



# *Mechanical Heat Pump*

## *R515*



Above: R515 shown fitted with standard wattmeter

- *Stabilises in minutes allowing many tests to be conducted in a typical laboratory period.*
- *Allows a complete refrigerant pressure-enthalpy cycle diagram to be drawn at all operating conditions.*
- *Operates on CFC free R134a refrigerant.*
- *Allows a complete energy balance to be performed between electrical input and thermal input/output.*
- *Allows generation of heat pump performance curves over arrange of conditions.*
- *Optional Data Acquisition Upgrade.*
- *Two year warranty*



## ***Introduction***

The R515 Hilton Mechanical Heat Pump has been designed to provide students with a practical and quantitative demonstration of the vapour compression cycle, and is suitable for all course levels, from vocational to undergraduate.

Both refrigerators and heat pumps use the vapour compression cycle, and although the applications of these machines differ the components are essentially the same.

The unit described here demonstrates the heat pump application where a large freely available energy source, such as atmosphere, is to be upgraded for water heating.

As a bench top unit designed for student use, the unit will be of particular interest to those studying:

- **Mechanical Engineering**
- **Agricultural Engineering**
- **Energy Conservation**
- **Thermodynamics**
- **Building Services**
- **Chemical Engineering**
- **Marine Engineering**
- **Plant & Process Engineering**
- **Refrigeration and Air Conditioning**
- **Food Technology**

## ***Experimental Capabilities***

- Determination of power input, heat output and coefficient of performance.
- Production of heat pump performance curves over a range of source and delivery temperatures.
- Plotting the vapour compression cycle on a p-h diagram and comparing this with the ideal cycle.
- Determination of energy balances for condenser and compressor.
- Production of heat pump performance curves based on R134a properties, at a variety of evaporating and condensing temperatures.
- Estimation of the effects of compressor pressure ratio on volumetric efficiency.

## ***Description***

The components of the heat pump and its instrumentation are mounted on a gloss finish high quality ABS plastic panel.

The heat pump consists of a hermetic compressor, an efficient plate heat exchanger condenser, a liquid receiver, a thermostatically controlled expansion valve and air heated evaporator.

The components are clearly but compactly arranged in a manner similar to that used for many domestic air-water heat pumps and all are visible from the front of the unit.

The operating cycle is as follows:

Slightly superheated Refrigerant R134a vapour enters the compressor from the evaporator and its pressure is increased. This brings about a rise in temperature and the hot vapour enters the water cooled condenser. Heat is given up to the cooling water and the refrigerant condenses to a liquid before passing to the liquid receiver and then the expansion valve.

On passing through the expansion valve the pressure of the liquid refrigerant is reduced, causing the saturation temperature to fall to below that of the atmosphere. Thus, as it flows through the evaporator, there is a temperature difference between the refrigerant and the air being drawn across the fins. The resulting heat transfer causes the refrigerant to boil, and on leaving the evaporator it has become slightly superheated vapour, ready to return to the compressor. The degree of superheat is automatically controlled by the expansion valve, which may be adjusted.

The temperature at which heat is delivered in the condenser is controlled by the water flow rate and its inlet temperature. Water may be delivered at up to 50°C.

The evaporating temperature is largely determined by the ambient conditions of temperature and humidity. However, a limited variation is possible, either by restricting the air intake to the evaporator, or by directing warmed air towards the intake. (The air inlet temperature should not be allowed to exceed 35°C to avoid overloading the compressor.)

Variable area flowmeters on both the refrigerant and cooling water circuits, an electrical energy meter recording power input to the compressor and a digital electronic thermometer recording all relevant temperatures, allow an interesting and comprehensive range of experiments to be conducted.



## Specification

### General

A fully instrumented bench top air to water heat pump operating on the mechanical vapour compression cycle with refrigerant R134a as the working fluid.

