

## FULLY VARIABLE VALVE ACTUATION UP TO 8,000 RPM

Lotus' Active Valve Train (AVT™) is an electronically controlled, hydraulically operated System that provides the control of individual valve lift profiles on single cylinder Research engines.

AVT™ replaces conventional camshafts with hydraulically operated actuators and proportional electro-hydraulic servo valves. A double-acting hydraulic actuator is fixed to the cylinder head and co-axially aligned with the engine valve. The actuators hydraulic piston is directly attached to the engine valve and a displacement transducer is connected to the top of the piston enabling the position of the valve to be accurately monitored.

The system employs a phase advanced Proportional Integral Derivative (PID) controller to detect and automatically correct the actual measured displacement towards achieving the desired displacement. The system operation is monitored continuously to identify potential malfunctions such as hydraulic pressure loss, crank or valve position signal loss, and potential valve to piston or valve to valve clash scenarios.

AVT™ is now supplied in a high speed 8,000 rpm variant that maintains the accuracy and repeatability for which the Lotus AVT™ system is renowned. We offer support and training as well as in-house research for clients using our own system.

### KEY FEATURES

AVT™ empowers our clients with a tool for faster research into advanced combustion performance and fuel economy

- AVT™ eliminates the need to change engine hardware, dramatically speeding up engine development times whilst reducing labour and manufacturing costs
- AVT™ provides a flexible research and development tool with the ability to independently control each valve with cycle to cycle variation and operating speeds up to 8,000 rpm
- AVT™ can be adapted to fit onto a variety of single cylinder research engines, including Lotus' own single cylinder research engines
- AVT™ controls the lift and timing of the valves, whilst still allowing conventional valve acceleration and velocity characteristics to be obtained
- AVT™ can simulate two, four, six and eight stroke combustion
- AVT™ allows the user to specify up to 128 valve lift profiles per valve from a library of many thousands of user specified lift profiles
- AVT™ can operate 8 valves and up to two engine cylinders simultaneously

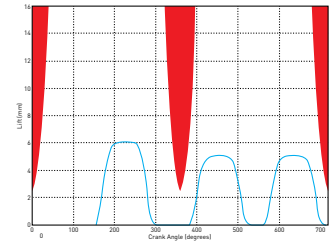
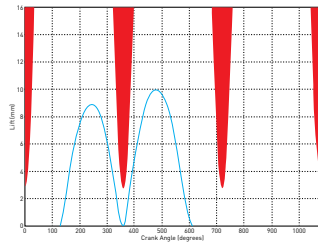
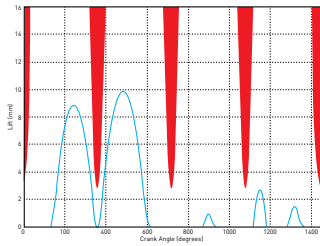
### RESEARCH

The AVT™ system was developed to support research into advanced combustion techniques including

- Prototyping conventional camshafts
- Low temperature combustion
- Optimised valve timing and lift
- Multi-stroke operation
- Controlled auto ignition (CAI)
- Homogeneous charge compression ignition (HCCI)

### SUMMARY OF THE AVT™ SYSTEM PACKAGE

- AVT™ actuator to cylinder head adaptation, design and manufacture
- Up to eight actuator assemblies including displacement transducers
- Hydraulic power pack (HPP)
- AVT™ electronic control unit, AVT™ actuator control, wiring and software
- AVT™ installation and system commissioning
- Client training and user manuals



AVT™ is Capable of Producing a Wide Range of Valve Lift Profiles for Multi-stroke Operation

AVT™ PACKAGE AND OPTIONS	
AVT™ Actuator to Cylinder Head	<p>Design method of installing the AVT™ actuator to the clients supplied head</p> <ul style="list-style-type: none"> <li>• Modify the clients supplied head to accept the AVT™ actuators</li> <li>• Design the hydraulic manifold and installation adaptor brackets</li> <li>• Manufacture the manifold and adaptor brackets</li> <li>• Design and manufacture the engine valves</li> <li>• Design and manufacture the specific test stand</li> </ul>
Actuator Assemblies and Displacement Transducers	<p>All relevant components to manufacture complete actuators with displacement transducers and electro hydraulic servo valves. Spare actuators can be supplied at additional cost.</p> <ul style="list-style-type: none"> <li>• All the necessary special tools to assemble the actuators</li> <li>• Hydraulic Power Pack (HPP)</li> </ul>
AVT™ Electronic Control Unit and Control Software	<p>AVT™ controller programmed with the relevant control software</p> <ul style="list-style-type: none"> <li>• All interfacing wiring looms to connect the operating system to the controller, the HPP and the actuators installed on the single cylinder engine prior to dispatch</li> <li>• Full operating system complete with AVT™ controller and PC equipment</li> <li>• Full system initial commissioning conducted</li> <li>• Validation of system carried out (over a number of days)</li> </ul>
Installation and System Commissioning	<p>The following will be with the client's nominated engineers in attendance</p> <ul style="list-style-type: none"> <li>• Instruction on how to maintain the AVT™ actuators</li> <li>• Install the AVT™ actuator onto the head</li> <li>• Connect hoses to the hydraulic manifold and HPP</li> <li>• Interface the controller with the engine, HPP and the operating system</li> <li>• Commission the system</li> </ul>
Client Training and User Manuals	<p>Commence operating training for the nominated engineers</p> <ul style="list-style-type: none"> <li>• Documentation of the AVT™ research system will be supplied</li> </ul>



UNITED KINGDOM

Potash Lane  
Hethel, Norwich  
NR14 8EZ

Phone: +44 (0)1953 608423  
eng-uk@lotuscars.com