

# Development of Variable Valve Event and Lift System (VVEL)

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## 1. INTRODUCTION

As worldwide interests in environmental problems have grown in recent years, lowering the environmental burden through reducing both fuel consumption and exhaust emissions has been an important challenge for automotive engines. On the other hand, enhancing driving performance has still been a strong demand from many customers as one of important appeals of automobiles.

One of the technologies that can enhance both environmental and driving performances at the same time is a variable valve system. Two kind of variable valve systems are already existing, variable valve timing control system (VTC, a cam phaser) for variable cam phasing, and cam-switching-type variable valve lift and timing system (VVL).

The new variable valve actuation system called Variable Valve Event and Lift System (VVEL) is developed for freely control all valve opening characteristics, continuously control both lift and event (duration) angle in a wide range.

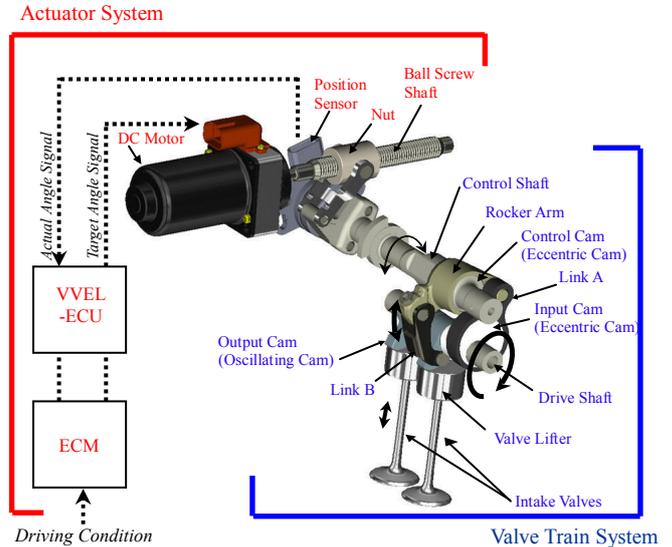


Fig. 1 Basic Structure of VVEL System

## 2. OUTLINE OF NEW TECHNOLOGY

### 2-1 Feature of Variable Valve Event and Lift System (VVEL)

As a mechanical system for varying valve lift and valve event angle, newly developed multi link valve opening mechanism is installed in the place of a conventional camshaft. Fig.1 shows a basic structure of its components and a layout of the VVEL linkage parts.

This mechanism is realized for varying valve event and lift by moving the fulcrum of the rocker arm. This rocker arm is located on the control shaft with eccentric control cam. This control shaft is rotated by an electrical DC motor, then valve event and lift is varied continuously with changing the whole linkage geometry.(Fig. 2)

The valvetrain mechanism adopted a forced drive type with an oscillating cam and multiple links. It does not require a return spring, enabling to reduce mechanical friction and at the same time realizing the compact and simple structure for a variable valve event and lift mechanism. With the aid of high efficiency ball-screw reduction gear and compact DC motor, VVEL provides excellent features such as lower friction, higher allowable engine speed, rapid varying response, lower electrical consumption and so on.

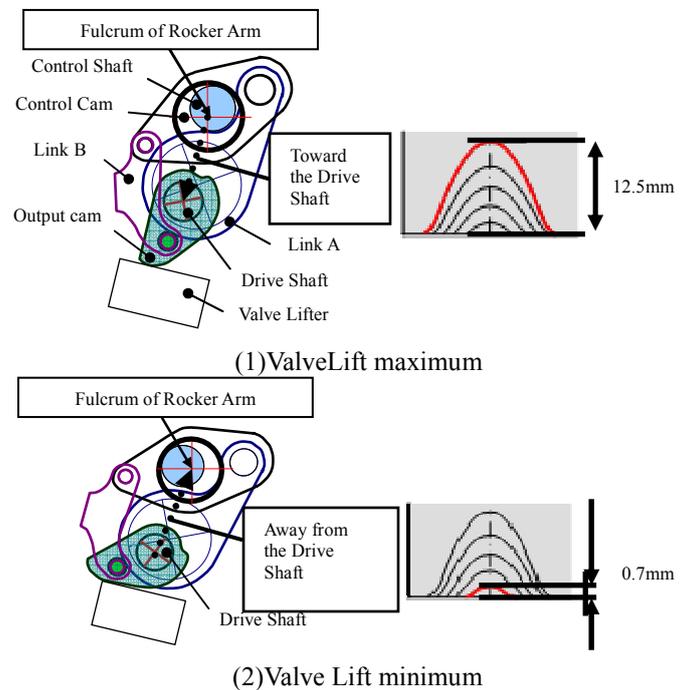


Fig. 2 Relationship between Oscillating Position of Output Cam and Valve Lift

## 2-1 Effects of Variable Valve Event and Lift System (VVEL)

### (1)Improvement in Fuel Economy Performance

the VVEL system with the VTC can improve 10% fuel efficiency by pumping loss reduction with early intake valve closing timing and low link friction without any return springs.

### (2)Cleaner Exhaust Emissions at the Cold Engine condition

Setting valve lift at low lift promoted fuel atomization (secondary atomization) due to an increased speed of intake airflow velocity into the cylinder.

Improved fuel atomization during warm up has improved the combustion stability at the cold condition, and thus enabled retarding the ignition timing for raising the exhaust gas temperature.

As a result, the VVEL engine has reduced Non-Methane Hydro-Carbon (NMHC) emissions by about half.

### (3) Improvement in Driving Performance

The VVEL system could enhance engine torque throughout the engine speed range by optimized valve timing setting

Further, the VVEL system has contributed to improving vehicle acceleration response. In take air control can be done by changing the valve opening timing, rapid increase of intake charge is possible especially at low speed and low load. (Fig. 3)

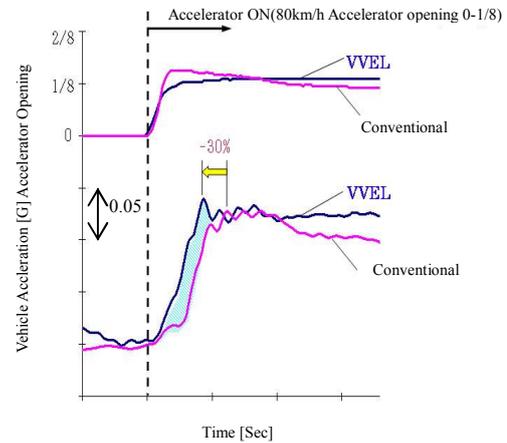


Fig. 3 Evaluation Result on Mild Vehicle Acceleration from 80km/h

## 3. SUMMARY

This newly developed Variable Valve Event and Lift has been applied to new V6 engine (VQ37VHR) for Infiniti G37 Coupe (Skyline Coupe), and then applied vehicle will be enlarged to Nissan 370Z, Infiniti FX37 and Infiniti G37 (Skyline Sedan). And also, new V8 engine (VH50VE) with VVEL has been applied for Infiniti FX50.

This technology has made it possible to achieve well-balanced improvements in all of the three major performance attribute to automotive engines - fuel economy, exhaust emissions and engine output. VVEL technology received many favorable comments, it will enlarge number of applied vehicles.