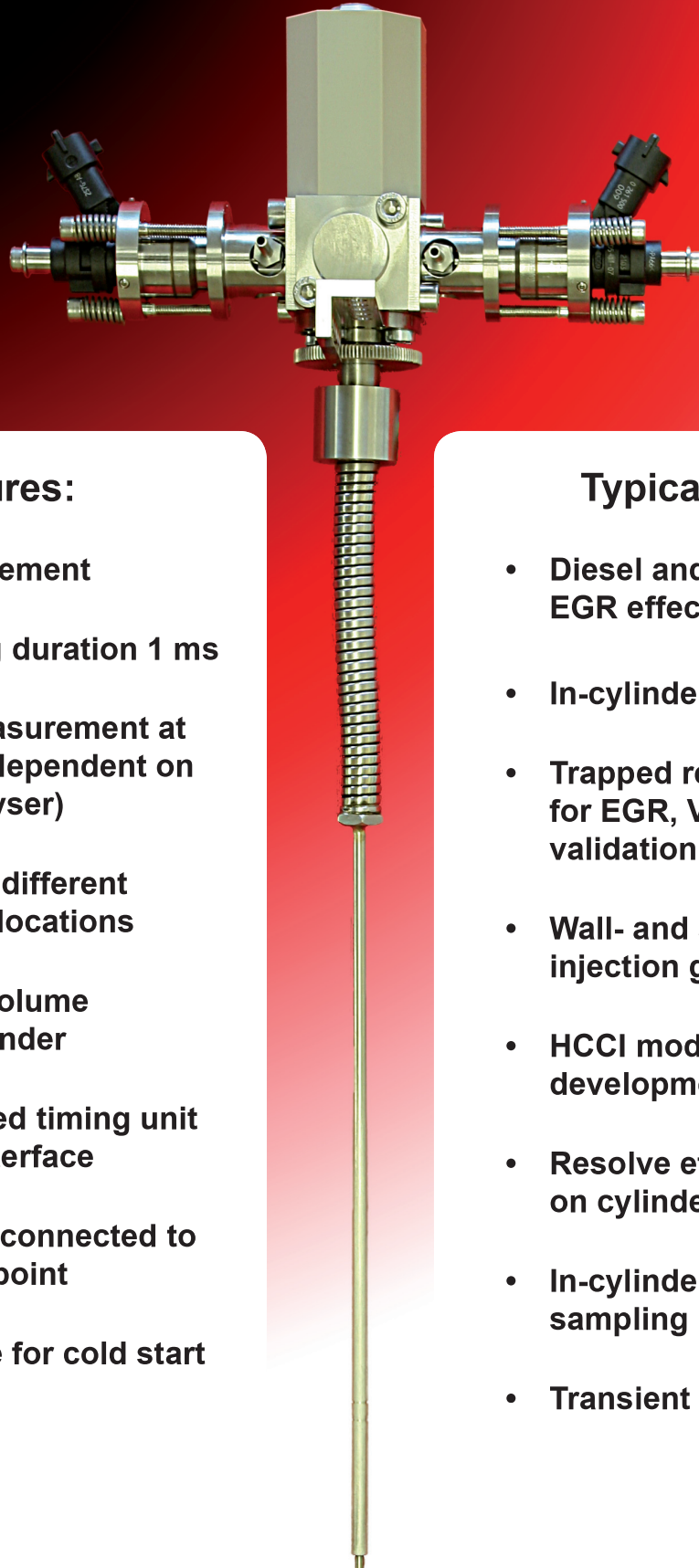




CAMBUSTION CSV550

Fast Sampling Valve System



Key Features:

- In-cylinder measurement
- Minimum sampling duration 1 ms
- Cycle by cycle measurement at up to 20,000 rpm (dependent on speed / load / analyser)
- Multiple valves for different sampling times or locations
- Minimise sample volume extracted from cylinder
- Computer controlled timing unit from remote PC interface
- Multiple analysers connected to a single sampling point
- Heated sample line for cold start

