V max
	Voltage resolution	0.001 V
	Voltage accuracy	1% measured value from 5 V to 180 V
	Current range	0 to 500 A
	Current resolution	0.12 A
	Current accuracy	1% from 25 A to 500 A
Thrust	Range	±1500 N
	Resolution	0.5 N
	Accuracy	±1.0% of measured value, with lower limit of ±250 N (± 2.5 to ± 15 N)
	Temperature effect	±1.5 N per 10 degree Celsius
Torque	Range	±150 Nm
	Resolution	0.01 Nm
	Accuracy	±1.25% of measured value, with lower limit of 25 Nm (± 0.3125 to ± 1.875 Nm)
	Temperature effect	±0.5 Nm per 10 degree Celsius
RPM Sensor	Range	0 to 30 000 RPM
	Operating environment	Indoor
	Accuracy	±1 RPM
	Operational distance	5 to 15 mm
Temperature	PT100	-30 °C to 100 °C, ±2 °C
General analog inputs	Range	2 inputs of ±10 V differential.
	Resolution	0.001 V
	Accuracy	±0.5% of measured value ±0.1 V
	Supply pin	5 V ± 0.1 V 30 mA max

Applications

Below is a non-exhaustive list of possible applications for the Flight Stand 150:

- **Real-time dynamic testing:** made possible by the FS150 Pro's 1,000 Hz sampling rate. Perform frequency and step input parameter identification.
- **Flight replay:** upload your flight controller data to the software and recreate your throttle input while your propulsion system is hooked up to the test stand*.
- **Efficiency and power characterization:** measure the efficiency of your motor, propeller and overall system and compare electrical power input with mechanical power output.
- **Endurance and reliability testing:** study the endurance of your system's components using automated tests designed by you. Our user-friendly testing interface allows you to easily design and run step tests, ramp tests, flight replay tests, or any protocol you can come up with.
- **Distributed electric propulsion (DEP) testing:** test up to 4 powertrains simultaneously* for a comprehensive understanding of your multirotor's performance. Data is recorded for each individual powertrain as well as the system as a whole.

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Advantages

Here's why the Flight Stand is the best propulsion testing tool on the market:

- **Frictionless measurement:** our tools have a solid-state system for measuring thrust and torque, meaning there are no moving parts between the motor and load cells. This design significantly improves the accuracy of measurements and eliminates the need for bearings and hinges, which cause friction and are prone to misalignment.
- **ASTM Calibration:** our test stands are rigorously calibrated to ASTM standards to ensure maximum measurement precision. Thrust is calibrated with the 211-point ASTM E74 procedure and torque is calibrated with the 213-point ASTM E2428 procedure.
- **Ultra compact design:** the compact shape of the Flight Stand ensures that there is minimal airflow disturbance from the tool's hardware and wiring. This promotes more realistic measurements and testing conditions that more closely mimic flight.
- **Realistic dual motor testing:** it is possible to perform dual motor tests in 3+ configurations with the Flight Stand, each representing a different aircraft design. In the back-to-back testing configuration, the motors are separated by a distance as little as 400 mm, similar to the distance you'd have in a multicopter.
- **Superior software experience:** our software allows you to perform manual or automated tests with no programming required. We also offer a Python API and data management system with index, plots, tables, filtering and resampling capability.
- **Exceptional customer support:** our team is ready to respond to any questions you may have in a friendly and timely manner.

Award Winning

In 2022, the Flight Stand won the Regional Innovation Award from the Order of Engineers of Quebec, thanks to its ground-breaking design and capabilities.

Test with confidence with the Flight Stand 150.

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Software

The Flight Stand Software is used to control your test stand and record your data. If you prefer to manually control your tests, you can enter throttle values in a front-end table. If you prefer to automate your tests, you can create a script directly in the UI or use the Python API to control the entire software. The protocols supported include:

ESC:
Standard PWM: 50, 100, 200, 300, 400, 490 Hz
Dshot: 150, 300, 600
Oneshot: 42, 125
Multishot

Servos:
Standard PWM: 50, 100, 200, 300, 400, 490 Hz

With the Flight Stand Software you can:

- Control the test stand manually and view live data as it is recorded
- Automate tests with an easy-to-use interface that requires no programming
- Control the whole system from a Python API
- Upload .CSV files from your flight controller to perform flight replay tests
- Save tests directly in the software and/or export them as .CSV files
- Re-sample data for smaller files and adjust sensor noise filtering
- Map and test up to four powertrains simultaneously (DEP testing)

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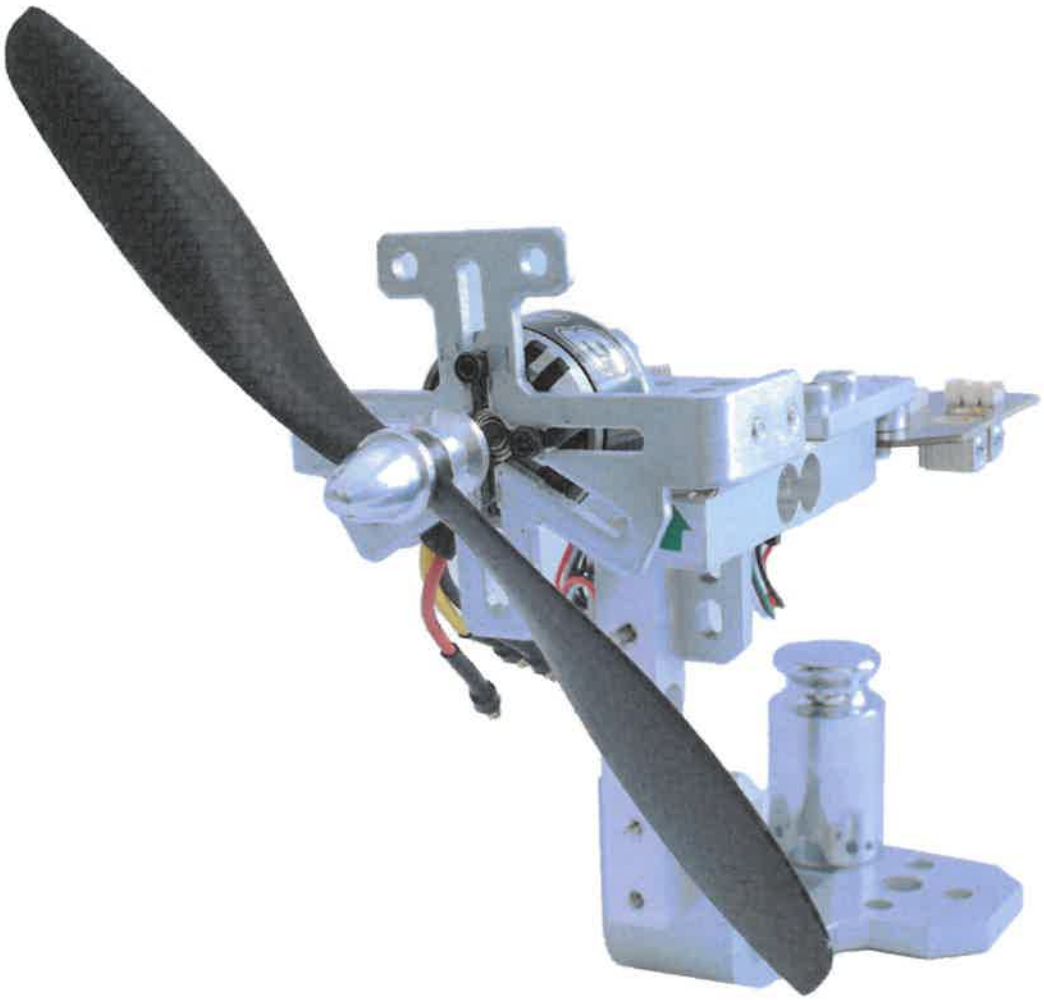
Series 1580 Test Stand Datasheet



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Introduction

The RCbenchmark Series 1580 Test Stand is designed to greatly reduce the time required for characterizing, testing, and designing brushless motor propulsion systems, while obtaining precise and accurate results. The Series 1580 is the only dynamometer developed specifically for drone designers with a USB interface and powerful software for automated control and data-logging.

Description

The Series 1580 Test Stand was specifically developed to allow drone designers to improve the efficiency of their propulsion systems. The test stand connects to your computer via USB and uses powerful software for automated control and data-logging. The ESC can be controlled manually or with custom scripts using the scripting interface.

Motor and propeller data can be viewed in real-time then exported to a .CSV file once tests are complete. Multiple accessories are available to help UAV developers further characterize their aircraft and achieve peak performance. It is the ideal tool for optimizing the performances of drones, robots and radio-controlled vehicles.

Direct measurements

- Torque (Nm)
- Thrust (kgf)
- Voltage (V) and current (A)
- Rotations per minute (RPM)
- Motor winding resistance (Ohm)
- Accelerometer on PCB (g)

Derived measurements

- Motor efficiency (%)
- Propeller efficiency (g/W)

- USB interface
- ESC manual control
- Three servo control ports
- Automatic control
- Powerful scripting
- Three accessory ports
- Three temperature probe ports
- Output data to CSV file
- Real-time sensor plots
- Included calibration hardware

Applications

- Inrunner and outrunner brushless motor characterization (0~55 A)
- Propeller characterization
- Calculate system efficiency
- Servo testing and control
- Battery endurance testing
- Factory tests

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Technical Specifications

Table 1: Design specifications of the Series 1580 Test Stand

Specification	Min.	Max.	Tolerance	Unit
Thrust	-5	5	0.5%∓0.005	kgf
Torque	-2	2	0.5%∓0.005	Nm
Voltage	0	50	0.5%∓0.05	V
Current	0	55	1%∓0.1	A
Angular speed*	0	190k	1	eRPM
Coil resistance	0.003	240	0.5%∓0.1	Ohm

*Electrical RPM, divide by the number of motor poles to obtain true mechanical RPM.

The tolerances are given as a percentage of the measured value plus a constant. Sampling rate depends on your computer (up to ~50 Hz) and is lower for the load measurements (~8 Hz). The torque measurement accuracy is valid for tools produced after 2020-01, or for tools using the rigid sheet metal connector between the motor mount and the load cells. The previous design using hinges had 0.5%∓0.01 Nm accuracy.

Your test accuracy depends on your experimental setup. Loose wires and objects in the test area will affect the accuracy due to the ground effect of the propeller.

Hardware

The Series 1580 Test Stand is designed to measure essential motor and propeller performance metrics. Figure 1 shows an overview of the important components of the tool.

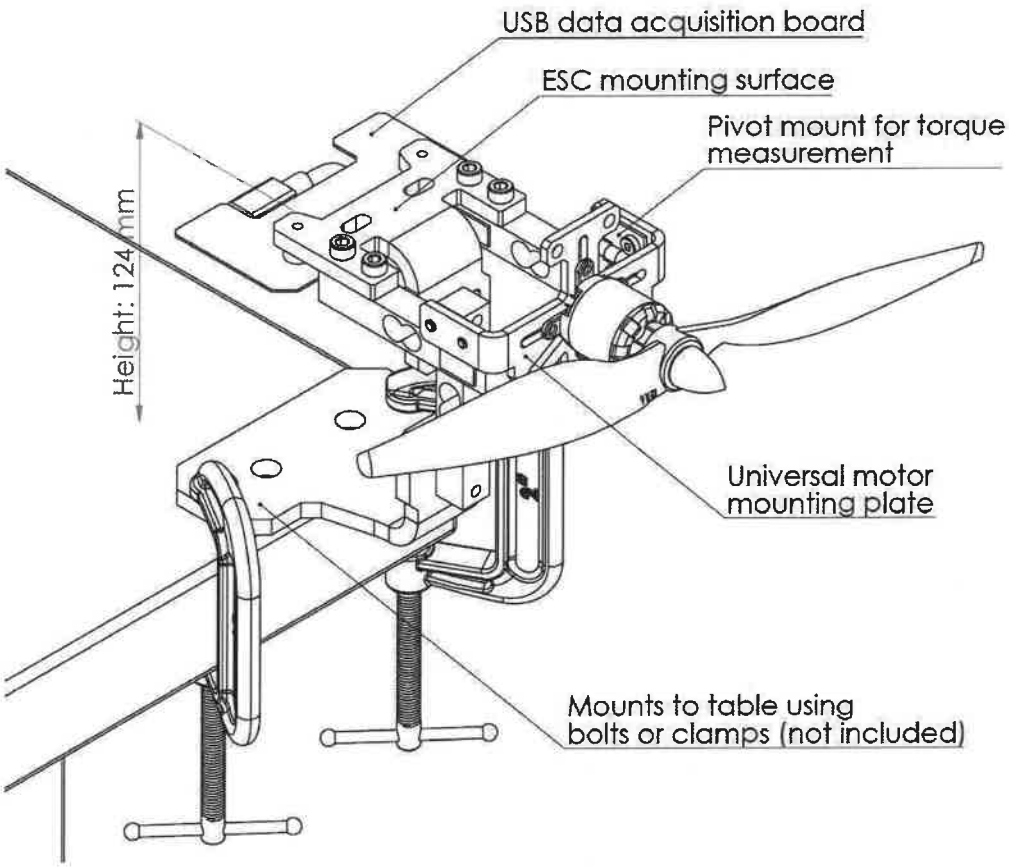


Fig. 1: Hardware overview

For a given **voltage**, brushless motor **speed** is a function of two variables: the **mechanical load** (in Nm), and the **electrical signal input** (which can be measured in duty cycle or percentage of the maximum command sent to the ESC). The motors are characterized by changing the input from the software and by changing the load with multiple propellers. The load changes as propellers have different size and pitch.

