

Development of New V6 3.5L Gasoline Engine for ACURA RLX

Nobuo Suzuki
Honda R&D Co., Ltd.

Yasutaka Hayashi, Marc Odell and Tatsuhito Esaki
Honda R&D Americas, Inc.

Atsushi Sato, Kazuya Ishiki and Satoshi Watanabe
Honda R&D Co., Ltd.

ABSTRACT

Honda has developed a new next-generation 3.5 L V6 gasoline engine using our latest Earth Dreams Technology. The overall design objective for the engine was to reduce CO₂ emissions and provide driving exhilaration.

The Earth Dreams Technology concept is to increase fuel economy while reducing emissions. To achieve this and provide an exhilarating driving experience, 3-stage Variable Valve Timing and Lift Electronic Control (VTEC) was combined with the Variable Cylinder Management (VCM) system. This valve train technology in conjunction with Direct Injection (DI), resulted in dramatic improvements in output (a 3.3% increase) and combined mode fuel economy (20% reduction).

Helping to achieve Midsize Luxury Sedan level NV, a new mount system was developed to reduce engine vibrations during three cylinder mode operation.

In this paper, we will explain the 3-stage VTEC with VCM + DI system, friction reducing technology, and the structure and benefit of the new engine mount system.

CITATION: Suzuki, N., Hayashi, Y., Odell, M., Esaki, T. et al., "Development of New V6 3.5L Gasoline Engine for ACURA RLX," *SAE Int. J. Engines* 6(1):2013, doi:10.4271/2013-01-1728.

INTRODUCTION

We developed the new engine with the following targets to achieve both environmental performance and strong customer appeal as a product for a midsize luxury sedan.

1. Top-class mode fuel economy
2. Top-class output competitiveness
3. NV performance suitable for a midsize luxury sedan

The VCM system is technology for the Honda V6 engine that reduces fuel consumption. The system allows the V6 engine to operate as two 3-cylinder engines. According to driving conditions, the valve train for the 3 cylinders on one bank is deactivated, leaving the engine to run with the remaining 3 cylinders. When increased engine performance is required in a passing maneuver for example, the engine responds quickly to activate all 6 cylinders. Through the use of this system, the engine can provide both the high power of a large displacement engine and the low fuel consumption of a small displacement engine [1].

This engine uses a VCM system. To maximize this engine's three cylinder operation range, VTEC and DI systems were added. In order to control the 3-cylinder engine vibration with the increased torque, an enhanced active engine mount was used. The result of the application of the combined technology was an overall increase in the 3-cylinder deactivation range.

ENGINE OVERVIEW

In applying the DI system, several specially designed components were developed including a specially shaped combustion chamber, head port, and intake manifold. The same external dimensions as the previous model were maintained by setting the DI system inside the V bank, while the total displacement was decreased from 3.7 L to 3.5 L. By applying the DI system, improved charging efficiency and reduced knocking was achieved. The engine schematic and main specifications are shown in [Figure 1](#) and [Table 1](#) respectively.



Figure 1. J35Y4 engine

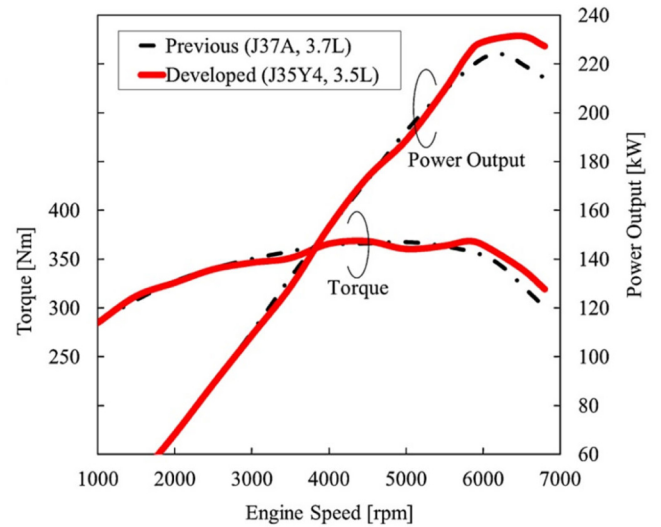


Figure 2. Power output and torque

Table 1. Engine specifications

	Developed	Previous
Engine Code	J35Y4	J37A
Engine Type	60 deg V6	
Displacement	3,471 cm ³	3,664 cm ³
Bore x Stroke	89 mm x 93 mm	90 mm x 96 mm
Valve Train	SOHC VTEC with VCM	SOHC VTEC
Valves/Cylinder	4	
Compression ratio	11.5:1	11.2:1
Fuel Injection System	Direct Injection	Port Injection
Max. Power	231 kW@6500 rpm	224 kW@6300 rpm
Power / Displacement	67 kW / L	61 kW / L
Max. Torque	369 Nm @4500rpm	368 Nm@5000rpm
Torque / Displacement	106 Nm / L	100 Nm / L
Redline	6800 rpm	
Fuel Grade	Premium	

POWER OUTPUT

Figure 2 shows the engine performance. Because of the increased torque through enhanced charging efficiency and reduced knocking due to the DI system, the specific torque improved 6%. As a result, the torque characteristics have exceeded the level of the previous model, even with the downsized displacement. By increasing the compression ratio, optimizing valve timing, and increasing the intake and exhaust flow rate, the maximum output was improved by 3.3% to 231 kW.

