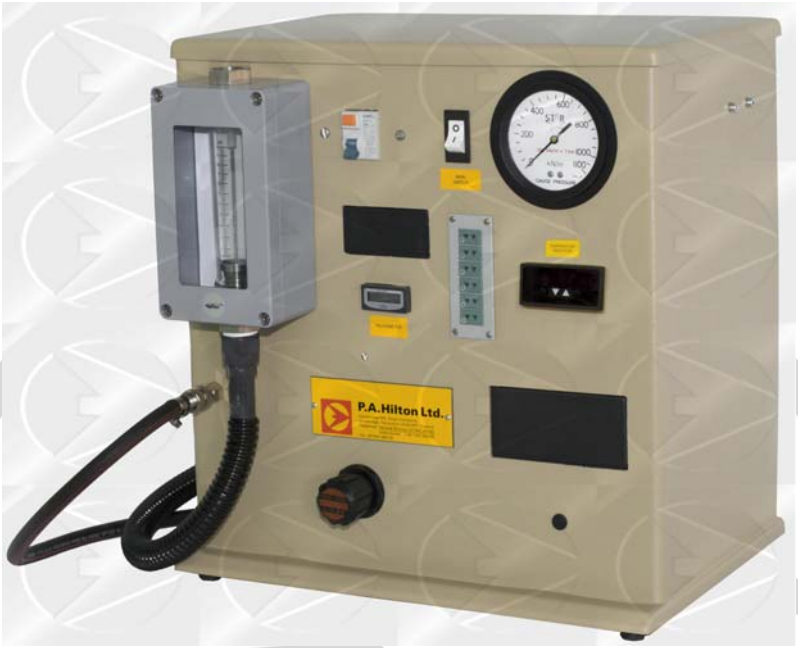
Compressible Flow Range
F300



F300 Base Unit

- ***An Expandable Range of Economic Bench Top Equipment That Enables Student Investigation of Compressible Air Flow and Associated Air Turbines***
- ***With The Optional Modules, Allows Detailed Investigation Of Sonic And Supersonic Flow In Nozzles, Jet Efficiency, Pressure Losses In Pipes And A Variety Of Heat Transfer Experiments***
- ***Safe and Suitable For Unsupervised Student Operation***
- ***Responds Immediately To System Changes Allowing Efficient Use Of Laboratory Time***
- ***Optional Computerised Data Acquisition Accessory for Most Options***
- ***Negligible Operating and Maintenance Costs***
- ***Two year Warranty***

Introduction

The phenomenon of compressible flow, sonic velocity and supersonic flow is possibly one of the most demanding areas of study for many students.
The Hilton Compressible Flow range F300 and its collection of optional accessories enable students to safely and clearly investigate the fundamentals of compressible flow, air turbines and a variety of heat transfer experiments.

The unit provides an extensive and expandable range of studies for students in the following disciplines.

- Aeronautical Engineering
- Mechanical Engineering
- Fluid Mechanics
- Nuclear Engineering
- Chemical Engineering
- Control and Instrumentation
- Plant and Process Engineering
- Building Services
- Engineering Physics
- Marine Engineering

Experimental Capabilities

The extensive range of optional accessories allow investigation of :-

- Nozzle Choking and Nozzle Efficiency
- Jet Reaction
- Over and Under Expansion in Supersonic Nozzles
- Pressure Distribution in Convergent and Convergent-Divergent Choked Nozzles
- Performance of Impulse Turbine
- Performance of Reaction Turbine
- Heat Transfer
- Pressure Losses in Pipes, Sudden Expansions and Bends
- Air flow Measurement Using Orifice Plates and Variable Area Flow Meters.

Specification

Compressible Flow Range F300

The main unit consists of an instrumentation and control console that supplies a variable flow of compressed air to the range of optional modules. The unit provides common instrumentation for all of the options. Specialised instruments are included as required with the modules.

Note that the Hilton Single Stage Compressor F860 OR Two Stage Compressor F865 can be used as a suitable air supply for the entire Compressible Flow Range F300

Dimensions

Height: 440mm Depth: 300mm
Width: 440mm Weight: 17kg.

