

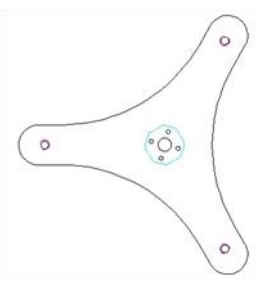

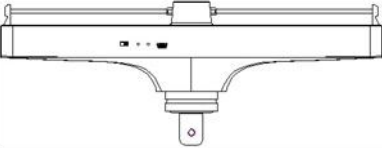



# Instruction Manual for Wireless Centripetal Force Demonstrator

Product No.: TP6012

## ■ Description

The product consists of Y-shape base, supporting rod, rotating stage, fastener, weights, Bluetooth adapter and power adapter. It is mainly used to explore the centripetal force.

## ■ Product Specification

NO.	Name	Picture	Quantity	Remark
1	Y-shape base		1 set	
2	Supporting rod		1 set	Include handle cover
3	Rotating stage		1 set	Include the adjusting screw
4	Fastener		1 set	Flat head screw M6*12, T-shape handle M6
5	Weights		1 set	2*20g, 2*30g, 1*50g
6	USB cable		1 piece	

## Wireless Centripetal Force Demonstrator

7	Power adapter		1 piece	5V, 0.5A
8	Bluetooth adapter		1 piece	Bluetooth 2.0

Tab.1

### ■ Product General Assembly Figure

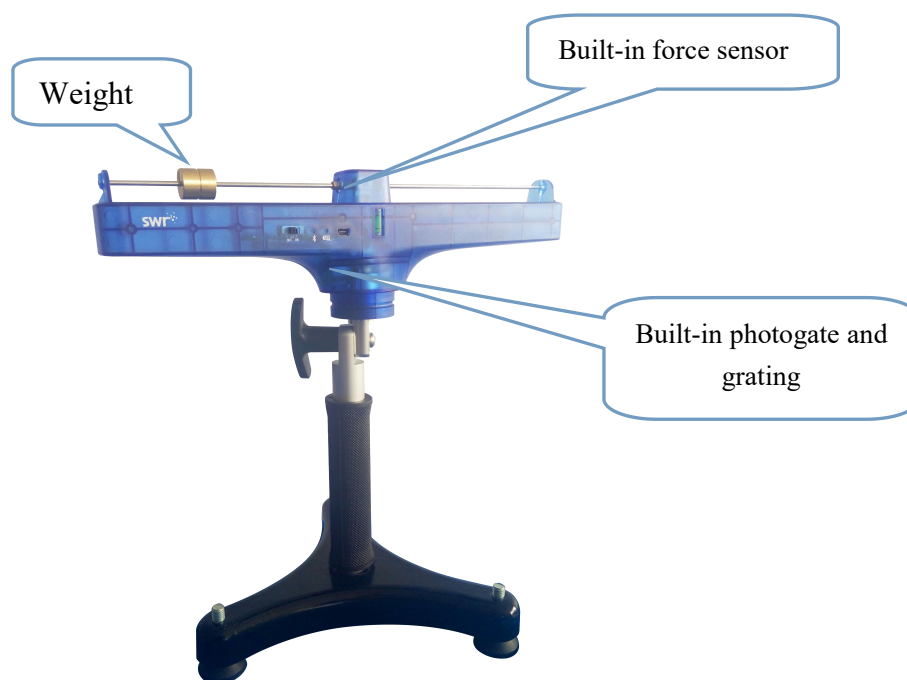


Fig.1

### ■ Product General Assembly Procedures

1. Fix the supporting rod on Y-shape base using fastener.
2. Mount the rotating stage on supporting rod using fastener. Mount the weights on the metal rod.
3. Place it on a level table and adjust the demonstrator in horizontal or vertical direction.

### ■ Experimental Case

#### Experiment name

Explore the centripetal force

#### Experimental aim

## Wireless Centripetal Force Demonstrator

1. To explore the relationship between centripetal force and angular velocity, radius and mass.
2. To observe centripetal force changing regulation with respect to time for circular motion.

### Experimental principle

The demonstrator has built-in force sensor and photogate. Force sensor is used to measure centripetal force. The built-in grating is used to calculate angular velocity by using the light blocking time of photogate so that the accuracy is increased. During experiment, angular velocity is decreasing. Apparatus records the experimental result and explore the relationship between centripetal force and radius and mass by changing them.

### Experimental apparatus

Computer, wireless centripetal force demonstrator and Bluetooth.

### Experimental installation figure



### Experimental procedures

#### Preparation:

Switch on the wireless centripetal force demonstrator. Open the experiment software. In 'Mechanics', select 'Wireless connect' and click 'wireless centripetal force'. Adjust the demonstrator to make it horizontal and click calibration.