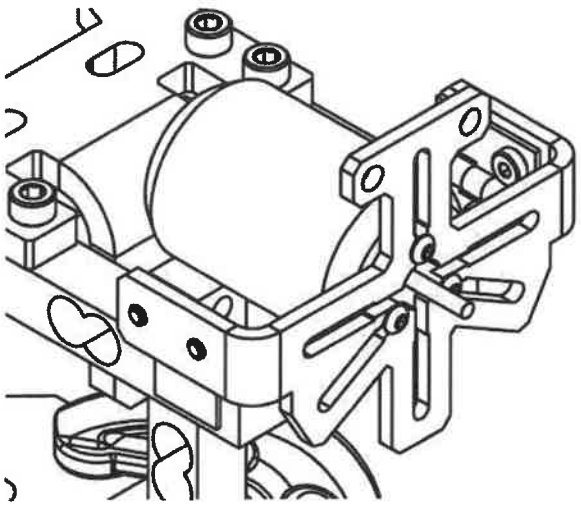


Fig. 2: Mounting shown with 36 mm∅ and 53 mm length inrunner motor.

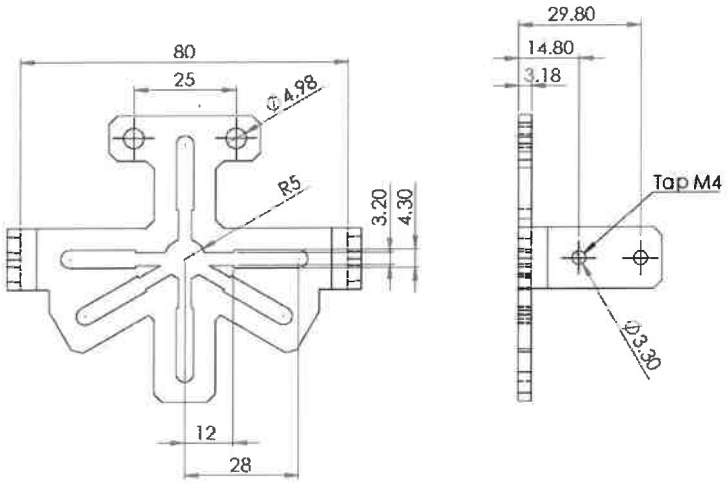


Fig. 3: Motor mounting part dimensions

The test device can accept most inrunner and outrunner brushless motors with M2 to M4 screws and screw spacing of up to 56 mm. Inrunner motors can have a maximum length of 55 mm and a maximum diameter of 48 mm. Figure 2 shows an example of an inrunner mounted on the device.

Use the drawing in Figure 3 to check if you can install your motor on the device. The pattern fits almost all standard medium-size motors. Otherwise, you can make a wood adapter, or design your own motor mounting part using the dimensions in the drawing.

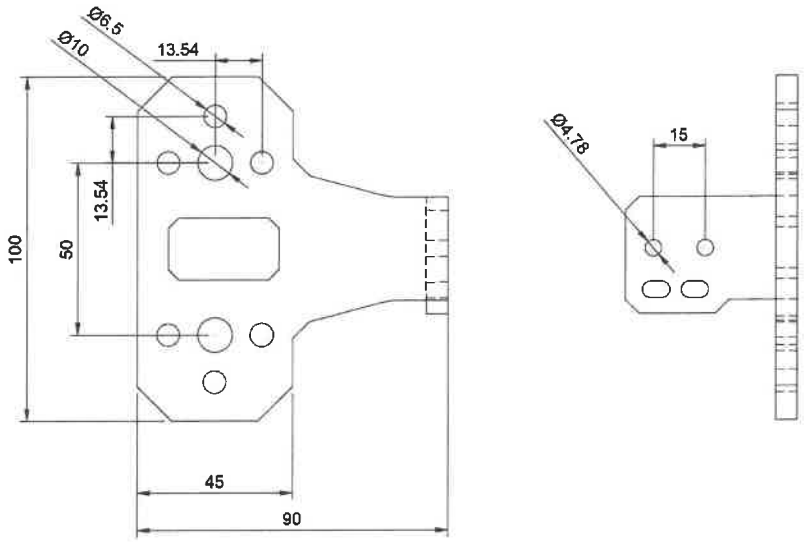


Fig. 4: Lower Mounting Part

Calibration

The test stand comes with hardware for calibrating the torque and thrust measurements. Figure 5 shows the device with its included calibration hardware and precision weight. See the instruction in the RCbenchmark GUI for detailed calibration instructions.

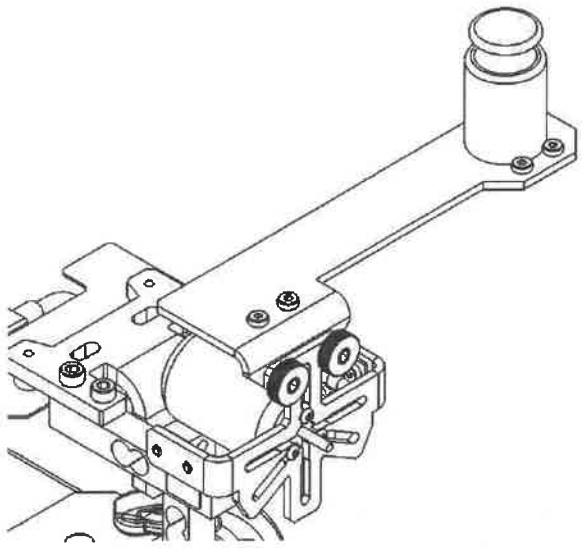


Fig. 5: Calibration hardware (included)

Circuit Board (PCB)

The Series 1580 circuit board is designed for the Series 1580 Test Stand, compatible with the RCbenchmark GUI. The circuit board is able to measure three load cell units, ESC power, RPM of the motor acceleration and winding resistor of the motor. It is compatible with three temperature probes, one optical RPM probe and three I2C interface accessories (from Tyto Robotics). Please find information on the accessories on the next page.

Accessories

The Serial 1580 Test Stand has several optional accessories. For the purchase information, please visit our online store.

1. Airspeed Probe / Pressure Sensor for Airspeed Measurement
   The airspeed probe is a precision differential pressure sensor fully integrated with the RCbenchmark software. The sensor is intended to be used with a pitot tube to measure the airspeed in a wind tunnel or the airspeed behind the propeller.

2. Temperature Probe
   Three temperature probes can be connected to the Series 1580 simultaneously. Each probe can be renamed in the software (ESC, Motor, Battery, Ambient, etc.) and configured with its own safety cutoff. Temperature data is also part of the generated log files. The software can be configured to work in Celsius, Fahrenheit, or Kelvin.

3. Optical RPM Probe
   The optical RPM probe provides precise RPM measurement and is easy to install. It measures speeds from 10 to 30,000 RPM. However, because of the hardware limit, the electrical RPM probe does not work effectively when the motor is running at low RPM (<500), or when testing a very low KV motor (<700 RPM/Volt).

4. No-solder Board
   The no-solder board can save time and improve your work efficiency when testing multiple motors and ESCs. It can be fixed directly on your test stand allowing the installation of various types of ESCs and motors without any soldering. Three lug connectors can accommodate bullet connectors up to 6 mm or bare wires.

5. Series 1520/1580 Enclosure
   The enclosure is an important safety feature, as propellers can break during the test. It can also help to avoid operators from getting too close to the spinning propellers. This product has been tested and proved safe for carbon and plastic propellers no larger than 16" (see product specifications for details). The enclosure comes with an extended lower support to center the propeller in the cage.

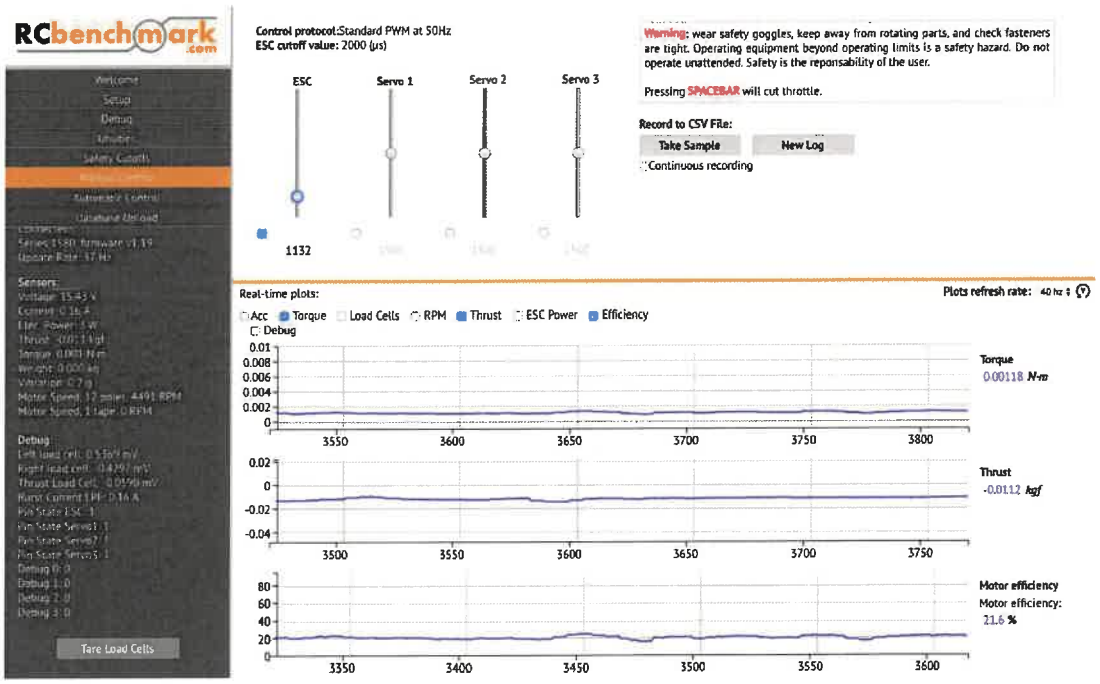
Software

Our open-source propulsion testing software is included with all test stands and allows you to control your propulsion system and record data easily.

The test stand can be controlled manually or automatically with Windows, Linux, Mac and Chrome OS. The interface displays sensor information in textual and graphical form, which can be recorded as single data points or continuous data. We provide pre-written test scripts, which you can then edit or you can write your own custom scripts.

Once the data is recorded, you can easily export it to a .CSV file, readable with most spreadsheet softwares. You can set-up your own working units, safety cut-offs and live plots to meet your needs. Your results will provide you with important information about propeller and motor efficiency as well as consumed power.

- Real time graphs
- Manual motor control
- Manual servo control (three channels)
- Calibration wizard
- Safety cutoffs based on any measured data
- CSV export
- Automated test
  - Ramps
  - Steps
  - Measure Kv
  - Measure number of poles
  - And more...
- User scripts with documentation



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Series 1780 Test Stand Datasheet

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Introduction

The Series 1780 Test Stand is the perfect tool for characterizing the propulsion systems of medium and large drones. The stand supports single motor or coaxial testing in several configurations. It comes in three convenient sizes to suit your testing needs:

- 25 kgf / 12 Nm / 0-100 A
- 40 kgf / 18 Nm / 0-150 A
- 75 kgf / 48 Nm / 0-500 A

Description

The stand was built with the needs of drone designers in mind, taking into consideration the features that would simplify testing. The stand comes with easy to use software controlled manually or with custom pre-written scripts for automated testing. Data can be viewed in real-time then exported to a .csv file once tests are completed. An external cutoff switch and load cell overload alarm offer enhanced safety and peace of mind.

