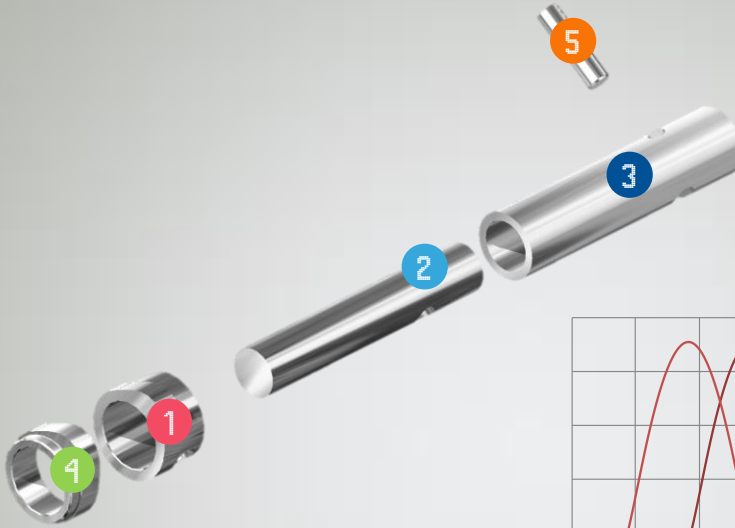


DUOCAM AND DUOPHASE

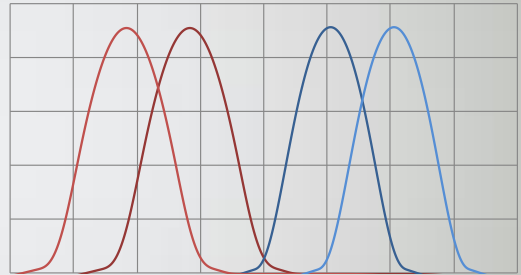
COMPACT, MODULAR AND VERSATILE

- 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
- DuoPhase is a mechanism that couples a DuoCam camshaft with a twin hydraulic actuator. DuoPhase provides independent phasing of two outputs relative to a drive input



DuoCam Function

The DuoCam shaft comprises a moving lobe (1), pinned to the inner shaft (2) via the drive pin (5). The fixed cam lobe (4) is attached to the tube (3). The phasing between the lobes (1) and (4) may be varied via an actuator (not shown for clarity).



DuoPhase Function

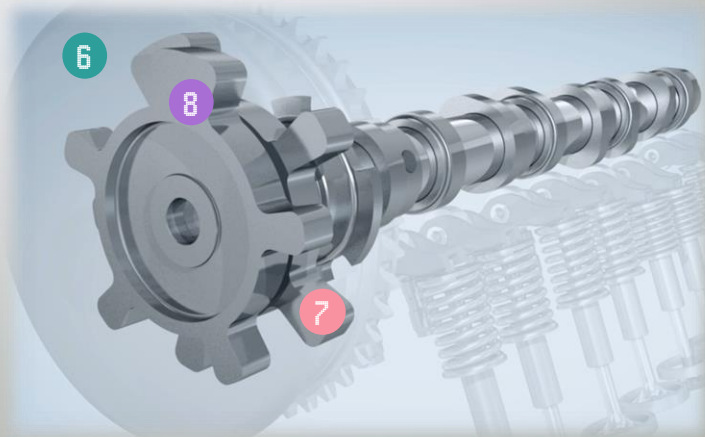
The camshaft mechanism is as described in DuoCam function

Drive is supplied to the actuator via the stator (6)

The rear rotor (7) is fixed to the tube (3) and moves the fixed lobes

The front rotor (8) is fixed to the shaft (2) and moves the moving lobes

A pair of solenoid valves are used to supply oil to the individual rotors to give independent control of the position of the cams (1 and 4)



Key Benefits

- Proven Technology - Equivalent System already in volume production
- The most reliable and cost-effective solution for phasing adjacent cam lobes on a single axis
- The DuoCam/DuoPhase system is the only viable mechanism available that provides Dual independent phasing for Cam in Block engines
- Applicable to both gasoline and diesel engines
- Conventional camshaft position and valvetrain interfaces are retained. System is modular with fixed valvetrains
- Potential to replace DOHC camshafts with twin phasers with a Single DuoCam / DuoPhase mechanism (SOHC) for reduced weight and cost

SOHC Engines



Exhaust/Intake only VVT with a DuoCam and single phaser

Dual-Independent VVT with DuoPhase

Cam-In-Block Engines



Exhaust/Intake only VVT with a DuoCam and single phaser

Dual-Independent VVT with DuoPhase

DOHC Engines



Adjacent lobe phasing

Variable valve opening or closing

Variable effective duration

	Detailed benefits
Fuel Consumption / CO₂ *	<ul style="list-style-type: none"> • ~5% improvement in fuel economy
Performance *	<ul style="list-style-type: none"> • >10% increase in mean Torque • >15% increase in low speed Torque
Emissions *	<ul style="list-style-type: none"> • ↓ 50% NOx
Baseline Specification	<ul style="list-style-type: none"> • Single camshaft with fixed timing
Mass Reduction	<ul style="list-style-type: none"> • 3.5 to 4Kg mass reduction when replacing DOHC camshafts with twin phasers for single DuoPhase camshaft

* Reference for estimated benefits: SAE 2002-01-1101, Phasing Strategy for an Engine with Twin Variable Cam Timing