#### Experiment:

##### 1. Horizontal:

Explore the relationship between centripetal force and angular velocity: insert the distance between weight and center. Rotate the rotating stage and click 'Start' to record data. The software records angular velocity and centripetal force for corresponding time. Click 'Stop' to stop collecting data. Click 'Fitting' and

## Wireless Centripetal Force Demonstrator

‘Quadratic fit’ to plot fitting line of the data. From the figure we can see the quadratic fitting line is similar to the trajectory of data points. Thus, we can deduce centripetal force is direct proportional to square of angular velocity.

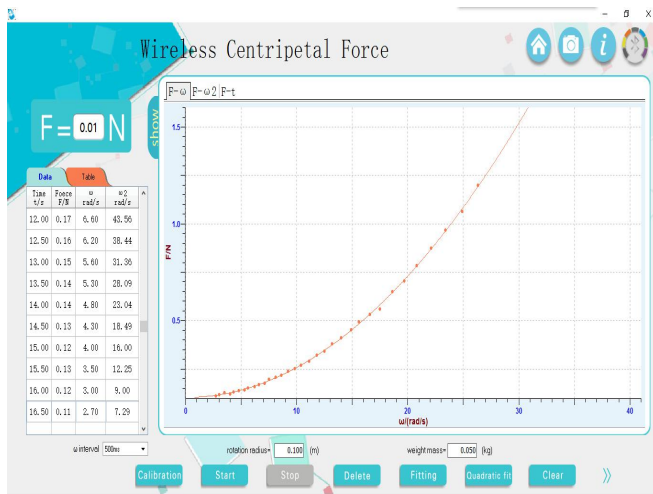


Fig.2:  $F - \omega$  Fitting Line

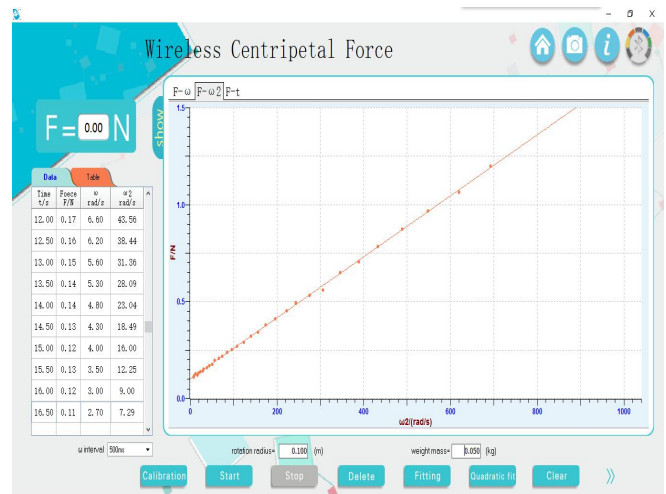


Fig.3:  $F - \omega^2$  Fitting Line

Explore the relationship between centripetal force and mass: keep the radius constant and change different weights. A set of data is measured and multiple  $F - \omega$  fitting line are obtained. Click ‘Select  $\omega$ ’ and click the software to select proper angular velocity. The software will automatically record the centripetal force for different mass under same angular velocity. Click ‘F-M graph’ and click ‘fitting’. From the figure we can deduce centripetal force is direct proportional to mass.

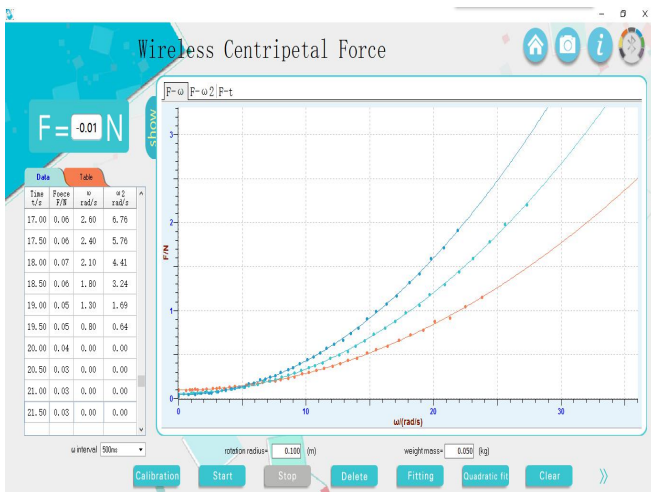


Fig.4:  $F - \omega$  Fitting Line



Fig.5: F-M Fitting Line

Explore the relationship between centripetal force and radius: keep the mass of weight constant (50g is suggested). Move the weight to change the radius. Measure multiple sets of data and click quadratic fit. From the figure we can deduce centripetal force is direct proportional to radius.