Services Required

Electrical: A: 220-240 Volts, Single Phase, 50Hz
(With earth/ground).
Line current up to 10A at 230v

B: 110-120 Volts, Single Phase, 60Hz
(With earth/ground).
Line current up to 20A at 110v

Compressed Air: 900kN/m^2 (9 Bar Gauge) at up to 8g/s
(400 litre/min free air)

Ordering Information

Order as: Compressible Flow Range F300

Electrical Specification

Either: **A**: 220-240 Volts, Single Phase, 50Hz
(With earth/ground).

or

B: 110-120 Volts, Single Phase, 60Hz
(With earth/ground).

Language

Either: English, Spanish or French.

Shipping Specification

Service Unit Net Weight: 50 kg.
Packing Case Volume: 0.52m^3

Accessories and Spares

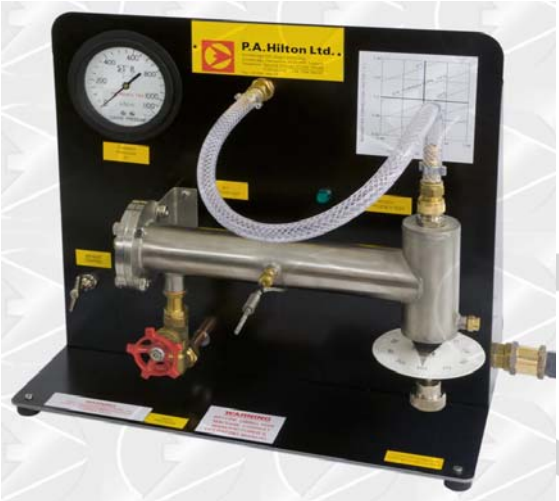
Unit supplied with:

- One experimental operating and maintenance manual in English, Spanish, French.
- Accessories and spares for 2 years normal operation. List available on request

Also Available On Request

Further detailed specification.
Additional copies of instruction manual.
Recommended list of spares for 5 years operation.

Optional Extra F300A
Nozzle Performance Test Module



Specification

A series of convergent and convergent-divergent nozzles may be installed in one of two locations in a high pressure measuring chamber. A pressure regulator, throttle valve and back pressure valve allow the air flow rate, inlet and discharge (or back) pressure to be varied.

Standard unit includes convergent – divergent ducts designed to produce Mach 1.0 at the throat and supersonic velocities downstream.

Inlet and outlet air pressures, temperatures and air flow rate are recorded by a combination of instrumentation on the Compressible Flow Range F300 base unit and the optional module.

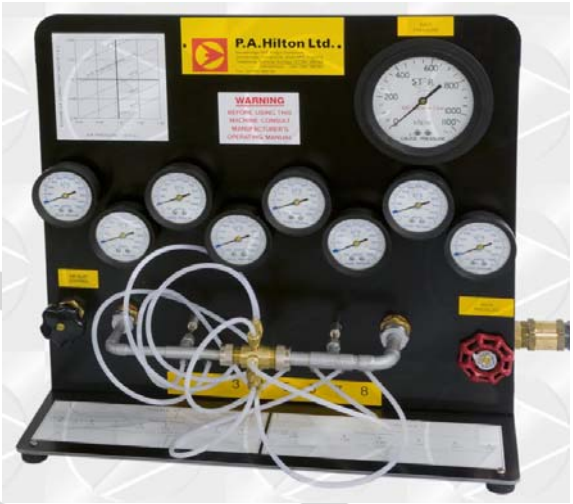
Experimental Capabilities

- Visual demonstration of nozzle choking
- Determination of the effect of inlet and back pressure on mass flow rate through nozzles.
- Comparison of mass flow rate with theoretical values.
- Measurement of the velocity of a jet issuing from a nozzle operating at a variety of inlet and back pressures.
- Calculation of nozzle efficiencies.
- Determination of jet reaction and specific thrust at a range of inlet and back pressures.

Ordering Information

Order as: Nozzle Performance Test Module F300A

Optional Extra F300B
Nozzle Pressure Distribution Module



Specification

Two convergent-divergent nozzles of with the same throat diameter but different discharge area and a single convergent nozzle having the same diameter are supplied and fit in the common test section. All three nozzles have axial static pressure tapings allowing the approach, throat and divergent section pressures to be measured. The variation of pressure ratio and mass flow may be investigated for all three nozzles.

Standard unit includes convergent – divergent ducts designed to produce Mach 1.0 at the throat and supersonic velocities downstream.