Typical Applications:

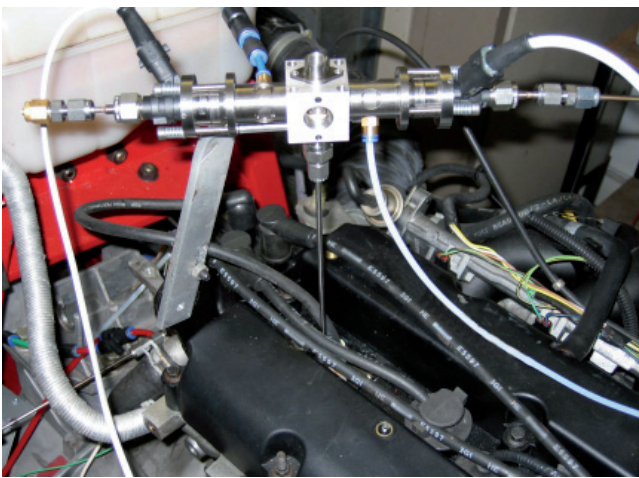
- Diesel and gasoline transient EGR effects
- In-cylinder CO, CO₂, NO_x & λ
- Trapped residuals measurement for EGR, VVT and model validation
- Wall- and spray- guided direct injection gasoline development
- HCCI mode switching development
- Resolve effects of valve-overlap on cylinder contents
- In-cylinder mass spectrometer sampling
- Transient fuelling calibration

CAMBUSTION CSV550

Introduction to the CSV550:

The Cambustion CSV550 sampling valve system uses one or more high-speed electronic sampling valves together with a Main Control Unit and Driver Box to offer a complete solution to in-cylinder sampling from a running engine. The system allows convenient measurement of a wide range of fast-changing gas concentrations.

With fast gas analysers, such as the Cambustion 500 series of NO_x and CO/CO₂ instruments, the CSV550 allows in-cylinder measurement at higher engine speeds than is possible using direct measurement techniques.



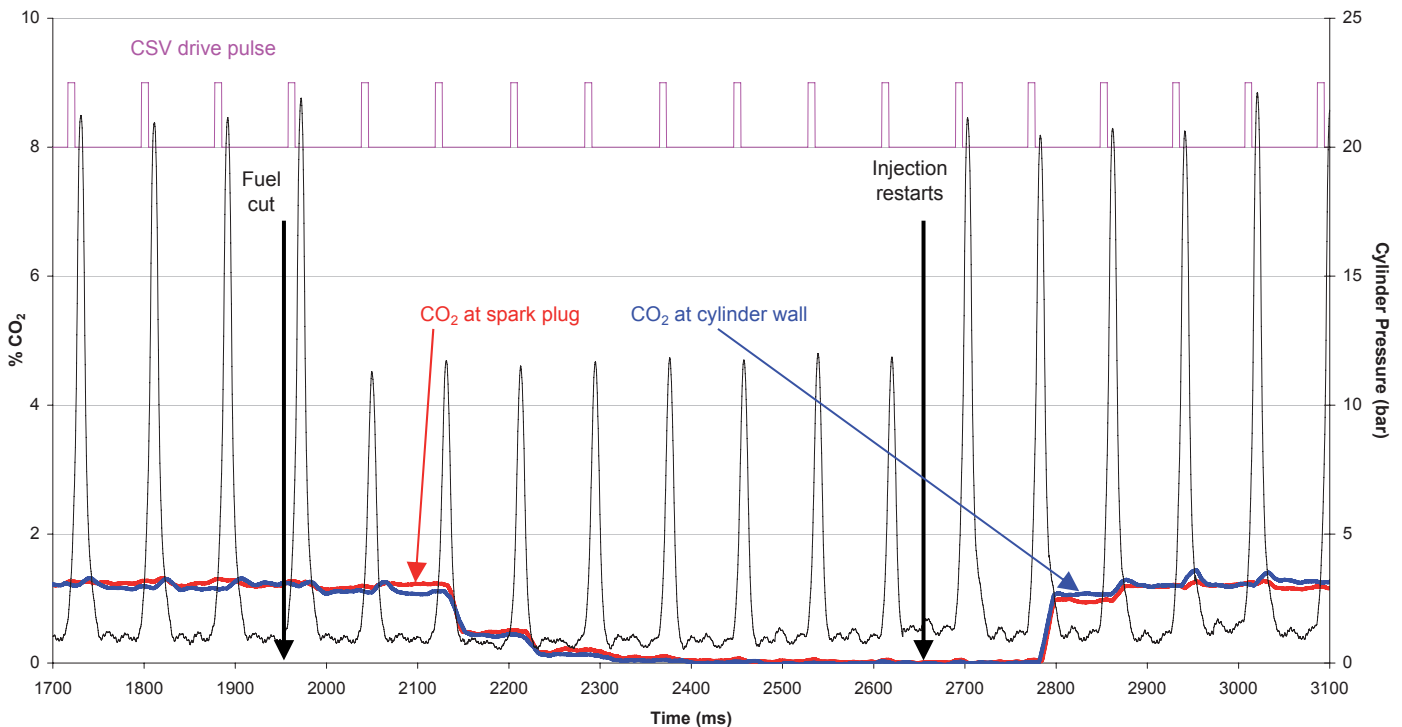
Standard System Hardware:

The CSV550 is supplied as a complete system to permit gas to be extracted and fed to a suitable analyser. Configurations with up to eight valves and heated or unheated sampling are available, but a typical system will comprise:

- Main Control Unit (controls up to two driver boxes)
- Driver Box (for up to 4 valves & 4 heaters)
- PC and user interface software
- 2 × high speed sampling valves mounted on distribution manifold
- Sample line for gas extraction from engine (heating optional for cold start)
- Heated sample storage tube

The use of two sampling valves in this configuration allows any stagnant gas to be purged from the sample line before the sample of interest is extracted.

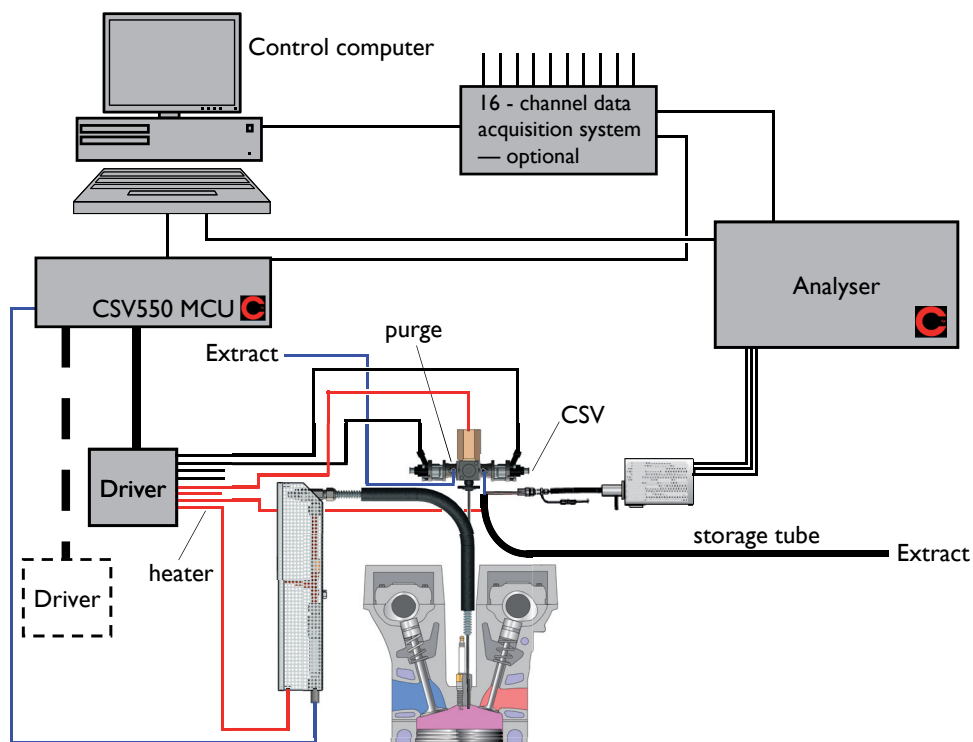
Sample Data: Measurement of CO₂ at Spark Plug and Cylinder Wall



