# HEAT FLOW EXPERIMENT

The Heat Flow Experiment is a process control plant ideal to demonstrate simple first order model control concepts as well as fluid dynamics and thermodynamics control fundamentals.

## A SYSTEM FOR STUDYING SIMPLE DYNAMICS

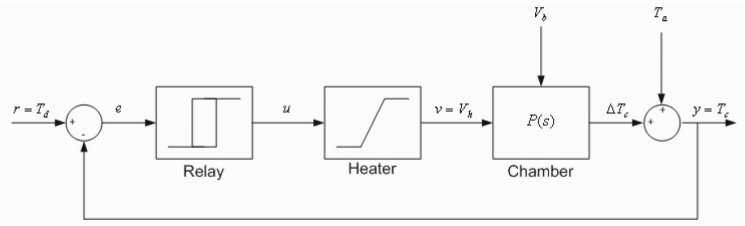
The Quanser Heat Flow Experiment demonstrates control topics related to fluid dynamics and thermodynamics. It introduces a "bump test" method, a simple technique used to find the first-order model of the system and helps students better understand temperature control strategies, such as an on-off control scheme using a relay switch, and advanced PID control topics including set-point weight and integral anti-windup.

## HOW IT WORKS

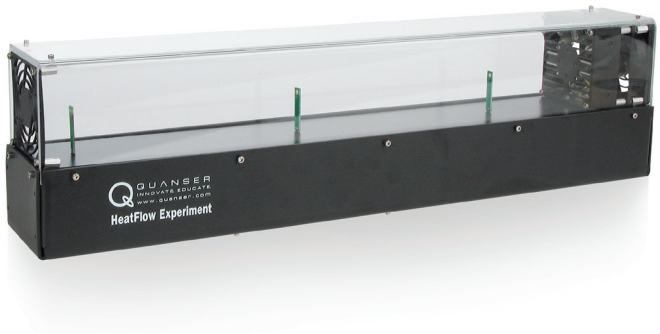
The Quanser Heat Flow Experiment plant consist of a fiberglass chamber that is equipped with a coil-based heater and a blower at one end and three temperature sensors located equidistantly along the chamber.

The Heat Flow Experiment has a built-in amplifier to deliver power to the heater and blower. The power delivered to the heater and blower is controlled using analog signals. The fan speed can also be controlled using an analog signal, and is measured by a tachometer mounted on the blower measuring angular rate of the blower fan.

The three temperature sensors in the chamber are fast settling platinum transducers.




The block diagram helps students understand how to implement on-off control using a relay switch.




**System specifications on reverse page.**

## HEAT FLOW EXPERIMENT WORKSTATION COMPONENTS

Heat Flow Experiment plant

Q8-USB data acquisition device

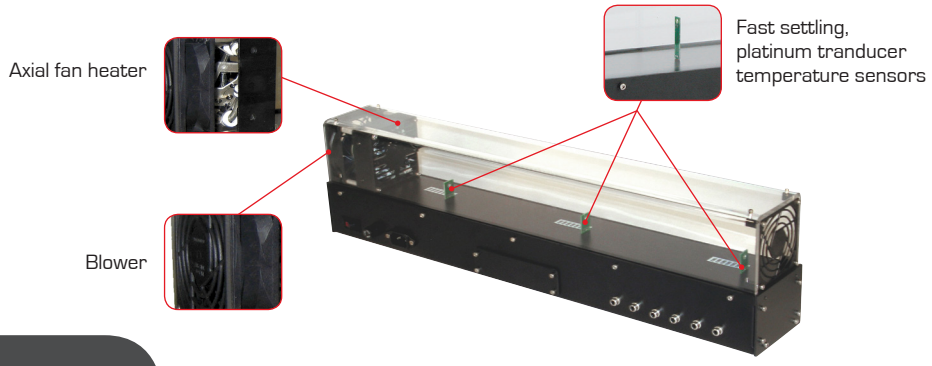
QUARC real-time control software for MATLAB®/Simulink®

Instructor and Student Workbooks, and User Manual (provided in digital format)

Sample pre-built controllers

# SYSTEM SPECIFICATIONS

## Heat Flow Experiment




### CURRICULUM TOPICS PROVIDED

- Experimental modeling – step response
- Transfer function representation
- Model validation
- PID control
- Set-point weighting
- Integrator windup
- Feed-forward

### FEATURES

- Fast settling platinum temperature transducers to measure the chamber air temperature
- Tachometer for measuring angular rate of the blower fan
- Coil-based heater
- Solid Plexiglas chamber
- Fully compatible with MATLAB®/Simulink®
- Fully documented system models and parameters provided for MATLAB®, Simulink® and Maple™
- Open architecture design, allowing users to design their own controller

### DEVICE SPECIFICATIONS

| | |
|---|---|
| Device dimensions (L x H x W) | 50 cm x 15 cm x 10 cm |
| Device mass | 0.5 kg |
| Cross sectional chamber area | 0.0064 $m^2$ |
| Blower nominal input voltage | 6 V |
| Blower nominal airflow | 1.02 $m^3$/min |
| Maximum wind speed | 159.4 m/min |
| Blower maximum speed | 2700 RPM |
| Tachometer calibration gain | 1064 RPM/V |
| Heater maximum power (at 5 V) | 400 W |
| Temperature sensor calibration gain | 20 °C/V |
| Temperature sensor settling time | 4 s |

### COMPLETE WORKSTATION COMPONENTS

| | |
|---|---|
| Plant | Heat Flow Experiment |
| Control design environment | Quanser QUARC® add-on for MATLAB®/Simulink® |
| Documentation | User Manual, Instructor and Student Workbooks |
| Real-time targets | Microsoft Windows® |
| Data acquisition devices | Quanser Q8-USB, QPIDe |

The system model and a sample controller(s) are supplied

About Quanser:
Quanser is the world leader in education and research for real-time control design and implementation. We specialize in outfitting engineering control laboratories to help universities captivate the brightest minds, motivate them to success and produce graduates with industry-relevant skills. Universities worldwide implement Quanser's open architecture control solutions, industry-relevant curriculum and cutting-edge work stations to teach Introductory, Intermediate or Advanced controls to students in Electrical, Mechanical, Mechatronics, Robotics, Aerospace, Civil, and various other engineering disciplines.



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