The stand supports multiple configurations such as: single motor, coaxial back-to-back, coaxial face-to-face and coaxial offset. We also offer a ground railing system and support structure to help secure the stand in your work area, and airspeed and temperature probes to cover all aspects of characterization.

Measured Data:

- Thrust
- Torque
- Optical RPM
- Current
- Voltage
- Temperature
- Wind velocity

Computed Data:

- Mechanical power
- Electrical power
- Motor efficiency
- Propeller efficiency
- Overall system efficiency

Applications

- Outrunner brushless motor characterization
- Propeller characterization up to 70”
- Battery characterization
- ESC characteristization
- Propeller icing test
- Servo testing and control
- Endurance testing
- Quality testing
- Drone structure optimization
- Flight simulation and replication
- Motor heat testing
- Drone propulsion system maintenance

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Technical Specifications

Table 1: Design specifications for the series **1780 single-motor (25 kgf - 100 A)**

Specification	Min.	Max.	Tolerance	Unit
Thrust	-25	25	±0.5%	kgf
Torque	-12	12	±0.5%	Nm
Voltage	0	60	±0.5%	V
Current	0	100	±1%	A
Angular speed*	0	190k	-	RPM

*Optical RPM.

Table 2: Design specifications for the series **1780 single-motor (40 kgf - 150 A)**

Specification	Min.	Max.	Tolerance	Unit
Thrust	-40	40	±0.5%	kgf
Torque	-18	18	±0.5%	Nm
Voltage	0	60	±0.5%	V
Current	0	150	±1%	A
Angular speed*	0	190k	-	RPM

*Optical RPM.

Table 3: Design specifications for the series **1780 single-motor (75 kgf - 500 A)**

Specification	Min.	Max.	Tolerance	Unit
Thrust	-75	75	±1%	kgf
Torque	-48	48	±1%	Nm
Voltage	0	100	±0.5%	V
Current	0	500	±1%	A
Angular speed*	0	100k	-	RPM

*Optical RPM.

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Table 4: Design specifications for the **series 1780 coaxial (25 kgf - 100 A)**

Specification	Min.	Max.	Tolerance***	Unit
Thrust side A*	-25	25	±0.5%	kgf
Thrust side B	-25	25	±0.5%	kgf
Torque side A	-12	12	±0.5%	Nm
Torque side B	-12	12	±0.5%	Nm
Voltage side A	0	60	±0.5%	V
Voltage side B	0	60	±0.5%	V
Current side A	0	100	±1%	A
Current side B	0	100	±1%	A
Angular speed**	0	190k	-	RPM

* Each side represents one motor and one propeller. The system can acquire data for both A and B sides in order to calculate a global performance.
** Optical RPM included.
*** This is the non-linearity of the rated output, meaning thrust accuracy over the entire range is ±0.005 * 25 kg = ±125 g.

Table 5: Design specifications for the **series 1780 coaxial (40 kgf - 150 A)**

Specification	Min.	Max.	Tolerance***	Unit
Thrust side A*	-40	40	±0.5%	kgf
Thrust side B	-40	40	±0.5%	kgf
Torque side A	-18	18	±0.5%	Nm
Torque side B	-18	18	±0.5%	Nm
Voltage side A	0	60	±0.5%	V
Voltage side B	0	60	±0.5%	V
Current side A	0	150	±1%	A
Current side B	0	150	±1%	A
Angular speed**	0	190k	-	RPM

* Each side represents one motor and one propeller. The system can acquire data for both A and B sides in order to calculate a global performance.
** Optical RPM included.
*** This is the non-linearity of the rated output, meaning thrust accuracy is ±0.005 * 40 kg =±200 g.

Table 6: Design specifications for the **series 1780 coaxial (75 kgf - 500 A)**

Specification	Min.	Max.	Tolerance***	Unit
Thrust side A*	-75	75	±1%	kgf
Thrust side B	-75	75	±1%	kgf
Torque side A	-48	48	±1%	Nm
Torque side B	-48	48	±1%	Nm
Voltage side A	0	100	±0.5%	V
Voltage side B	0	100	±0.5%	V
Current side A	0	500	±1%	A
Current side B	0	500	±1%	A
Angular speed**	0	100k	-	RPM

* Each side represents one motor and one propeller. The system can acquire data for both A and B sides in order to calculate a global performance.
** Optical RPM included.
*** This is the non-linearity of the rated output, meaning thrust accuracy is ±0.01 * 75 kg = ±750 g.

***The tolerance in the tables above only represents non-linearity. There's also hysteresis and creep in the measurement error. For more details and explanations, please refer to appendix A at the end of this datasheet. The sampling rate depends on your computer (50 Hz+).

The load, power and optical RPM measurement units from side A and side B share the same design parameters. Thus, for the Series 1780 Coaxial, users can expect a maximum overall thrust and torque of twice the rated output of each measurement unit. For example, when you purchase the Series 1780 Dynamometer 25 kgf - 100 A: Coaxial, you can expect to measure up to 50 kgf for your dual-motor setup and up to 200 A for the global power output.

Resonance Frequencies

Mode 1 & 2: 15 Hz
Mode 3: 95 Hz

Note for the user:

- Resonance frequencies have nothing to do with how much thrust you put, but rather how well you tighten the structure, or how balanced your rotor is.
- These modes are for reference only.
- When observing the resonance (e.g. 1200 RPM for them), you shall not hold the speed for a long time at that speed; instead, quickly bypass that speed, and/or check the fasteners each time if you decide to hold for more than 15 seconds.

Hardware

The RCbenchmark Series 1780 is designed to greatly reduce the time required for characterizing and testing high power brushless motors and large propellers while obtaining precise and accurate results. Figure 2 and Figure 3 show an overview of the important components of the tool for different configurations and ratings.

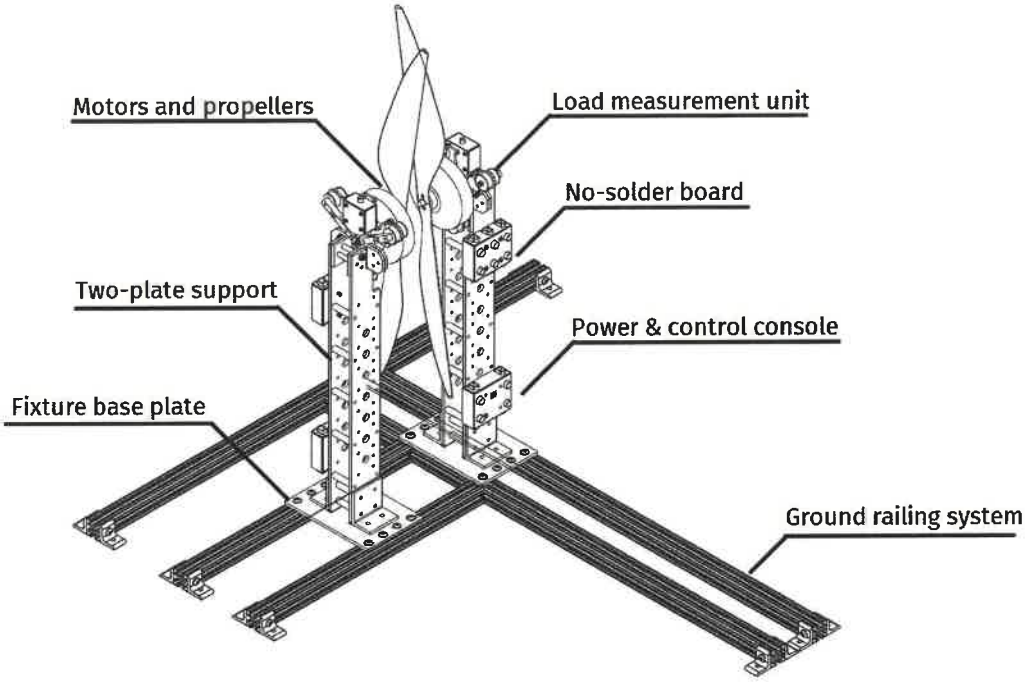


Figure 2: Series 1780 Test Stand 25/40 kgf Coaxial (propeller face-to-face mode)

For a given voltage, brushless motor speed is a function of two variables: the mechanical load (in Nm), and the input (which can be measured in duty cycles or percentage of the maximum command sent to the ESC). The motors are characterized by changing the input from the software and by changing the load with multiple propellers. The load changes as the propellers vary in size and pitch.

If you require additional power resources to run your tests, we also offer Power Supply Units.

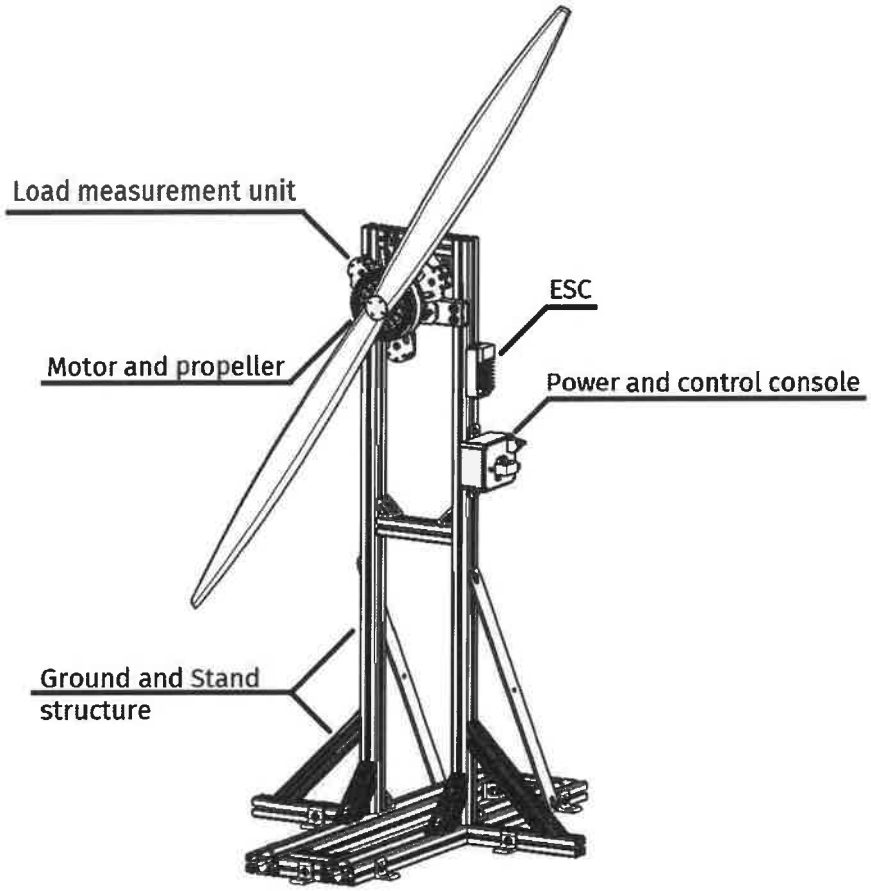


Figure 3: Series 1780 Test Stand 75 kgf Single-Motor

Mountings and Assemblies

The load measurement unit is pre-assembled and calibrated before its shipment. Users will need to fix in place the unit support structure and finish assembling it with the motor mount, the optical RPM probe, and other electrical components. Detailed instructions are provided in the user manual.

It is highly recommended to use the supports provided to hold the load measurement units. Six holes for M5 bolts on the load measurement unit are reserved for support. All necessary fasteners and hand-tools for mounting and assembling were included in all variants of the Series 1780.

Configurations

The Series 1780 is designed to be modular. Those modules can be replaced or reconfigured to adapt to different testing needs. Currently, you can order the Series 1780 test stand in two different configurations: single-motor or coaxial. Both configurations are available in three different thrust and torque ratings: 25 kgf / 12 Nm, 40 kgf / 18 Nm, 75 kgf / 48 Nm

Figure 4: Series 1780
Single-Motor Testing Mode

Figure 5: Series 1780 Coaxial Testing Modes

Both configurations share mostly the same hardware, except that the coaxial contains two times more hardware than the single-motor configuration. The coaxial configuration can be used to test different setups: single motor, two motors back-to-back, two motors face-to-face, and two motors offset. When testing two motors, coaxial configurations will allow motor control and data processing for two motors simultaneously. When testing in a coaxial back-to-back configuration, the minimum distance between the backs of the motors is:
100.34 mm for the 25 kgf or 40 kgf rated stands and 298.106 mm for the 75 kgf rated stand.

All RCbenchmark Series 1780 test stands are calibrated before the product's shipment. Upon receiving the product, you may mount the unit onto the test bench and start testing right away.

