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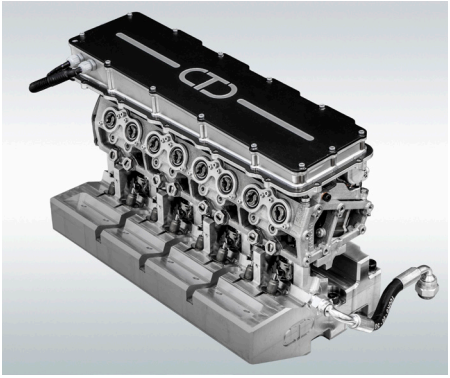


Intelligent Valve Actuation (IVA) from Camcon Auto brings real-time digital control to the gas exchange process in combustion engines. Dramatically reducing emissions and improving drivability, IVA is designed for manufacture and affordability.

Unprecedented combustion control

IVA | Intelligent Valve Actuation

Your Last Camshaft

Digital control of gas exchange

Through extensive development in collaboration with industry partners and OEMs, Camcon Auto introduces IVA. The world's first fully controllable poppet valve actuation system for Internal Combustion Engines (ICE).

With proven ability to significantly reduce CO2 and other emissions, while maintaining performance and drivability, IVA is a key enabler for the next generation of ICE, be they in conventional or hybrid powertrains. At a vehicle level, IVA connects powertrain response to dynamic requirements as never before, allowing optimum fuel economy in all driving conditions. Calibrate without compromise.

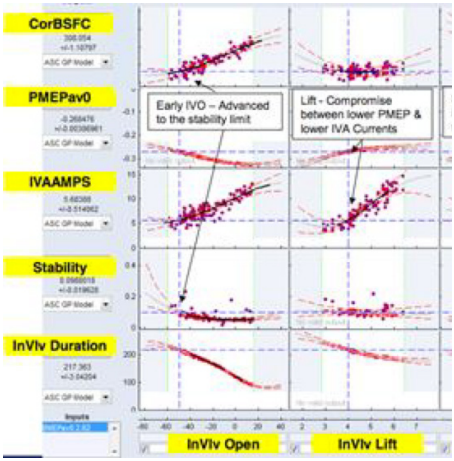
IVA has been developed and tested on the dyno and in-vehicle….

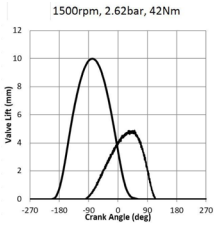
Intelligent Valve Actuation (IVA) brings digital control to the last controllable combustion variable – gas exchange. Designed for 12 volt operation, IVA far exceeds the capability of all other variable valve systems and has been designed as a practical, cost effective solution in these days of CO2 constraints. Development work to date has utilised the state-of-the-art Jaguar Land Rover 2 litre, 4 cylinder, petrol engine which already uses a very advanced variable valve system. Using IVA on the inlet valves only steady state fuel economy improvements of up to 7.5% have already been demonstrated. Further work will yield significantly more. Throttle-less operation is inherent, transient response unprecedented and the opportunity for "smart" integration with other systems broad indeed.

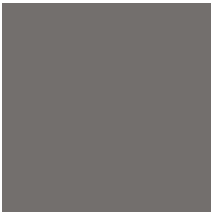
The hardware tested to date represents the culmination of a phase of work begun in 2014 and has successfully demonstrated that the fundamental concept works – we can run a real engine over the full load speed range using IVA on the inlet valves. We have shown that the additional event control capability is genuinely valuable in terms of engine operation and we have built a car as a demonstrator. We have also learned a huge amount both about how to optimise the actuator design and the fact that, despite greater capability than any alternative system, the current hardware is not fast enough to allow us to reach the best fuel consumption results.

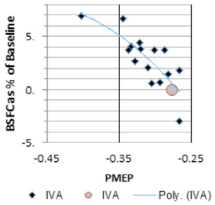
Over a significant part of the speed-load range – the engine wants more! In fact, it is fair to say that, in order to extract maximum value from the IVA opportunity other engine systems including the combustion system will have to be improved or re-optimised. The work to date does not scratch the surface of the potential. The next level of hardware will provide more – the "Mark 4" actuators are currently being procured and will feature a minimum full rotation event duration of 5.5 ms rather than 7ms, rated speed will be 6750 rather than 6000 RPM, power demand for a given event will be 40-60% less than today's hardware. Furthermore, the new design is significantly more compact than that used to produce the results to date.

