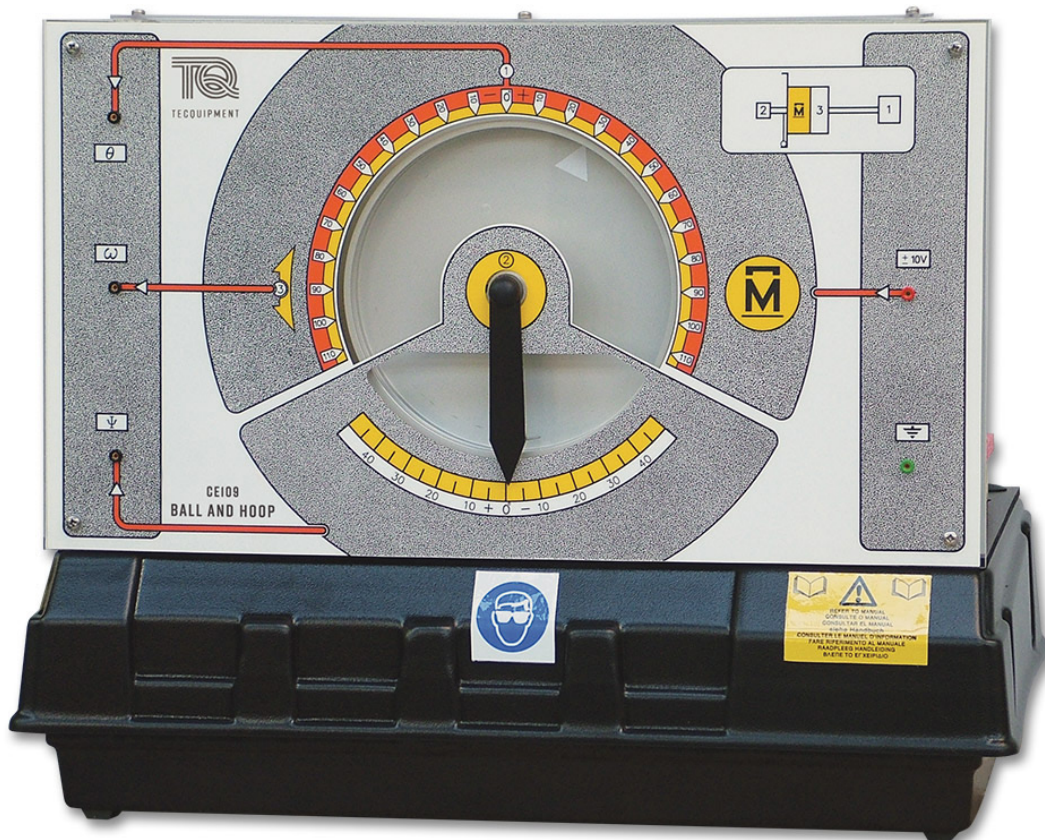




## ≡ BALL AND HOOP APPARATUS

CE109

A self-contained, benchtop apparatus to demonstrate basic control of position or speed of a ball in a hoop, and more advanced studies of liquid slop.



### KEY FEATURES

- Self-contained and compact benchtop unit for basic control of position or speed, and advanced studies of liquid slop
- Demonstrates the problems of speed and position control of a mobile body or liquid in a container
- Mimics industrial, aeronautical, fluid transport and pumping system problems with realistic results
- All inputs and outputs buffered for connection to TecQuipment's optional controllers or other suitable controllers
- Front panel includes a mimic diagram of the process so that students can see what they are controlling



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## DESCRIPTION

The CE109 Ball and Hoop Apparatus shows the use of electromechanical servo systems for position and velocity control. It also works as a model to show liquid slop problems, for example: aircraft missile fuel storage, fuel tankers and industrial pumping systems.

The apparatus has a steel ball that rolls inside a hoop. The hoop is free to rotate, but controlled by a servomotor. Transducers give outputs of the hoop and ball positions.

When the hoop is under angular position control, the ball moves like a cylindrical pendulum. This allows students to use it as a model for the study of liquid slop dynamics.

Advanced studies cover:

- The influence of liquid slop behaviour on vehicle control system design
- The use of 'pole zero' in the analysis of control systems

TecEquipment recommend that you use the optional Tachometer (OT1) for experiments in calibration of hoop velocity. Also, if you are not using the optional software, then an oscilloscope (OS1) will help to analyse the transient signals in some experiments.

## ESSENTIAL BASE UNIT

- Controller (CE120) – A controller with analogue and digital controls and instruments

**OR**

- Digital Interface (CE122) – An interface which connects between most products in the Control Engineering range and a suitable computer (not included)

**OR**

- Other suitable controller with +/- 10 V inputs and outputs

Both the CE120 and the CE122 include TecEquipment's CE2000 Control Software (see separate datasheet) with editable, pre-made control experiments for use with the CE109.

## STANDARD FEATURES

- Supplied with comprehensive user guide
- Five-year warranty
- Made in accordance with the latest European Union directives
- ISO9001 certified manufacturer

## LEARNING OUTCOMES

- The design and analysis of servo control systems for position and velocity control
- The analysis and modelling of liquid slop dynamics
- The use of 'pole zero' in the analysis of control systems

The flexible design of the equipment allows the user to develop many other analysis and control exercises to suit their needs. It is good for extended or advanced control experiments, and is ideal for student project work.

## RECOMMENDED ANCILLARIES

- Optical Tachometer (OT1)
- Oscilloscope (OS1)

## ESSENTIAL SERVICES

### ELECTRICAL SUPPLY:

Single Phase 90 – 250 VAC, 50/60 Hz, 0.4Amp, with earth

### BENCH SPACE NEEDED:

1 m x 750 mm

## OPERATING CONDITIONS

### OPERATING ENVIRONMENT:

Laboratory

### STORAGE TEMPERATURE RANGE:

-25°C to +55°C (packed)

### OPERATING TEMPERATURE RANGE:

+5°C to +40°C

### OPERATING RELATIVE HUMIDITY RANGE:

80% at temperatures < 31°C decreasing linearly to 50% at 40°C

## SOUND LEVELS

At operating work station, a maximum of 85 dB

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## SPECIFICATIONS

TecQuipment is committed to a programme of continuous improvement; hence we reserve the right to alter the design and product specification without prior notice.

### NETT DIMENSIONS AND WEIGHT:

540 mm x 330 mm x 420 mm, 18.7 kg

### PACKED DIMENSIONS AND WEIGHT:

0.3 m<sup>3</sup>, 41 kg (approx – packed for export)

### INPUTS (0-10 VDC):

- Motor drive signal: 0 to +/- 10 VDC

### OUTPUTS (0-10 VDC):

- Hoop angle: 0 to +/- 10 VDC
- Hoop velocity
- Ball position

### OTHER PARTS INCLUDED:

- Connecting cables
- Liquid colouring