Airspeed and Temperature Probes - for 75kgf version only

The Series 1780 75 kgf single motor test stand comes with one airspeed pressure sensor and three (3) temperature probes. The Series 1780 75 kgf coaxial test stand comes with one airspeed pressure sensor and six (6) temperature probes. The airspeed pressure sensor has a measurement range of ±6.8 kPa and an accuracy of 1% FS when tared but not calibrated. The temperature probes measure temperatures from -10 °C to +120 °C with a ±0.5 °C accuracy from -10 °C to +85 °C. They have an 800 ms update rate.

Compatible Motors

The motor mounts for the Series 1780 are compatible with most brushless motors for UAVs on the market. They contain three major features:

1. Attachment points to install the motor mount to the load measurement unit with the standoffs and M5 nuts.

2. Two tapped holes to install the optical probe to the motor mount with the supplied spacers and M4 screws.

3. For the 2 5kgf and 40 kgf versions, the motor can be mounted directly on the motor mount with M3, M4, M5, M6 screws. The screws go through slots. There are slots at 0, 90, 120, 180, 240 and 270 degrees in order to adapt to multiple motor geometries. For inrunner motor testing, there is also a center hole of ϕ15 that allows a rotating shaft through the plate.

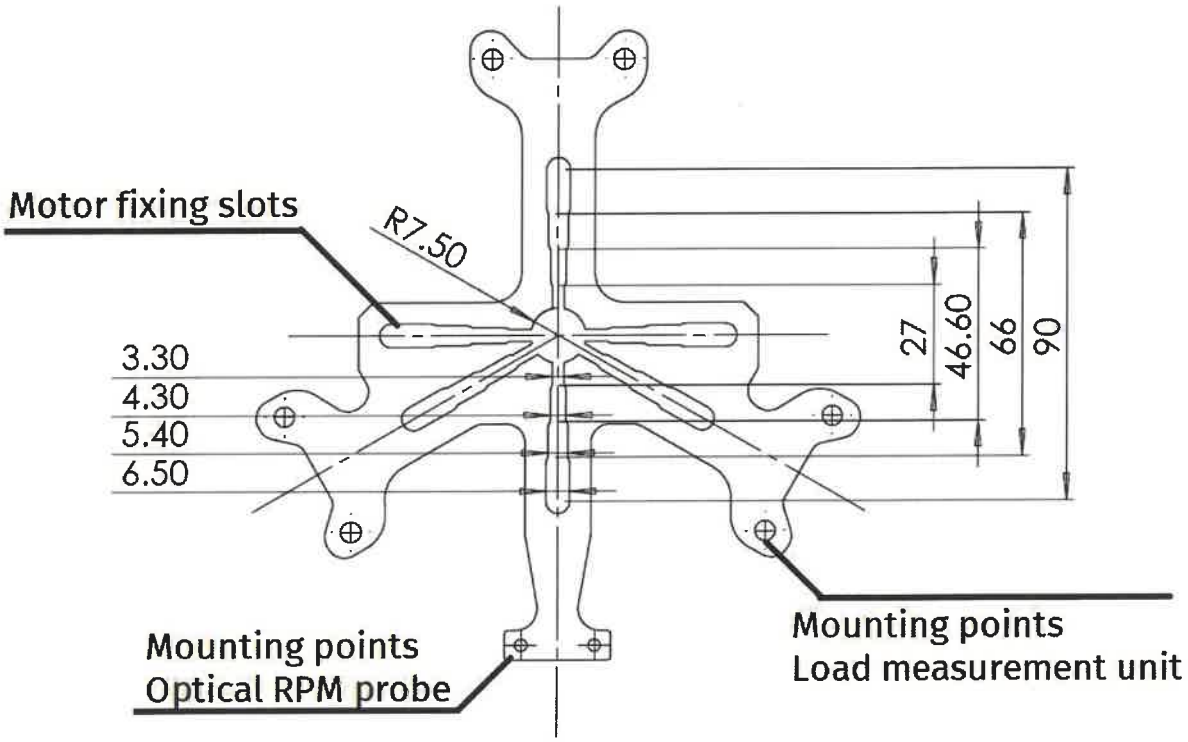


Figure 6: Series 1780 25 kgf / 40 kgf Motor Mount

For the 75 kgf version, the motor can also be mounted directly on the heavy-load motor mount with M5, M6, M8 and M10 screws. This motor mount is specially designed for the 75 kgf version, as it can support the higher thrust and torque generated by the motors. The screws go through slots. There are slots at 0, 90, 120, 180, 240 and 270 degrees in order to adapt to multiple motor geometries. For inrunner motor testing, there is also a center hole of ϕ30 that allows a rotating shaft through the plate.

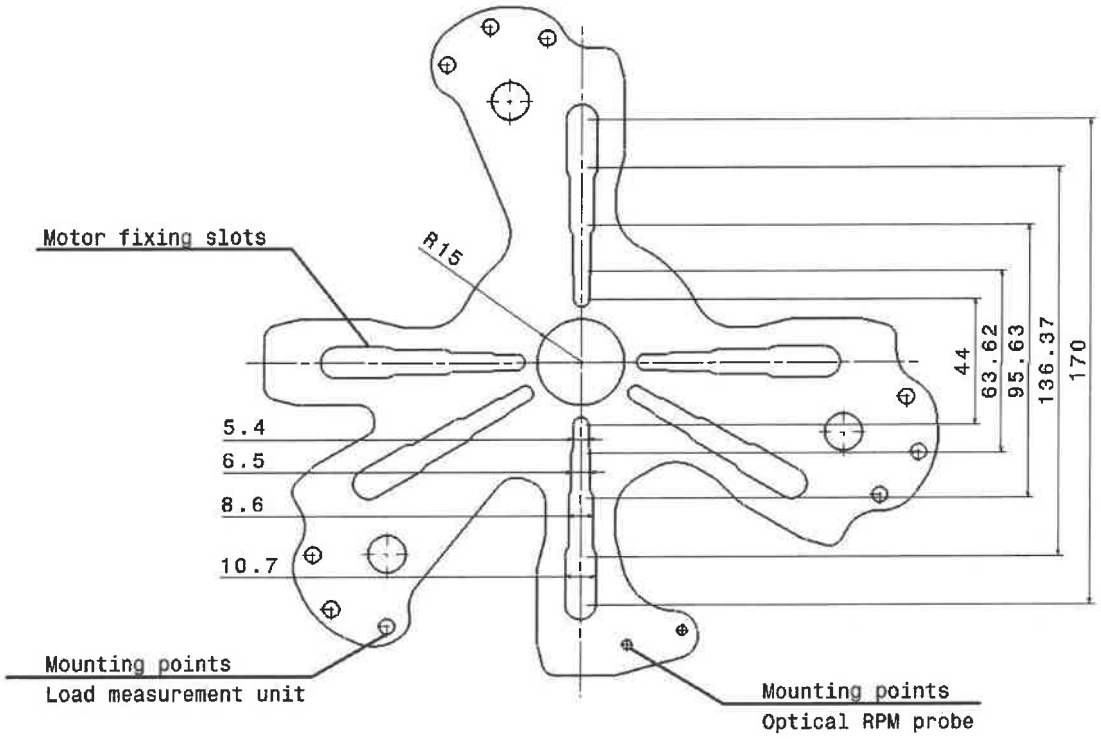


Figure 7: Series 1780 75 kgf Motor Mount

If necessary, customers who purchased the Series 1780 Test Stand 75 kgf - 500 A can still use the thinner and smaller motor mount from the 25 kgf and 40 kgf.

If you are planning to test motors outside of the specifications of this motor mount, we offer a service whereby we will build you a specialized motor mount for a reasonable fee. Please contact us with the dimensions and motor specifications. You can also manufacture your own mounting plate.

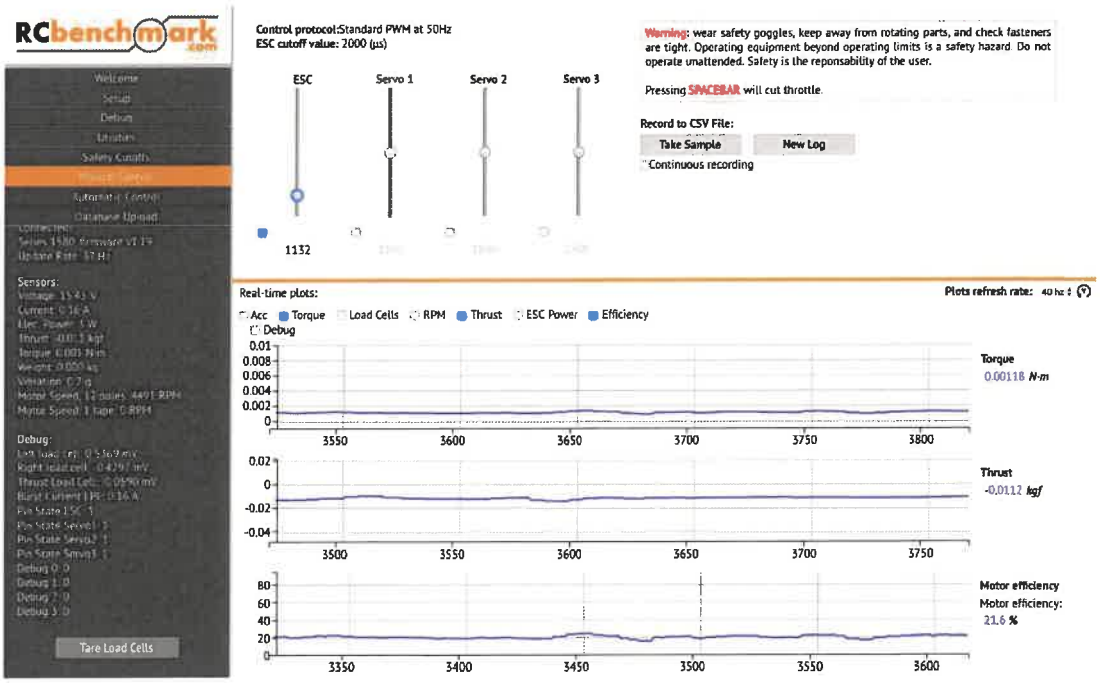
Software

Our open-source propulsion testing software is included with all test stands and allows you to control your propulsion system and record data easily.

The test stand can be controlled manually or automatically with Windows, Linux, Mac and Chrome OS. The interface displays sensor information in textual and graphical form, which can be recorded as single data points or continuous data. We provide pre-written test scripts, which you can then edit or you can write your own custom scripts.

Once the data is recorded, you can easily export it to a .CSV file, readable with most spreadsheet softwares. You can set-up your own working units, safety cut-offs and live plots to meet your needs. Your results will provide you with important information about propeller and motor efficiency as well as consumed power.

- Real time graphs
- Manual motor control
- Manual servo control (three channels)
- Calibration wizard
- Safety cutoffs based on any measured data
- CSV export
- Automated test
  - Ramps
  - Steps
  - Measure Kv
  - Measure number of poles
  - And more...
- User scripts with documentation



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Appendix A

1. Data Table

Product name	Rated output (R.O.)	Non-linearity	Hysteresis	Creep (5 minutes)	Resolution
Series 1780 - 25 Kgf	25 kgf	±0.5% R.O.	±0.12% R.O.	±0.15% R.O.	<1 g
	12 Nm	±0.5% R.O.	±0.16% R.O.	±0.12% R.O.	<1 Nm
Series 1780 - 40 Kgf	40 kgf	±0.5% R.O.	±0.12% R.O.	±0.12% R.O.	<1 g
	18 Nm	±0.5% R.O.	±0.16% R.O.	±0.13% R.O.	<1 Nm
Series 1780 - 75 Kgf	75 kgf	±1% R.O.	±0.12% R.O.	±0.18% R.O.	<1 g
	48 Nm	±1% R.O.	±0.16% R.O.	±0.16% R.O.	<1 Nm

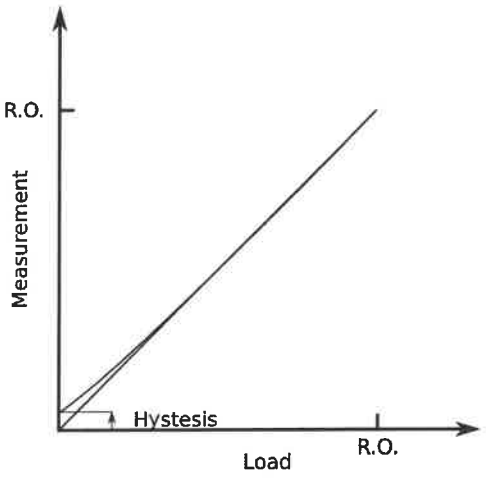
After calibration, our load measurement units are checked under static load to measure a 3 kgf, 5 kgf or 10 kgf load within 0.5% of the **measured** value. The values shown in Table 7 are maximum, and you will likely experience better results when testing.