### Detailed

**Refrigerant:** R134a (HFC134a)

**Panel:** High quality ABS plastic panel on which the following components are mounted.

**Compressor:** Fully hermetic single cylinder reciprocating type. Displacement  $8.85 \text{ cm}^3 \text{ rev}^{-1}$

**Condenser:** Refrigerant to water. Efficient plate type heat exchanger.

**Liquid Receiver:** With valves. Contains entire refrigerant charge if required.

**Evaporator:** Air to refrigerant. Serpentine copper tube with aluminium fins and with integral fan.

**Digital Thermometer:** Resolution  $0.1^\circ\text{C}$ , with switch to select from six thermocouples.

**Flow Meters (2):** Variable area type – to indicate R134a and  $\text{H}_2\text{O}$  flow rates.

**Pressure Gauges (2):** To indicate R134a pressures in evaporator and condenser.

**Electrical Energy Meter:** Watt-hour type recording electrical input to the compressor. (*Digital Wattmeter available as optional extra R515A*).

**Safety Features:** Condenser high pressure switch and compressor thermal overload switch. Residual current circuit breaker and a combined double pole main switch and overload cut out. All electrical components connected to common earth conductor.

### Optional Data Acquisition Upgrade

An optional Computerised Data Acquisition Upgrade RC516A is available to enable all relevant system parameters to be automatically recorded on a PC for further analysis and display. Data may also be transferred to spread sheet format for complex analysis and calculation.

## Dimensions

Height: 46cm Depth: 65cm  
Width: 95cm Weight: 65kg.

## 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.

## Services Required

### Electrical: A:

Either: 600W 220-240 Volts, Single Phase  
50 Hz (with earth /ground). Line  
current up to 3.0A at 230v.

Or:

**B:** 600W 110-120 Volts, Single  
phase, 60Hz (with earth /ground).  
Line current up to 6.0A at 110V.

**Water:** Cold water, continuous supply.  
180 litres/Hour at 15 m head  
minimum.

## Ordering Information

**Order as:** R515 Mechanical Heat Pump Unit

### Optional:

R515A Digital Wattmeter Upgrade  
RC516A Data Acquisition Upgrade

## Electrical Specification

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

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

## Language

Either: English, Spanish, French.

## Shipping Specifications

**Net Weight:** 65kg. (approx.)

**Gross Weight:** 95 kg. (approx.)

**Packing Case Dimensions:** 112 x 82 x 76 cm (approx.)

**Packing Case Volume:**  $0.69\text{m}^3$  (approx.)

## Also Available On Request

Further detailed specification.

Additional copies of instruction manual.

Recommended list of spares for 5 years operation.



**Optional Extra R515A**  
**Digital Wattmeter Upgrade**



***Specification***

Optional upgrade – digital wattmeter fitted to panel in place of the standard watt-hour recorder.

***Experimental Capabilities:***

Measurement of the electrical power used to drive the compressor.

***Ordering Information***

**Order as:** Digital Wattmeter Upgrade R515A.

**Optional Extra RC516A**  
**Data Acquisition Upgrade**

***Hardware details***

The Optional Computerised Data Acquisition Upgrade RC516A 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 R515 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 R515.

***Software Details***

The pre-configured menu driven Software supplied with the Computer Upgrade RC516A allows all recommended experiments involving the electronic transducers and instruments on the R515 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 ( $\pm 100\text{mv DC}$ ), 8 single ended DC voltage inputs ( $\pm 8\text{v}$ ), 4 logic or frequency inputs and one mains voltage input.

In addition there are on board 12v DC,  $\pm 5\text{V DC}$  and  $\pm 15\text{v DC}$  power supplies for most commercially available transducers.



The Hilton Data Logging software supplied as standard with the RC516A package allows the D103 to be disconnected from the R515 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 R515 package from teaching and demonstration into the field of research and postgraduate study.

***New for 2013: p-h software also available.  
Contact a sales representative for more details***

## ***Computer Hardware Requirements***

The menu driven Software supplied with the Computer Upgrade RC516A 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 RC516A

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