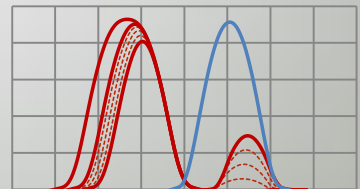
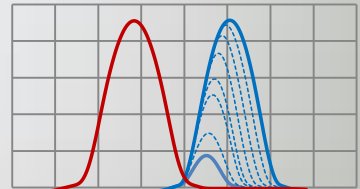
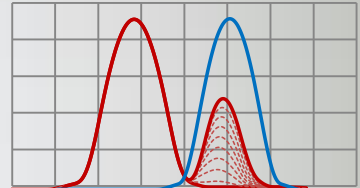
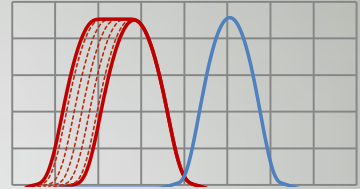
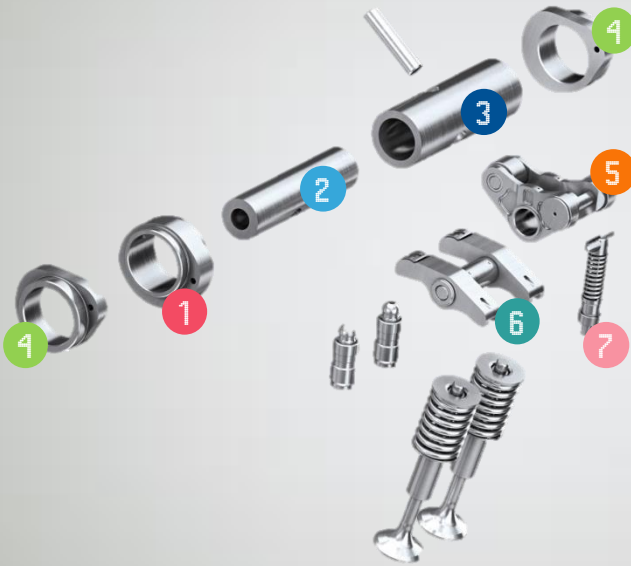


FLEXVALVE

COMPACT, MODULAR AND VERSATILE

Design and Function

- FlexValve is a camshaft actuated mechanical valvetrain capable of providing a range of fully variable valve lift characteristics
- FlexValve incorporates DuoCam technology. DuoCam is an assembled camshaft that can vary the angle of one set of cam lobes relative to another
- An actuator, similar to a cam phaser, changes the angular relationship of the shaft and tube and hence their associated cam lobes, which are in contact with the FlexValve rocker
- The FlexValve rocker system combines the two cam profiles to produce the valve lift. Thus, altering the angle between the shaft and the tube allows the valve lift to be varied
- FlexValve can be designed into an integrated valvetrain module, that will allow interchangeability with conventional valvetrain system without the need to change the cylinder head



The FlexValve system comprises a single lobe (1), pinned to the inner shaft (2) of the DuoCam shaft. The two outer cam lobes (4) are fixed to the tube (3). The phasing between the lobes (1) and (4) may be varied via an actuator (not shown for clarity).

The rollers of the FlexValve rocker (5) follow both cam profiles. This rocker pivots on a shaft (6), which connects it to both finger followers. The return spring (7) keeps all the parts in contact when the valves are closed.

Depending on the shapes and relative positions of both cam groups, the FlexValve rocker either rotates about the pivot shaft (6) or generates a valve movement. Different cam contours are possible and through their design can produce multiple valve openings. The four figures show some of the potential lift curve families.



Key Benefits for Gasoline Engines

Valve head throttling

- Reduction of intake pumping work
- Optimisation of volumetric efficiency

Trapped mass control

- Increased volumetric efficiency, improving transient response and increasing downsizing potential

Key Benefits for Diesel Engines

Internal EGR

- Volume reduction of after-treatment systems through improved thermal management
- Reduced warm up and catalyst light-off times

Trapped mass control

- Control of effective compression ratio for HCCI
- Widening of the effective compressor map for down-speeding or downsizing engines

	Gasoline	Diesel
Fuel Consumption / CO₂ *	<ul style="list-style-type: none"> • ~8-12% improvement in fuel economy • 25% for a downsized engine 	<ul style="list-style-type: none"> • ~4% improvement in part load fuel economy (exhaust 2nd lift) • 10-20% for a down speeded engine (scavenging enabler)
Performance / After treatment *	<ul style="list-style-type: none"> • 5% to 10% increase in peak power output • 15% to 20% increase in low speed torque • Optimised expansion work • Improved cylinder scavenging 	<ul style="list-style-type: none"> • Improved thermal management (up to 100deg increase in Exhaust temperature – AFR limited) • Rapid warm-up from cold start • Volume reduction of catalyst/after-treatment and SCR system • NVH - 50% reduction of idle roughness during cold, light load operation
Emissions *	<ul style="list-style-type: none"> • Faster catalyst light-off giving reduced emissions • ↓ 60% NOx • ↓ 40% CO / HC 	<ul style="list-style-type: none"> • Enabler for LTC / HCCI (50-60% HC/CO reduction) • Up to 15% NOx reduction -> Potential to meet Euro 6 emission limits with no NOx after treatment • Optimised soot/CO trade off
Driveability	<ul style="list-style-type: none"> • Improved transient response • Reduced turbo lag 	<ul style="list-style-type: none"> • Significant improvement of torque control during particulate filter and NOx trap regeneration
Baseline Specification	<ul style="list-style-type: none"> • 4 valves per cylinder, Intake and Exhaust Phasers 	<ul style="list-style-type: none"> • RFF - 4 valves per cylinder
FlexValve Specification	<ul style="list-style-type: none"> • Intake FlexValve (lift control – throttle-less operation) • Exhaust DuoCam & DuoPhase 	<ul style="list-style-type: none"> • RFF Intake Concentric Cam (Duration control) • FlexValve Exhaust (Second event control)

* Benefits are estimates based upon published data for equivalent VVA systems