2. Hysteresis

Hysteresis is the maximum measurement error after applying and removing a load equal to the rated output of the load measurement unit.

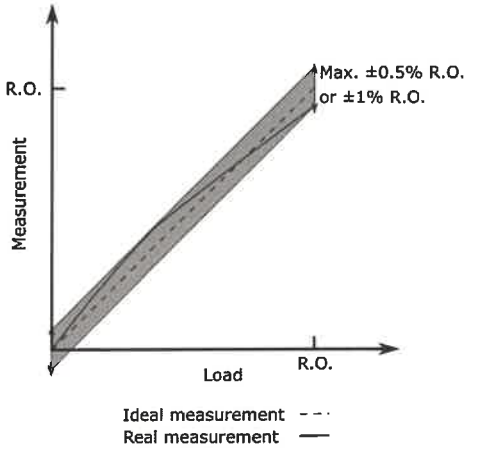
It is possible to minimize hysteresis with the following procedure:

1) Apply the full load to be measured then return to zero load
2) Tare the unit
3) Apply the full load to be measured and record the measurement



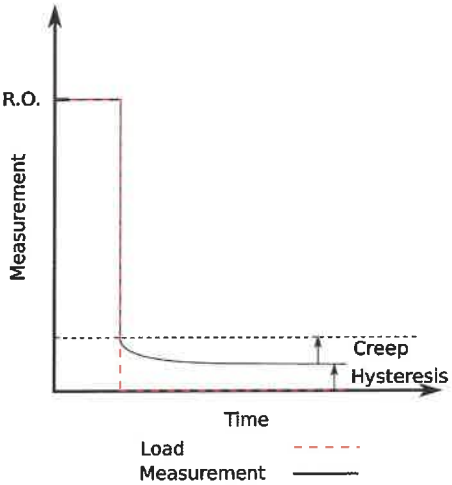
3. Non-linearity Error

The nonlinearity error is the maximum deviation from the ideal measurement line. This error is for the worst-case scenario with high perpendicular load and torque. You will likely obtain a much lower measurement error.



4. Creep

Creep is the change in the measured value over time caused by a constant strain.



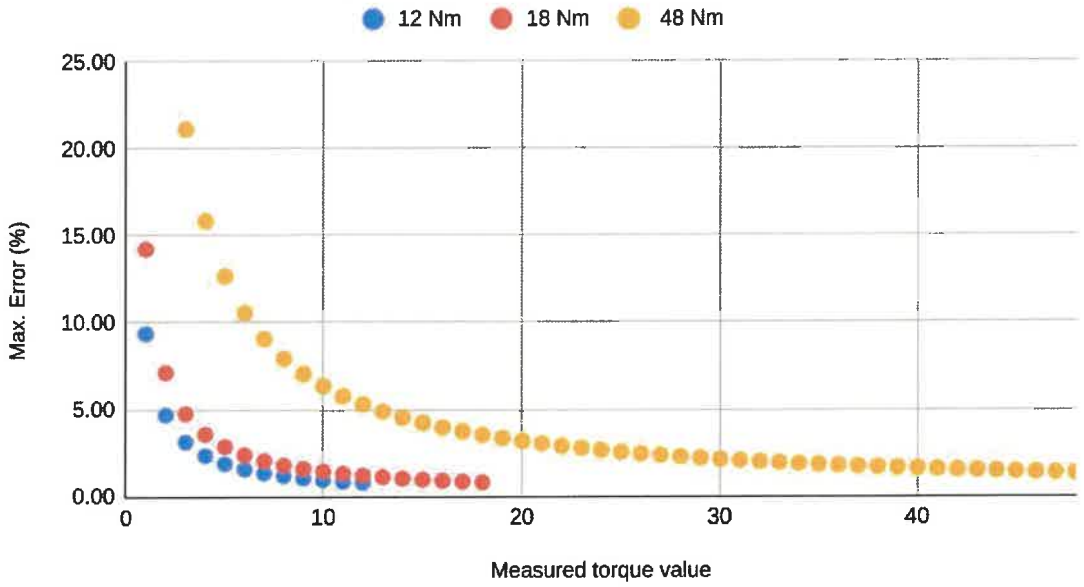
5. Note on Measurement Error

We do not recommend testing propellers with a maximum thrust under 25% of the test stand's rating. Aerodynamic effects, vibration and cables can affect the measurements of more than 0.5% of the full-scale rating. For useful, comparable and repeatable results, we recommend that you note and control all the test variables (room geometry, temperature, cable management, etc.) and use a checklist for tests.

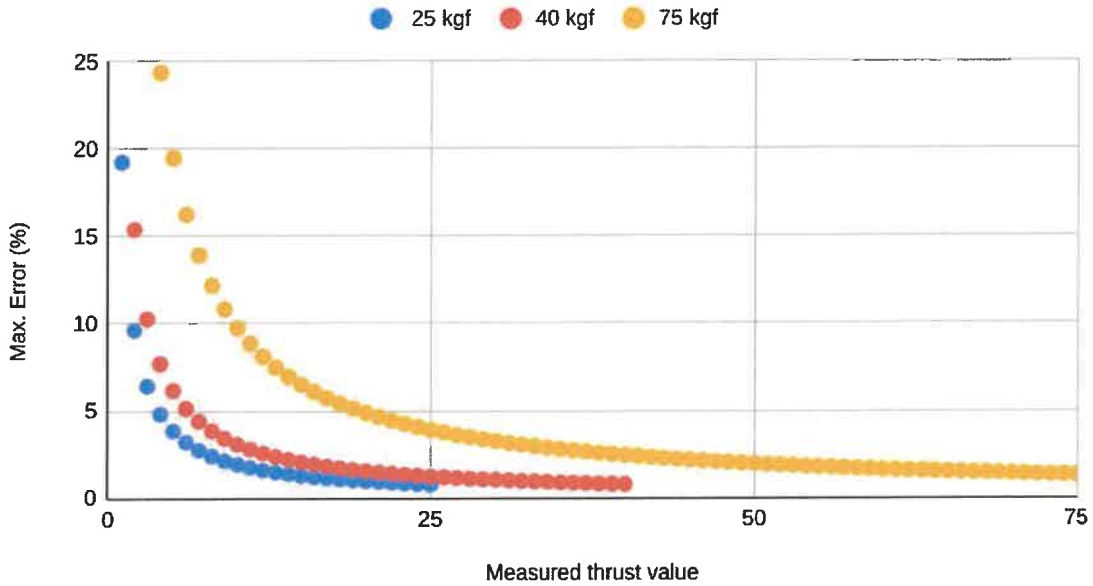
During production, we always find the measured error to be far lower than the maximum anticipated error values. Our load cells are tested after calibration and we ensure that the observed load is within 0.5% of the true value when it is placed on the LMU from the top. For an M1 class 3 kg standard weight for example, the measured load would need to be between 2.985 kg to 3.015 kg to pass the test. A similar requirement applies to the torque calibration.

For highly accurate, comparable results, you can perform a standard test at the beginning of each test session using a motor, propeller and power supply reserved for calibration purposes. This calibration test can be used to check that there is no significant difference from your previous tests, and it can be used to calibrate the measurement to a specific air pressure and temperature.

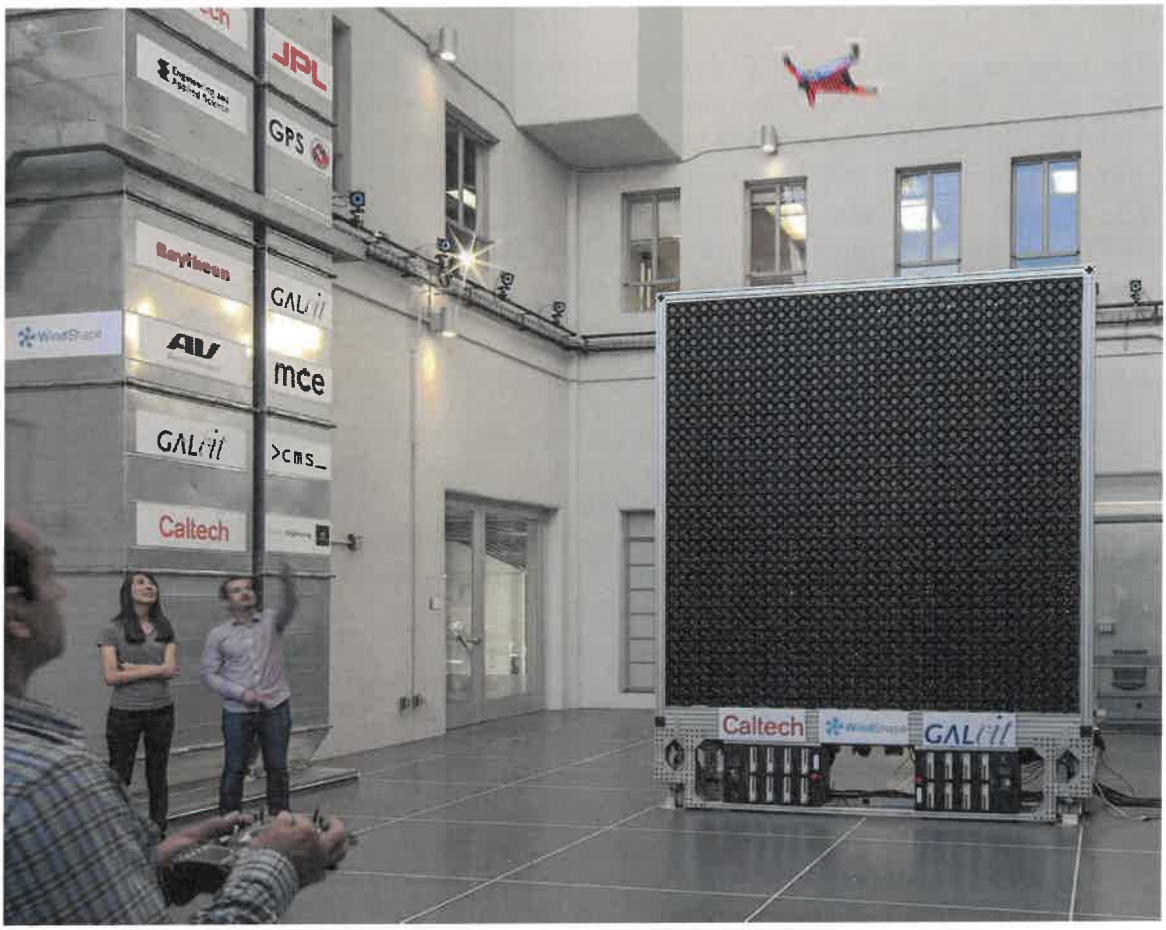
6. Maximum Torque Error on the Measured Value



7. Maximum Thrust Error on the Measured Value



Custom Wind Facility Datasheet



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Introduction

This product is a fully customizable wind facility that provides endless possibilities for free flight testing. You have full control over the Windshaper (wind generator) size, shape and accessories. It is specifically designed to study the effects of different wind profiles on motors, propellers, ESCs, batteries, drones and any electric aircraft.

Description

The main piece of equipment in a wind facility is the Windshaper wall, custom-made to fit your needs. The Windshaper is composed of stackable modules that each have 9 wind pixel fan units (figure 1). Each wind pixel is equipped with 2 counter-rotating fans that can generate a flow speed up to 16 m/s (or greater with a convergent, page 7). By analogy with a TV screen, where more pixels yield a better image, Windshaper walls are composed of hundreds of wind-pixel fans that enable precise control over the airstream. The Windshaper is managed with software that allows you to precisely control wind settings with simple commands.