Instrumentation on the Compressible Flow range F300 base unit and the optional module allow all relevant temperatures, pressures and flow rates to be recorded.

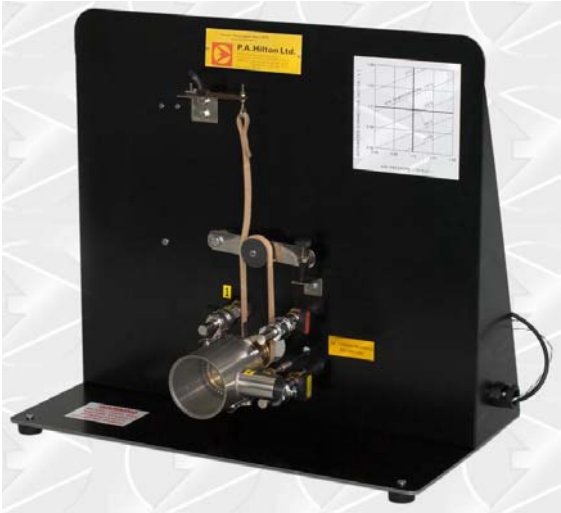
Experimental Capabilities:

- Visual demonstration of nozzle choking
- Visual demonstration of under expansion and over expansion with re-compression(shock wave)..
- Investigation of the relationship between inlet pressure and mass flow rate.
- Investigation of the relationship between outlet pressure and mass flow rate for:- A convergent nozzle, Two convergent-divergent nozzles
- Investigation of the pressure distribution in convergent and convergent-divergent nozzles over a variety of overall pressure ratios.

Ordering Information

Order as: Nozzle Pressure Distribution Module F300B

Optional Extra F300C
Experimental Impulse Turbine



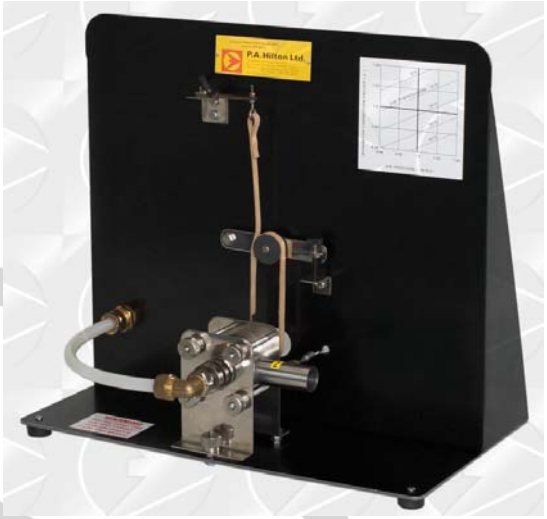
Specification
An impulse turbine with 4 separate nozzles and control valves, a throttle valve and belt brake dynamometer. Inlet and outlet air temperatures are recorded allowing the temperature drop due to work output to be measured.

Inlet and outlet air pressures, temperatures and air flow rate, turbine torque and speed are recorded by a combination of instrumentation on the Compressible Flow Range F300 base unit and the optional module.

Experimental Capabilities
- Visual examination of a small impulse turbine.
- Production of torque/speed and power/speed curves from a no load speed of approximately 40,000 rev/min to stall and at a range of inlet pressures.
- Comparison of turbine performance including specific air consumption when using throttle control or nozzle(4) control.
- Application of the First law of Thermodynamics to a simple open system undergoing a steady flow process..
- Determination of the isentropic efficiency of a turbine and plotting the end states on a temperature/entropy diagram.
- Determination of resisting torques due to bearing friction and disc aerodynamic friction at various speeds.

Ordering Information
Order as: Experimental Impulse Turbine F300C

Optional Extra F300D
Experimental Reaction Turbine Module



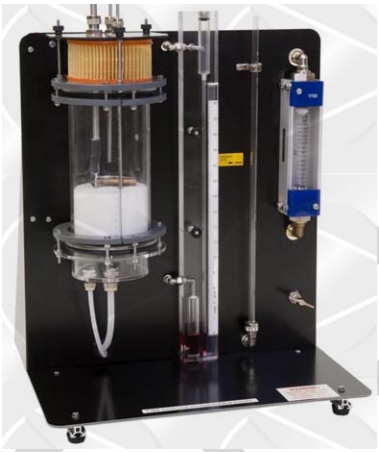
Specification
A single stage, radial flow , two jet reaction turbine with a throttle valve and belt brake dynamometer. Inlet and outlet air temperatures are recorded allowing the temperature drop due to work output to be measured.