There will also be an exhaust valve capable version and a 16 valve engine on the dynamometer. The new hardware has been designed with cost and production feasibility very high on the list of objectives. Nevertheless, the opportunities for integrating IVA with other engine and vehicle systems should not be overlooked. Some of these are obvious, for example, in the case of inlet plus exhaust IVA redesign of the turbo/wastegate plumbing. However, even in the case of inlet only arrangements, it has been demostrated that cold cranking torques can be reduced by over 30% - which will permit significant reductions in size, cost and weight of starter motors. However, CO2 emissions reduction is the main objective and we anticipate very significant further progress in this regard as we progress to the next hardware and software iterations.









Proven

Tested side by side with 2l 4 cyl Ingenium

The Ingenium engine is an in-line 4-cylinder unit of 83mm bore and 92.3mm stroke. The combustion system is based on a 4-valve per cylinder architecture with direct fuel injection in a symmetric layout, CR is 10.5:1. The base valvetrain has variable intake and exhaust cam timing; the inlet valvetrain features an electro-hydraulic fully variable valve lift system. The boosting system has a twin scroll turbo-charger and the engine is designed for SULEV 30/EU6c/CN 6. Performance is rated at 184kW at 5500rpm with maximum torque of 365Nm between 1300 and 4500rpm. When comparing the IVA BSFC and emissions with the base engine there are three elements to consider, pumping losses, friction losses and combustion. In short: IVA offers benefit in all three areas. Minimum BSFC coincided with low pumping losses and demonstrated a 5.3% reduction from base engine levels

Results are presented in detail in our Aachen Colloquium paper, which can be downloaded from our website.

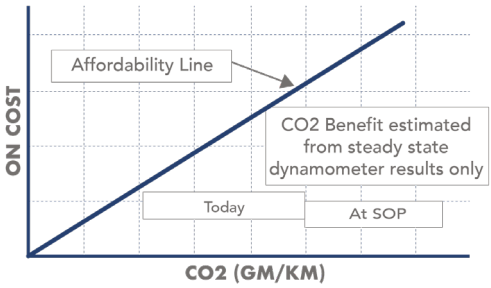
But isn't it expensive?

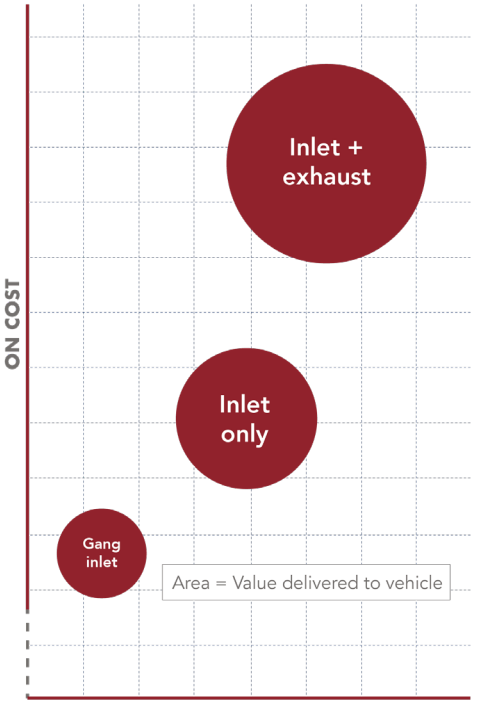
Camcon has continuously refined the design from its "concept proving" stage to the current level using DFM/DFA to minimise costs. Nevertheless…

Working with OEMs ,Tier 1 suppliers and our own experts, Camcon has analysed the design cost of the IVA system. We have then developed road maps for cost reduction both in mechanical and electronic systems which we are implementing, and can fully implement with a production partner. We believe the cost of IVA is well below the economic value it delivers to OEMs.

As IVA is integrated more deeply into the vehicle systems, other opportunities for cost reduction become apparent, such as reduced size starter motors, integration of engine and valve ECU's, reduced after-treatment costs. For Hybrid vehicles IVA offers opportunities for battery capacity reduction or range extension with the potential for further, significant, cost savings.

IVA is also very quiet in operation which may allow cost and weight reductions in the under-bonnet NVH package.





Will it work for me?

IVA is a family of products for all levels of vehicle

GANGED OPERATION

IVA is flexible and lends itself to a staged approach depending on the needs of a vehicle and the cost trade-off that makes most sense. So, a vehicle that needs only a small improvement to meet targets may benefit most cost-effectively from a system where an IVA actuator is "ganged" or shared between both inlet valves in a cylinder and the exhaust valve train is conventional. The benefits then accrue from simply being able to select the optimised common lift, timing, period and lift curve shape for the paired inlets. Similarly ganged exhaust can be paired with individual inlet IVA control.