Applications

- Free flight testing
- Landing phase optimization
- Determine turbulence limits
- Optimize fixed wing profiles
- Study performance in various wind profiles
- VTOL transitions in flight
- Evaluate waterproofing
- Drone failure effects (loss of GPS, motor, sensor)

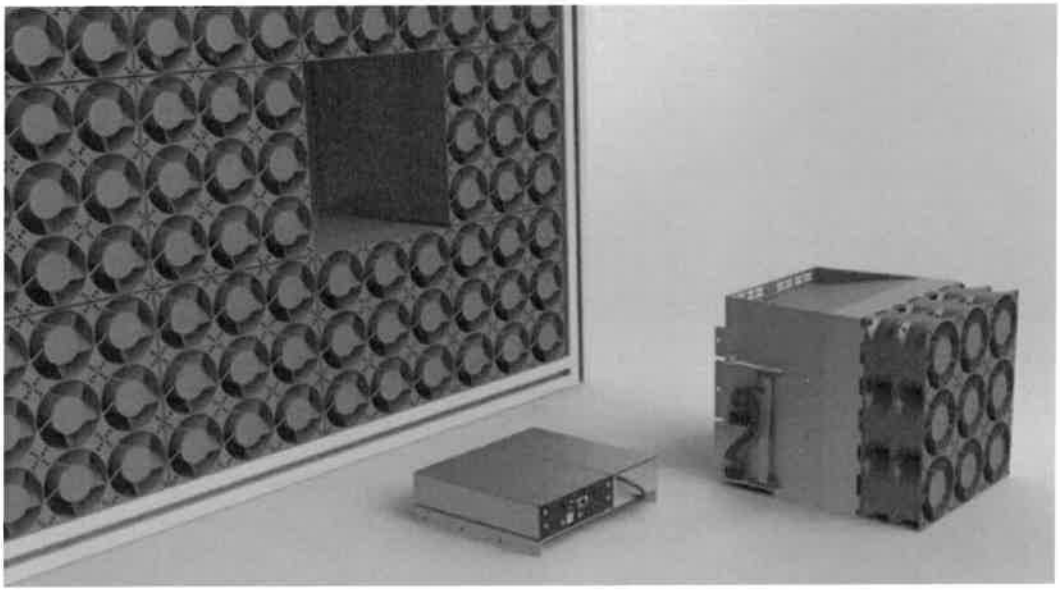

Fig. 1: Structure of a wind module

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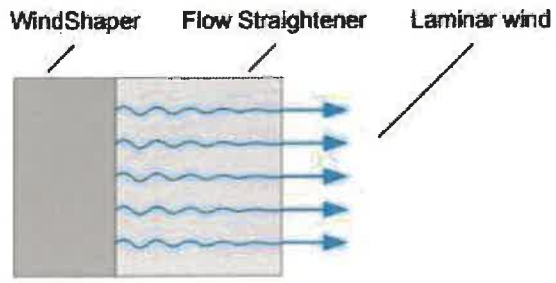
Wind Profiles

What makes Windshapers unique is their ability to create dynamic wind profiles. Traditional wind tunnels produce a uniform flow, whereas Windshapers use 3D input ($u = f(x, y, t)$) to generate unique flow patterns such as wind shear, turbulence, and time-variable flows.

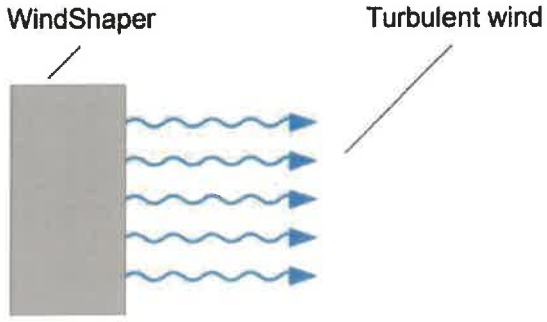
Uniform Laminar Flow

This setting can be used to simulate a drone flying at a given speed in still air. This is generated in the test area by setting the Windshaper's flow speed (in m/s) to the speed the drone would be traveling in still air, while the drone maintains its position. In this scenario, the relative wind speed, as seen by the drone, is equivalent to the speed the drone would be flying.



Turbulent Flow

Ideal for simulating the conditions a drone is likely to face in its work environment due to weather and topology. In the test setting, the level of simulated turbulence is controlled by the wind speed delivered by each wind pixel. This may be equal across pixels or different in each section of the test area.



Shear Flow

The term 'shear flow' describes a wind profile where adjacent layers of fluids move parallel to each other at different speeds. This can lead to flow instabilities near walls, foliage or in regions with noticeable thermal effects. This can be simulated by setting wind pixels on one fan array to a slow wind speed and setting wind pixels on an adjacent fan array to a higher wind speed.

Time-variable Flow

With time variable flows you can create unique wind profiles by changing the wind speed of each wind pixel over time. A given wind pixel may begin at 2 m/s, increase to 10 m/s, then return to 2 m/s and so on. With this level of control you can create wind shapes like the sine wave shown below (top view).

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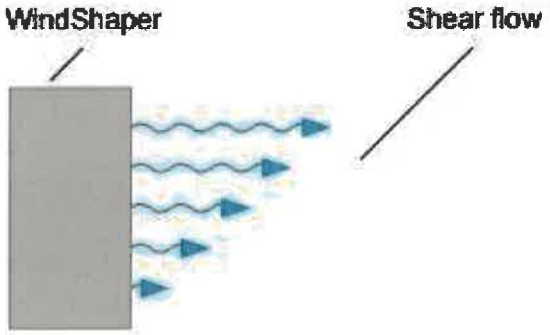
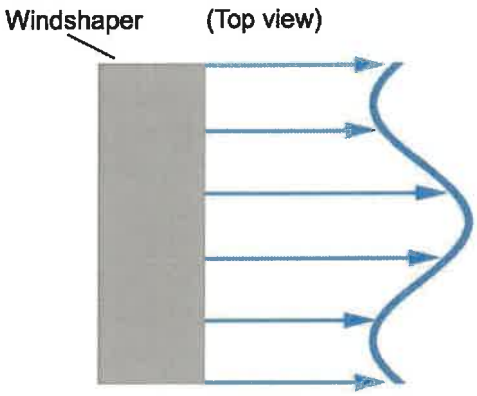


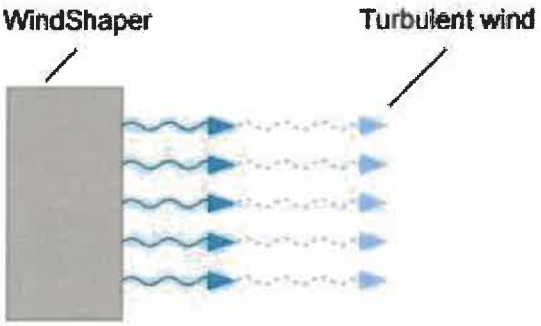


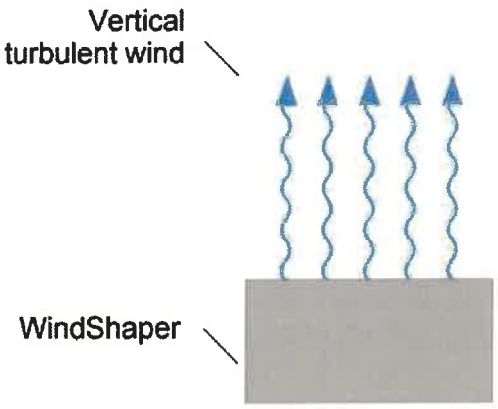
Wind Gust

Sudden changes in wind speed (gusts) can be challenging for a drone to navigate. Gusts can be simulated with rapid changes in wind speed coming from the wind pixels. This allows you to study drone displacement or resistance to gusts, and the responsivity of the flight controller.

Vertical Wind

While landing, drones experience a relative wind from below caused by their own turbulence (downwash), which leads to an unstable situation. To simulate this situation, the Windshaper is placed horizontally and generates a wind flow equivalent to the drone's downwash.





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Hardware

Structure (figure 2):

The facility's Windshaper consists of a wall of fans that generate both horizontal and vertical flows (1). Side walls (2) can also be installed to generate various cross wind profiles. The system is powered by two main distribution boxes (3) and a control network consisting of Ethernet switches, routers, and an onboard computer (4).

Fig 2. Windshaper components

Power and Control Unit

Each Windshaper module is connected to a Power and Control (P&C) unit. This unit contains two different systems: the module's control system and the module's power system. The power system can convert the input AC tension into 12VDC which is needed to power the fans. The control system is controlled with a microcontroller. It is connected to the Windshaper's Local Area Network (LAN) and communicates with the onboard computer through an Ethernet protocol. The integrated microcontroller interprets the signals received and pilots the fans accordingly. The status of the module (power status, health, fan status,...) is sent back to the main onboard computer.

Customizable Parameters (figure 3):

- Windshaper size
- Wind flow shape and direction
- Take-off and landing conditions
- Filters to reduce turbulence
- Convergent to increase max wind speed
- Tilting system from 0° to 90°

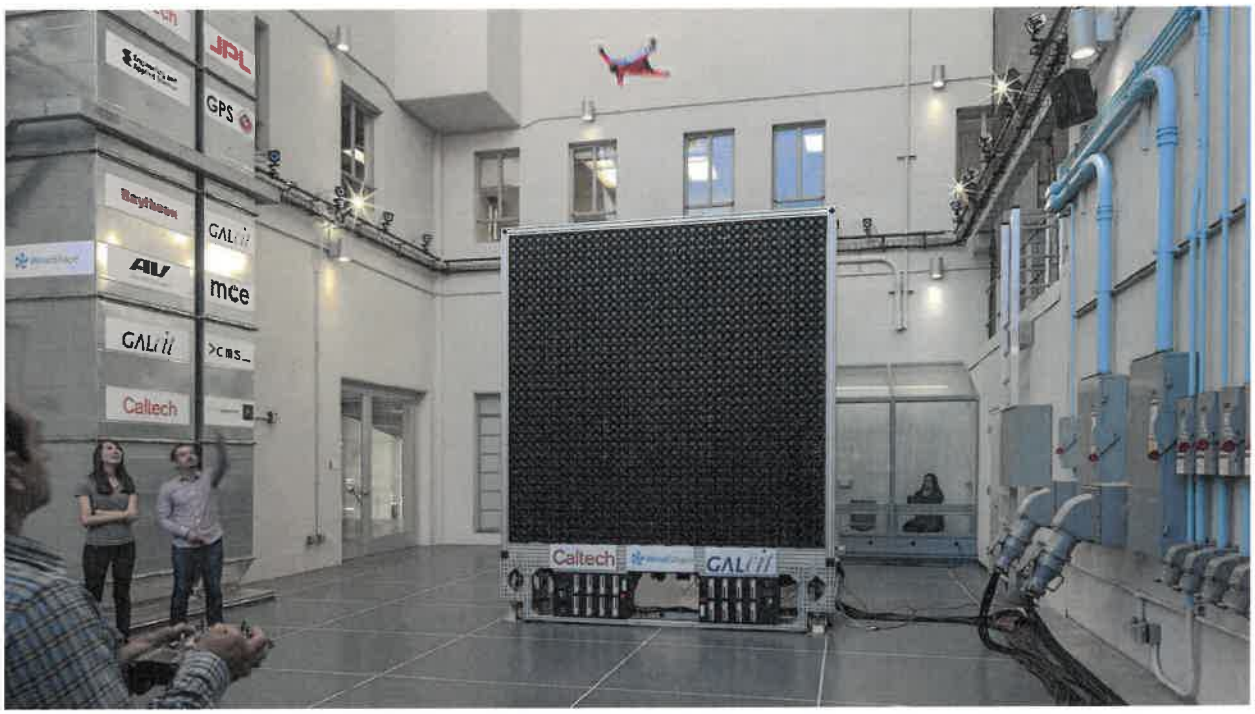

Fig. 3: A sample of possible Windshaper sizes and shapes

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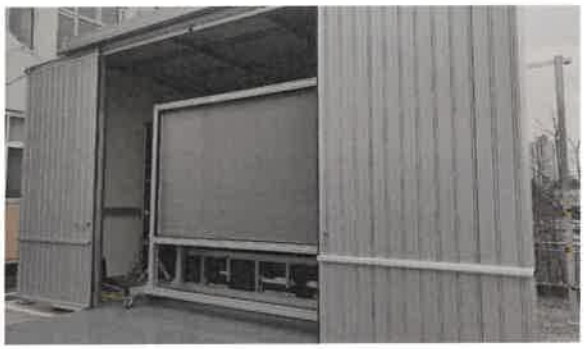
Customizable Features:

These features are optional add-ons you can use to enhance your testing capabilities.

Filter:

The Windshaper can be equipped with a flow filter to reduce unwanted turbulence. This feature ensures an even flow of air and is a great option for studying ground effect and a multicopter's ability to fly in its own landing-phase turbulence.



Tilt:

The Windshaper can be constructed with a tilting mechanism to allow for wind flow in any direction. With tilting capability up to 90°, an entire progression can be simulated from take-off to forward flight and back to landing.

Convergent:

A convergent device can be added to your Windshaper to increase the speed of the wind from 16 m/s up to 45 m/s, depending on the test section dimensions. Ask our sales team for more information about this add-on.