Inlet and outlet air pressures, temperatures and air flow rate, turbine torque and speed are recorded by a combination of instrumentation on the Compressible Flow Range F300 base unit and the optional module.

Experimental Capabilities
- Visual examination of a small reaction turbine.
- Production of torque/speed and power/speed curves from a no load speed of approximately 35,000 rev/min to stall and at a range of inlet pressures.
- Application of the First law of Thermodynamics to a simple open system undergoing a steady flow process.
- Determination of the isentropic efficiency of a turbine and plotting the end states on a temperature/entropy diagram.
- Determination of resisting torques due to bearing friction and disc aerodynamic friction at various speeds.

Ordering Information
Order as: Experimental Reaction Turbine F300D

Optional Extra F300E
Fluidisation / Fluid Bed Heat Transfer Module



Specification
A glass cylindrical chamber with an air distribution plate at the bottom end allows the granular material supplied to be fluidised by a controlled and measured air flow. An adjustable cylindrical heater with surface thermocouple and power meter can be immersed at any level in, or out of the bed to allow measurement of the local heat transfer coefficient.

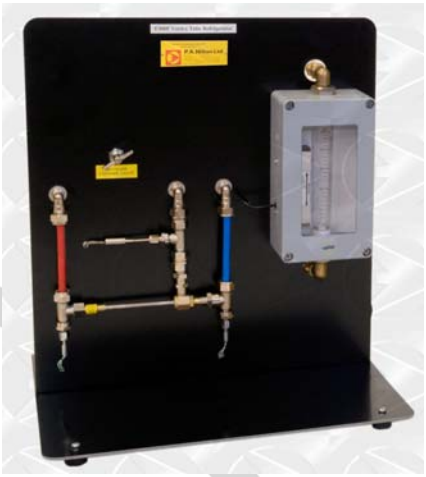
A moveable pressure tapping and separate thermocouple allow the pressure and temperature within the bed at any depth to be measured. The pressures, temperatures and air flow rate are recorded by a combination of instrumentation on the Compressible Flow Range F300 base unit and the optional module.

Experimental Capabilities:
- Observation of the behaviour in a fluidised bed of a wide range of granular materials, from the start of fluidisation to entrainment of the material.
- Measurement of air flow and pressure drop through a variety of granular materials as packed and as fluidised beds.
- Investigation of the effect of distributor design and bed behaviour.
- Investigation of the effect of :-
    - Superficial velocity
    - Depth of immersion
    - Particle size

  on the heat transfer coefficient for a hot cylindrical surface in a fluidised bed.
- Demonstration of separation by particle size and density.

Ordering Information
Order as: Fluidisation/Fluid Bed Module F300E

Optional Extra F300F
Vortex Tube Refrigerator Module



Specification
A compressed air vortex tube has two outlet ports that can be adjusted to vary the proportion of flow that leaves from the hot and cold exit points.

Using a common compressed air source at ambient temperature, the cold stream can reach temperatures below -30°C and the hot stream temperatures above 50°C.

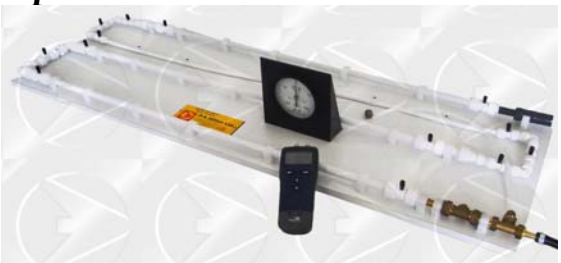
The effect of air supply pressure on the performance can be investigated together with the overall refrigerating effect. The pressures, temperatures and air flow rate are recorded by a combination of instrumentation on the Compressible Flow Range F300 base unit and the optional module.

Experimental Capabilities:
- Demonstration of the ability to produce hot and cold air streams from a device with no moving parts
- Production of performance curves for a vortex tube with:-
    - Variation of inlet pressure
    - Variation of hot and cold gas ratios
    - Variation of gas used (locally sourced)
- Determination of the refrigerating effect and comparison of this with the estimated power required to drive the compressed air source.