# Wireless Centripetal Force Demonstrator

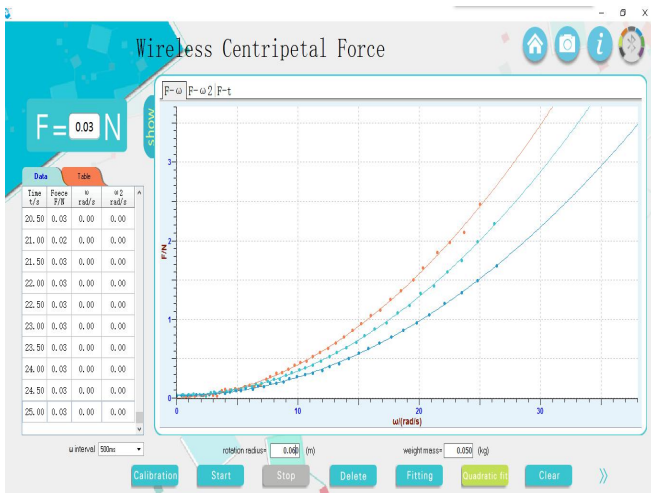


Fig.6:  $F - \omega$  Fitting Line

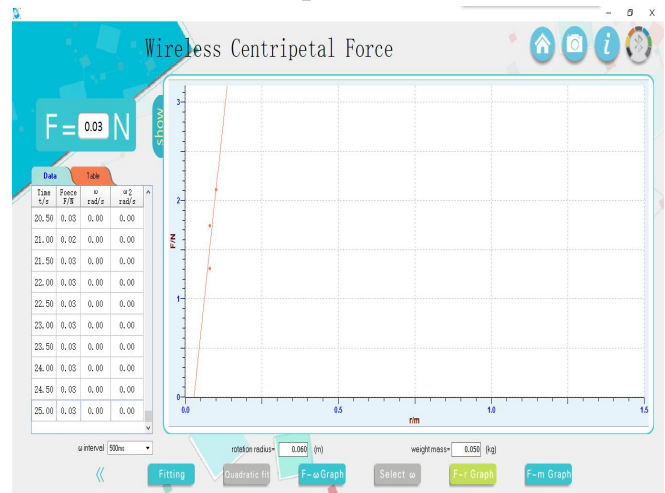


Fig.7: F-r Fitting Line

## 2. Vertical

Explore relationship between centripetal force and time: adjust the fastener and keep the direction of rotating stage vertical. Change the acquisition interval to 50ms. Click F-t after data collecting. From the figure we can deduce centripetal force change with respect to time periodically.

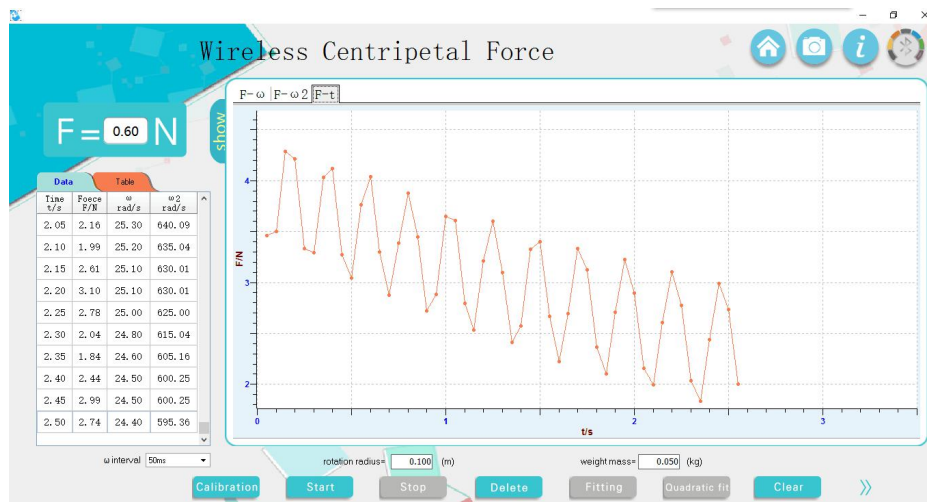


Fig.8: F-t Graph

## ■ Notes

1. Do not apply a force which over the range (10N) of the sensor to the metal bar because the force sensor is built-in the wireless centripetal force demonstrator.
2. Assembly and disassembly: use and preserve it carefully. Operate follow by the procedures. Generally, assembly starts from the bottom to the top while disassembly starts from top to bottom. Also, do not bend apparatus violently.
3. When performing experiment on horizontal direction, make sure the demonstrator is adjusted to horizontal so that the accuracy is kept high. Calibrate it before using each time.
4. When performing experiment on vertical direction, make sure the acquisition interval is 50ms.

5. You can adjust the angel of rotating stage to any value to observe the centripetal force change with respect to time.

■ **Operating System**

Connection	Support only wireless connection. The wire port is used to charge the demonstrator.
Supported system	Windows XP and above, iOS 8.0 and above, android 2.0 and above.

■ **Maintenance**

The device should be placed in a cardboard box if not in use. Use a damp cloth to wipe out the dust on the surface lightly. Avoid scratches caused by sharp articles on the surface.