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Software

The Windshaper is managed with the WindControl software that allows you to fully and precisely control wind settings with simple commands. You can manually select the wind pixels that you wish to activate or you can input a mathematical function to reproduce any steady or time-variable wind profile. You can also control your Windshaper directly from a Python script using WindShape's Python 3.x control API.

- Dynamic control of the wind profile u = f(x, y, t)
- Smallest possible time step with dynamic control: 0.1s
- Ready swirl control for each wind pixel
- Improved WindControl Version 2.2 software
- Cross-platform portability (operating system)
- Network communication between user and Windshaper through Ethernet connexion
- Custom scripting interface using Python 3.x API
- Web-based graphical user interface

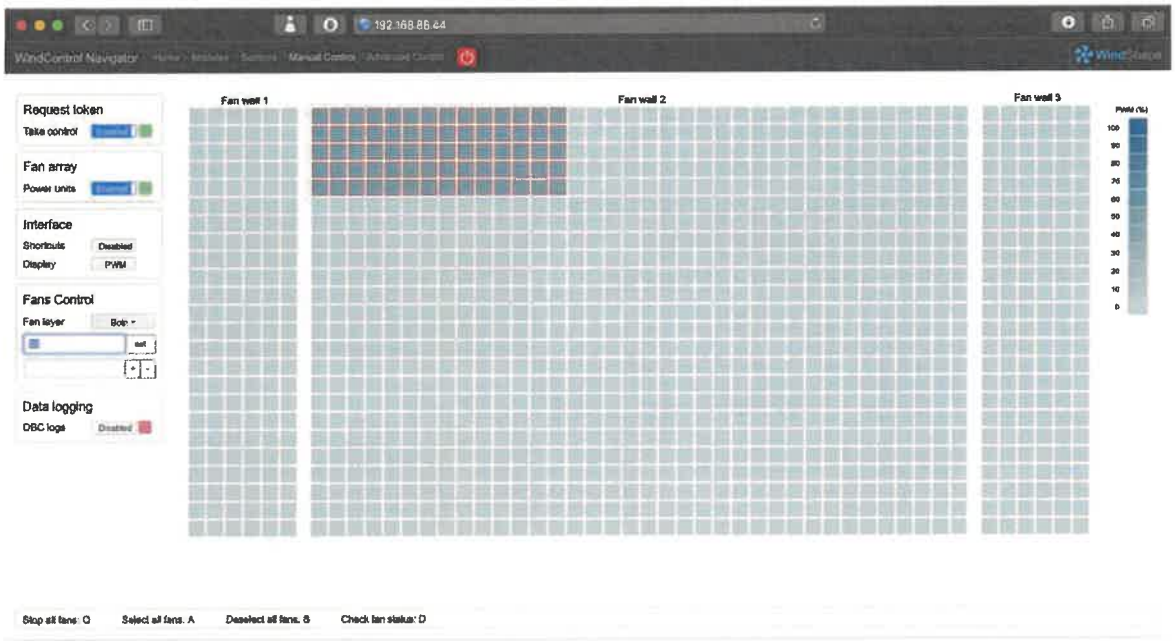
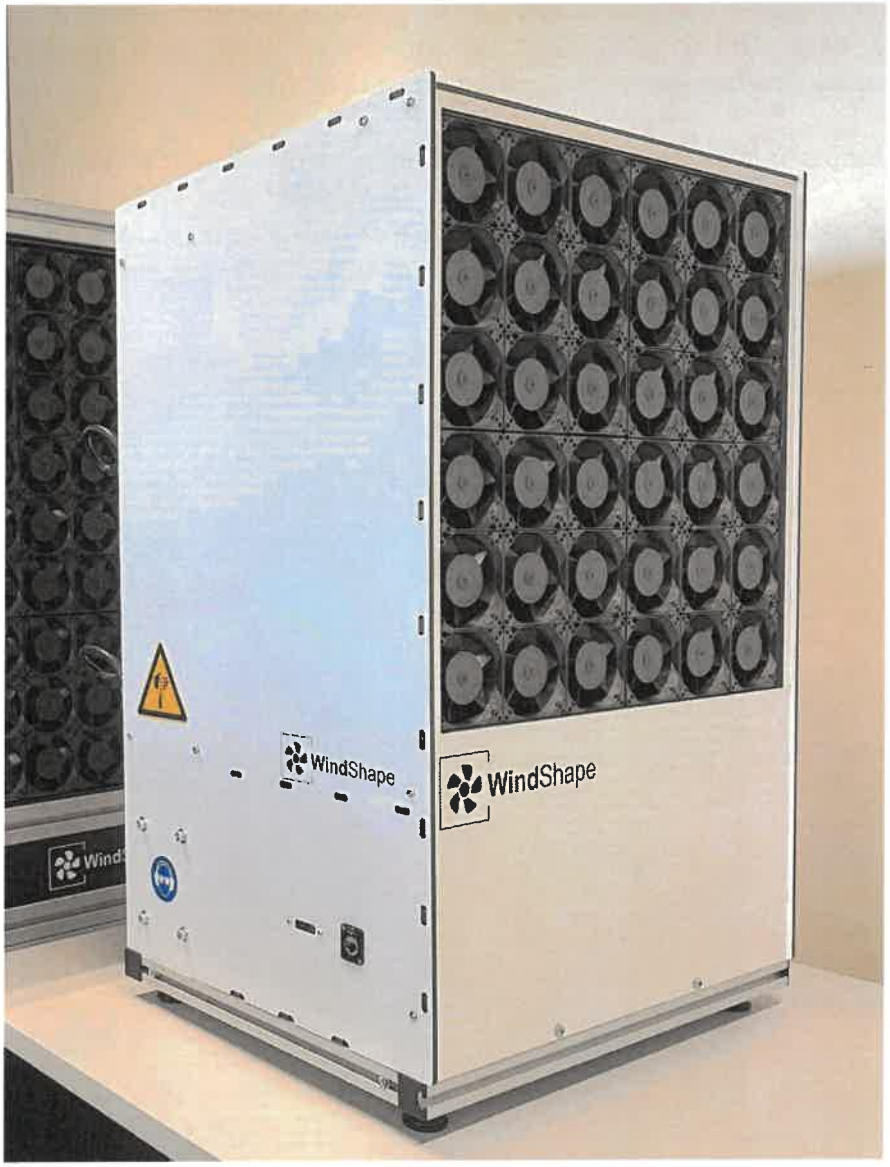


Fig. 4: WindControl GUI

2 x 2 Windshaper Datasheet



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Introduction

The 2 x 2 Windshaper allows the user to produce custom wind profiles in order to study their effects on propulsion systems, drones and aircraft profiles. The user has full control over the 3D wind profile, allowing for dynamic testing with wind flows up to 16 m/s.

Description

The 2 x 2 Windshaper is a 50 x 50 cm open air wind tunnel. The wind generator is composed of 4 modules, each with 9 wind pixel fan units. Each wind pixel is equipped with 2 counter-rotating fans that generate a flow speed up to 16 m/s.

The wind tunnel is managed with the WindControl software that allows you to precisely control wind settings with simple commands. 3D dynamic wind profiles are created either manually or with the custom scripting interface that uses a Python 3.x API. Each wind pixel is individually controlled, giving the user maximum control over the shape and speed of the wind profile.

Fig 1. 2 x 2 Windshaper rear view

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Applications

- Study performance with diverse wind profiles
- Dynamic / endurance testing
- Characterize wind / surface interactions
- UAV propulsion system testing
- Conventional aerodynamic study

Technical Specifications

Table 1: Design Specifications of the 2 x 2 Windshaper

Fan module specifications	Value	Unit
Number of pixels per module	9	(n/a)
Number of fans per wind pixel	2	(n/a)
Total number of fans per module	18	(n/a)

Fan array design parameters	Value	Unit
Number of modules along x-axis	2	(n/a)
Number of modules along y-axis	2	(n/a)
Number of modules	4	(n/a)
Width of the fan array	0.49	(m)
Height of the fan array	0.49	(m)
Surface of the fan array	0.24	(m^2)

Flow specifications	Value	Unit
Minimum flow speed (without flow manipulator)	2	(m/s)
Maximum flow speed (without flow manipulator)	16	(m/s)
Maximum flow rate	3.8	(m3 /s)
Ramp-up flow acceleration (hot wire at 1m from the fans)	4.0	(m/s^2)
Ramp-down flow deceleration (hot wire at 1m from the fans)	3.6	(m/s^2)

Electrical specifications	Value	Unit
Power consumption at max load and max pressure drop	5.0	(kW)
Power consumption at max load and zero pressure drop	3.9	(kW)
Power factor (higher than)	0.9	(n/a)
Input voltage (3P + N + GND)	230/400	(V)
Line current rating (per phase) *i* phase	7.2	(A)

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Hardware

The 2 x 2 Windshaper is designed to provide the full open air wind tunnel experience while fitting in smaller labs and test facilities. The system comes with four modules of nine fans each, a power and control unit with ethernet interface, the structural and fastening elements and the power distribution box and cables. Figure 2 shows the Windshaper's dimensions and module layout.

Recommended wall receptacles:

- 1x CEE32 (3P + N + GND) for 0A < iphase < 32A
- 1x CEE63 (3P + N + GND) for 32A < iphase < 63A
- 1x CEE125 (3P + N + GND) for 63A < iphase < 125A
- Nx CEE125 (3P + N + GND) for 125A < iphase

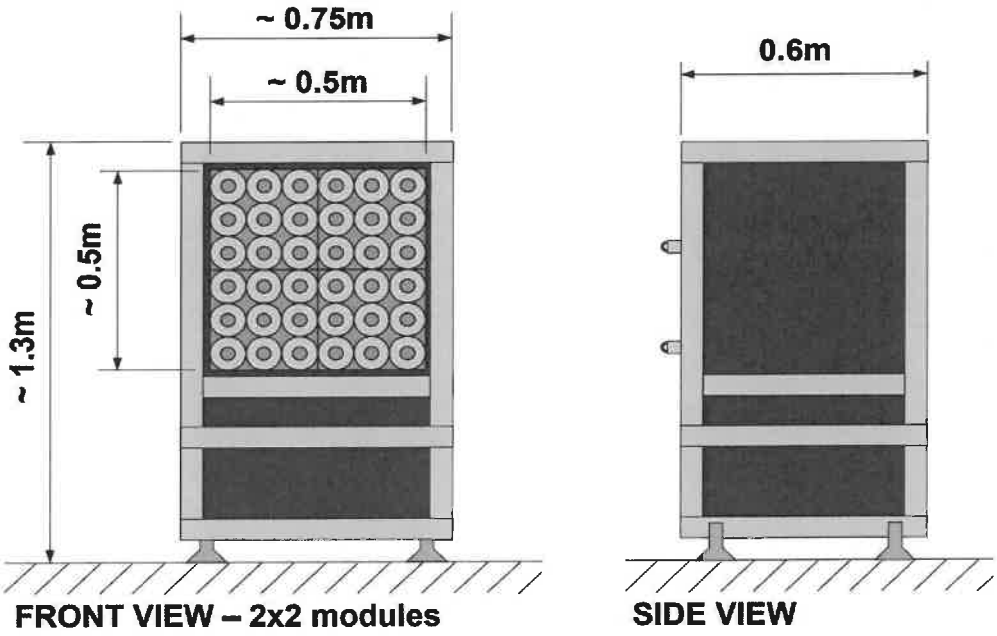


Fig. 2: Windshaper hardware dimensions

Software

The wind tunnel is managed with the WindControl software that allows you to fully and precisely control wind settings with simple commands. You can manually select the wind pixels that you wish to activate or you can input a mathematical function to reproduce any steady or time-variable wind profile. You can also control your wind tunnel directly from a Python script using WindShape's Python 3.x control API.