The data show measurements made from two CSVs sampling simultaneously from different locations in the same cylinder: one measuring CO₂ via the spark plug and the other measuring CO₂ directly adjacent to the cylinder wall. The valves are set to open in the compression phase; the concentration at this time is clearly resolved as a step for the duration of the engine cycle. Initially the engine is firing as normal, and then at $t=1950$ ms the fuel is cut: the decay in measured levels of CO₂ shows the effect of trapped residuals and the 1-cycle phase lag in the build up of CO₂ after fuel injection restarts is clearly shown.

Fast Sampling Valve System

Typical CSV550 Schematic:



Optional Hardware:

When used with Cambustion 500 series gas analysers, an optional adaptor allows calibration of the analysers without requiring disconnection from the sampling valve assembly.

A Sampling Spark Plug adaptor allows the sampling line to be screwed into the adaptor to extract gas from the cylinder. When applicable this avoids the need to make access holes into the cylinder and allows for faster installation.

Software:

The Timing Control Unit is linked via RS485 to a PC running a graphical user interface. This software controls all heaters and pressures and allows the user to parameterise the sampling routine in various ways, including open-angle / close-angle or open-angle / duration. The interface also incorporates a manual adjustment slider, allowing sampling timings to be varied by $\pm 100^\circ$ around the initial setpoint.

The software supports sequenced operation in which a predefined series of valve openings can be executed. These valve openings may vary from cycle to cycle, allowing a better understanding of changing in-cylinder conditions.

Sampling Capabilities:

The CSV allows extraction of gas from the cylinder during a specified crank angle window for analysis during the remaining portion of the engine cycle. The sample flow is driven by cylinder pressure, meaning that during certain conditions it may not be possible to make cycle-cycle measurements. Normally only gas from crank angles corresponding to *rising* cylinder pressure can be sampled. In addition at high engine speed and low load, the open duration of the valve is low (for a given crank angle duration) and the cylinder pressure is also low, potentially leading to inadequate sample flow for cycle-cycle measurements.

Cambustion can advise on whether specific engine conditions are suitable for CSV based measurements.

Cambustion Fast Gas Analysers

Cambustion fast analysers are ideal for use with the CSV550 fast sampling valve system as the fast response time of these instruments reduces the volume of sample required to make a measurement, thus allowing minimum opening periods over the widest range of engine speeds.

CLD500 Fast NO_x:

- Fast response time (2 ms)
- NO₂ converter optional accessory
- Transient EGR calibration
- Cycle-by-cycle measurement
- NO_x trap development



NDIR500 Fast CO/CO₂:

- Fast response time (6 ms)
- Inlet / exhaust port measurement
- Ultra-fast lambda measurement
- Cold start fuelling analysis
- Transient fuelling calibration
- Catalyst storage investigations
- Cold-start studies
- Transient EGR calibration
- Residual mixing studies
- Spatial EGR distribution



CSV550 Specifications:

Power supply	100/110/220 V AC Auto-switching
Maximum power consumption	1700 W
Valve effective flow area	0.8 mm ²
Maximum sample line temperature	200 °C
Sample line tip thread	M3 x 0.5
Minimum closed-open-closed cycle	1 ms
Crank angle inputs required	1° & 1/revolution (RS422 differential recommended)
Cam ID signal	1/720° Hall Effect or VRS type
Max engine speed	20,000 rpm
Communications protocol	RS485 via RJ45 connector.
Umbilical length (MCU to Driver Box)	10 metres

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All specifications subject to change without notice