Ordering Information
Order as: Vortex Tube Refrigerator Module F300F

Optional Extra F300G

Pipe Friction Module



Specification

A series of four straight tubes of different diameters with end pressure tapings allow pressure losses in a straight pipe to be investigated at a range of Reynolds numbers. Bends, sudden enlargements and contractions are included to allow investigation of pressure loss and recovery.

The unit is driven by an ejector (jet pump) allowing investigation of entrainment ratio and ejector performance.

The pressures, temperatures and air flow rate are recorded by a combination of instrumentation on the Compressible Flow Range F300 base unit and the optional module. A digital hand held manometer is supplied.

Experimental Capabilities

- Simple Pipe Friction
- Performance of an ejector.
- Variation of friction coefficient with Reynolds number.
- Friction coefficient for compressible flow.
- Pressure recovery across a sudden change of pipe cross section.
- Pressure drop across a bend

Ordering Information

Order as: Pipe Friction Module F300G

Optional Extra FC301A

Data Acquisition Upgrade

The optional Computer Upgrade FC301A is compatible with most of the optional units in the F300 range (F300C, F300D, F300E, and F300F).

Hardware details

The Optional Computerised Data Acquisition Upgrade FC301A consists of a 21 channel Hilton Data logger (D103), together with pre-configured, ready to use, Windows™ compatible educational software.

Factory fitted coupling points on the F300 allow installation of the upgrade to the unit at any time in the machine's extensive life.

The Hilton Data logger (D103) connects, using the cable supplied, to a standard USB port on the user-supplied PC. If more than one logger is required connection is via a second USB port or standard USB hub.

The combined educational software and hardware package allows immediate computer monitoring and display of all relevant parameters on the F300.

Software Details

The pre-configured menu driven Software supplied with the Computer Upgrade FC301A allows all recommended experiments involving the electronic transducers and instruments on the F300 to be carried out with the aid of computerised data acquisition, data storage and on-screen data presentation. This enhances student interest and speeds comprehension of the principles being demonstrated.

Students are presented with either raw data for later hand calculation or alternatively data may be transferred to most spreadsheets for computerised calculation and graphical presentation.

Data may be stored on disc and displayed at any time using the software supplied. Alternatively data may be transferred to any compatible spreadsheet together with individual time and date stamp on each reading for complex analysis.

Additional Data Logging Facility Supplied As Standard

The D103 is the third generation of Hilton Data Logger. It comprises an industrially proven 21 channel interface with 8 thermocouples (type T and K as standard) / differential voltage inputs (±100mv DC), 8 single ended DC voltage inputs (±8v), 4 logic or frequency inputs and one mains voltage input. In addition there are on board 12v DC, ±5V DC and ±15v DC power supplies for most commercially available transducers.

The Hilton Data Logging software supplied as standard with the FC301A package allows the D103 to be disconnected from the F300 and used together with most standard transducers as a stand alone computer data logger for the instrumentation and monitoring of existing laboratory equipment using locally sourced industrial transducers. The software is also backwards compatible with our many second generation D102 data loggers that are already in use worldwide.

Full data logger command protocol and communications details are provided in an extensive user manual that allows other software applications to communicate with the logger via the USB interface. Users can write their own software, typically in LabView, Matlab, C, C++, Visual Basic etc. This further expands the student project capabilities of the FC301A package from teaching and demonstration into the field of research and postgraduate study.

Computer Hardware Requirements
The menu driven Software supplied with the Computer Upgrade FC301A will operate on a PC which has at least 0.5Gb Mb ram, VGA graphics, 1Gb hard drive, CD drive and an available USB port. The software is Windows 2000, XP and 7 compatible.

Ordering Information

Order as: Data Acquisition Upgrade FC301A

P.A.HILTON Ltd.

Horsebridge Mill, King's Somborne,
Stockbridge, Hampshire, SO20 6PX, England.

Telephone: National (01794) 388382
International +44 1794 388382

Fax: National (01794) 388129
International +44 1794 388129

E-mail: sales@p-a-hilton.co.uk
Website: www.p-a-hilton.co.uk

SCAN ME WITH A SMARTPHONE

P.A.HILTON Ltd.