- Dynamic control of the wind profile u = f(x, y, t)
- Smallest possible time step with dynamic control: 0.1s
- Ready swirl control for each wind pixel
- Improved WindControl Version 2.2 software
- Cross-platform portability (operating system)
- Network communication between user and wind tunnel through Ethernet connexion
- Custom scripting interface using Python 3.x API
- Web-based graphical user interface

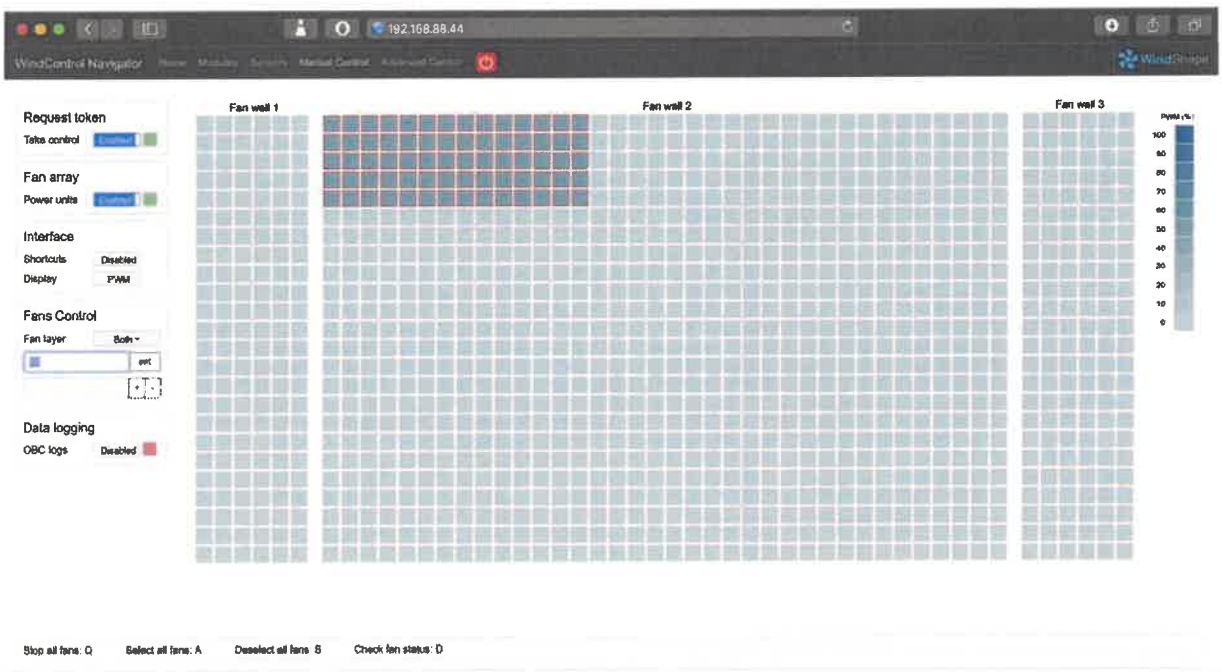
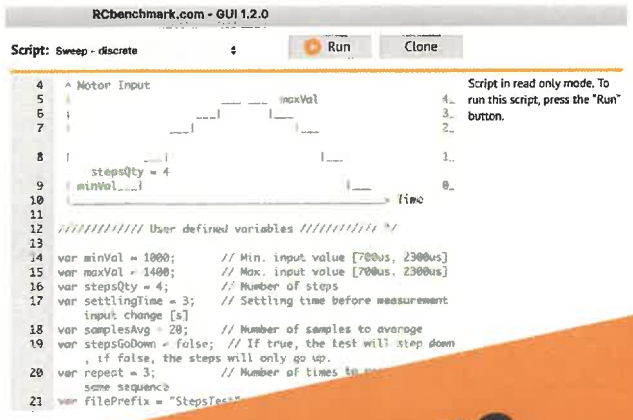


Fig. 3: WindControl GUI



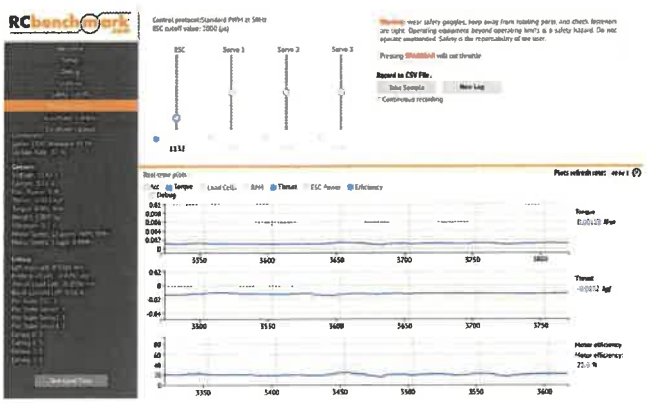
Software

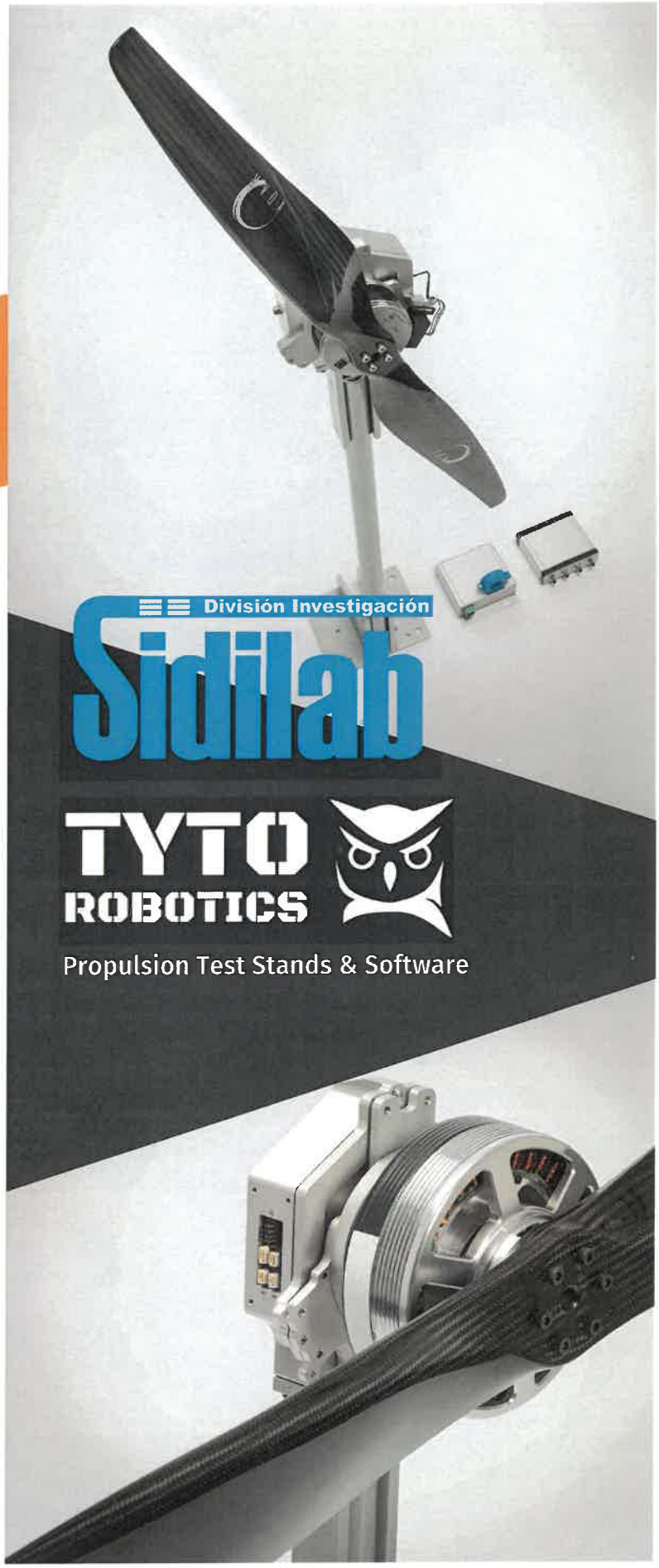
For data-acquisition and control

Our software is included in all test stand bundles and is used to control your test stand, view data in real-time, and export recorded data to a .CSV file.

Features:

- Manual servo control (three channels)
- Calibration wizard
- Safety cutoffs based on measured data
- User scripts with documentation
- Automated tests:
  - Ramp & Step tests
  - Measure Kv & the number of poles
  - Flight replay and much more!





Series 1580/1585

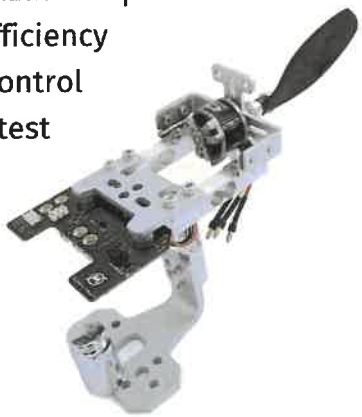
Small drone test stand

Technical Specs:

	Series 1580	Series 1585
Thrust (kgf)	(-5) – (+5)	(-5) – (+5)
Torque (Nm)	(-1.5) – (+1.5)	(-1.5) – (+1.5)
Voltage (V)	0 – 35	**0 – 50**
Current (A)	0 – 40	**0 – 55**
Speed (RPM)	0 – 190,000	0 – 190,000
Sampling rate (Hz)	7 - 8	**40 - 50**
Timing accuracy	20 ms	20 ms

Use Cases:

- In-runner & out-runner motor characterization
- Propeller characterization up to 16"
- Calculate system efficiency
- Servo testing and control
- Battery endurance test
- Factory tests



Series 1780

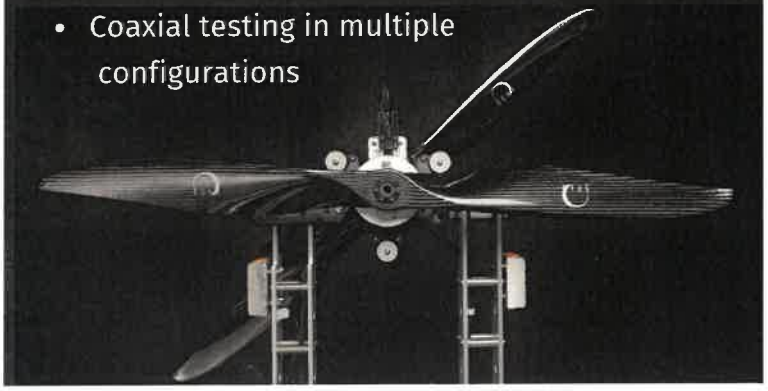
Large drone test stand

Technical Specs:

	25 kgf	40 kgf	75 kgf
Thrust (kgf)	(-25) – (+25)	(-40) – (+40)	(-75) – (+75)
Torque (Nm)	(-12) – (+12)	(-18) – (+18)	(-48) – (+48)
Voltage (V)	0 – 60	0 – 60	0 – 100
Current (A)	0 – 100	0 – 150	0 – 500
Speed (RPM)	0 – 190,000	0 – 190,000	0 – 100,000
Sampling rate (Hz)	40 - 50	40 - 50	40 - 50
Timing accuracy	20 ms	20 ms	20 ms

Use Cases:

- Characterize motors & propellers (up to 70")
- Quality control & maintenance testing
- Endurance & flight replay testing
- Coaxial testing in multiple configurations



Flight Stand

High precision drone test stand

Technical Specs:

	15 Standard (Pro*)	50 Standard (Pro*)
Thrust (kgf)	(-15) – (+15)	(-50) – (+50)
Torque (Nm)	(-8) – (+8)	(-25) – (+25)
Voltage (V)	0 – 180	0 – 180
Current (A)	0 – 150	0 – 300
Speed (RPM)	0 – 30,000	0 – 30,000
Sampling rate (Hz)	50 **(1,000*)**	50 **(1,000*)**
Timing accuracy	1 ms **(5 µs*)**	1 ms **(5 µs*)**

Use Cases:

- Real-time, dynamic testing of brushless motors and propellers (up to 30")
- Multi-powertrain testing
- Flight replay testing
- Control tests using a Python API

Windshaper

Open air wind tunnel

- Wind flows up to 16 m/s
- Create dynamic 3D wind profiles
- Custom-built to the size & shape you need
- Add a motion capture system or tilting capability

Use Cases:

- Free flight testing with drones and eVTOL
- Study turbulence tolerance and endurance
- Simulate take-off and landing phase
- Visualize airflow & study drone aerodynamics

Or try the pre-sized 2x2 Windshaper

TYTO ROBOTICS

At Tyto Robotics (formerly RCbenchmark) we specialize in the development of professional testing tools for the characterization of drone propulsion systems.

We manufacture several varieties of test stands that fully characterize brushless motors and propellers, measuring thrust, torque, RPM, power, efficiency and more.

Thousands of companies across the globe have benefited from our products, including NASA, Airbus, Skydrive and numerous prestigious research institutions.

Contact us for more information or a quote.

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Education Kit

Test stand and learning materials

Kit Components:

- Series 1580 or 1585 Test Stand
- 1.5h courseware about propeller theory
- 1.5h courseware about motor theory
- Optical RPM probe
- No-solder board
- 5 propellers
- 2 motors
- Motor controller (ESC)
- Safety enclosure

Topics covered:

- Mechanical and electrical power
- Electric motor theory
- Propeller theory
- Efficiency