INLET ONLY

IVA on each inlet valve in multi-valve chambers allows maximum control over charge air and minimised parasitic losses. Flow volume is valve controlled, eliminating throttling loss. At low flows air velocity is kept high by switching to single valve operation, swirl, tumble and swumble can be selected and their level adjusted as required for the load/speed condition - and, indeed adjusted according to prevailing conditions if appropriate. This is achieved by selecting the operating mode and precise control over lift, period timing and even lift curve shape on a cycle-by-cycle basis.

INLET & EXHAUST

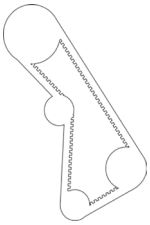
Further advantages accrue with Inlet + Exhaust IVA. Cylinder deactivation of any kind becomes simple, Single exhaust valve operation at low load permits minimisation of parasitic loss without gas flow penalty. Staggered EVO on each valve in a given cylinder reduces the silencing challenge. Separate exhaust ports in multivalve chambers allow more sophisticated turbo strategies, the elimination of the wastegate, better transients with lower back pressure and corresponding fuel consumption benefits - studies have shown 5% fuel benefit from this alone.

Single Cylinder Development Systems

Camcon Auto makes and sells IVA systems for single cylinder combustion development engines. OEMs, Tier 1s and Universities can use this system, which offers unparalleled opportunities to vary combustion variables on the fly and permitting dramatic productivity improvements from SCE development programmes and also aiding the development of innovative approaches to engine management and operation.

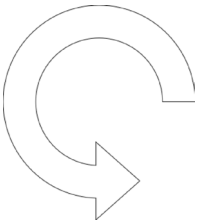
IVA for Hybrid vehicles

Saving cost and improving performance



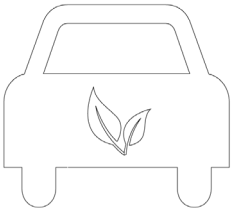
PACKAGE SIZE REDUCTION

Implementing IVA on Inlet and Exhaust valves for hybrid powertrain ICE brings substantial package size benefits. Overall package height can be reduced and engine length is reduced through deletion of timing drive. This provides much needed space for electric powertrains, or more capable ICE in smaller volume.



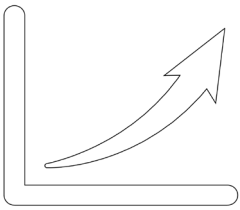
EXTENDED RANGE

IVA enables reduced motoring torque - which in turn reduces the energy cost of switching the engine off and back on again - allowing more frequent changes and improved fuel consumption/lower emissions. This will also permit faster restarts with other benefits such as smaller batteries for the same range, or extended range with the same battery capacity.



OPTIMISED COMBUSTION

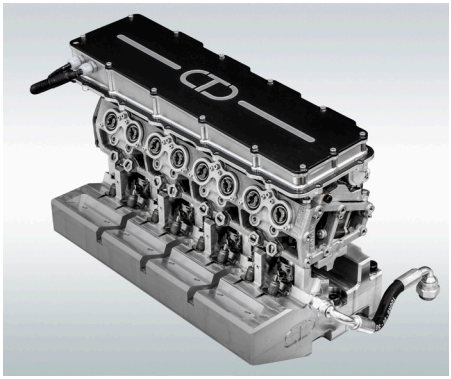
The fact that Atkinson/Miller cycle valve timing can be engaged or disengaged at a moments notice means that the vehicle can benefit from the CO2 advantage of Miller cycle during hybrid running but benefit from the driveability improvement brought by more conventional timings when the IC engine is doing the majority of the work.



VEHICLE INTEGRATION

The very rapid transient response available from the IVA system will allow hybrid calibration engineers greater flexibility in their optimisation of vehicle calibration with benefits both fuel consumption and driveability. The very low noise inherent in the IVA system will improve the refinement of hybrid vehicles because there is less NVH impact from engine on vs engine off driving.

Cylinder de-activation allows battery re-charging to be undertaken at higher bmep under many road load conditions thus reducing the fuel burn both for re-charge and tractive effort



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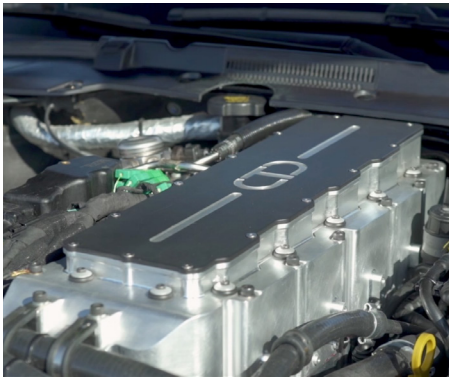

To find out more, contact us

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