FUEL CONSUMPTION

Figure 3 shows BSFC characteristics at an engine speed of 1500 rpm. BSFC with 6-cylinder operation at 12.5 kW was improved by 5.2% as a result of enhanced thermal efficiency with the DI system and reduced friction. Under the same conditions, 3-cylinder operation saw BSFC improved by 20.1% due to the reduced pumping loss.

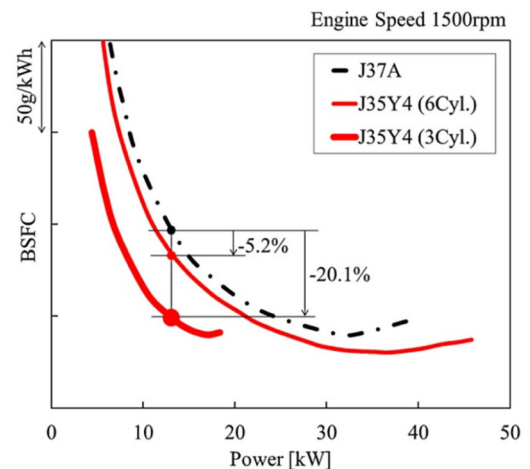


Figure 3. Fuel consumption

MAIN TECHNOLOGY

3-Stage VTEC with VCM

Both VTEC system and VCM system functions were incorporated, including a 3-stage valve mechanism to activate low valve lift, high valve lift and cylinder deactivation (Fig. 4).

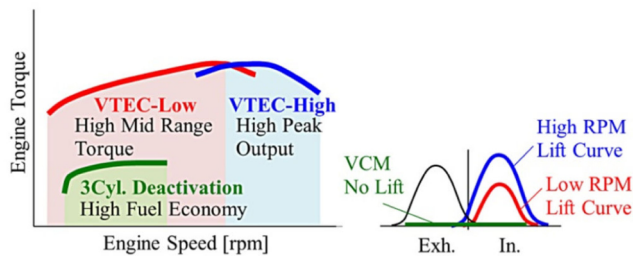


Figure 4. 3-Stage VTEC with VCM operation

Honda has developed 3-stage rocker arm systems in the past for the Civic and Civic Hybrid. Applying such previously developed mechanisms to a new V6 engine would present design layout limitations. Therefore a new valve train structure was developed to combine the merits of VTEC and VCM without compromise. Figure 5 shows the camshaft lobe and rocker arm overview.

Seven camshaft lobes were required for a 3-stage VTEC with VCM system. The intake rocker arm needed 3 exclusive lobes on the camshaft for low, high and valve lift deactivation. Additionally each exhaust valve required 2 lobes for standard valve lift and deactivated valve lift. Existing 3-stage rocker arm concepts would not fit due to minimum cam width requirements governed by rocker arm roller life and camshaft manufacturability (Fig. 5 “Base Design”). The new rocker arm structure consolidated 3 deactivated lift lobes to 1 shared lobe. This reduced the lobes required from 7 to 5 and enabled the 7 required rocker arms to fit (Fig. 5 “Developed Design”). As a result, the quantity of cam lobes was reduced from 7 to 5, machining was improved, and the required 7 camshaft functions were enveloped in a compact space.

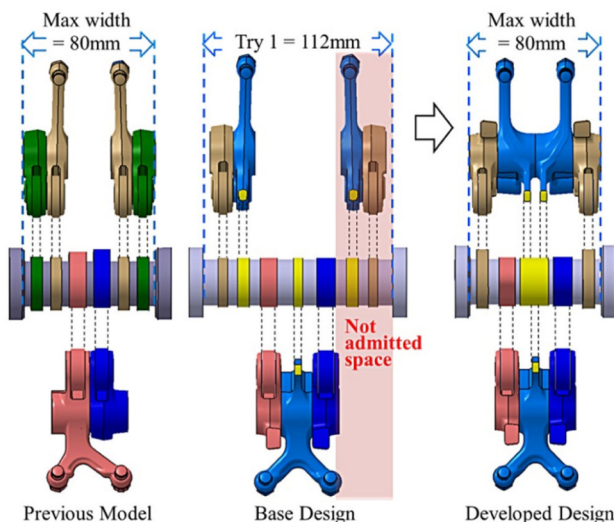


Figure 5. Rocker arm & camshaft diagram

The rocker arm designs were considered next. Aiming to improve upon the performance of the previous 3-stage SOHC

VTEC model with redline of 6500 rpm, the peak power engine speed was set to 6500 rpm and redline was set at 6800 rpm. The inertia weight increase of the 3-rocker system required a valve spring load increase to maintain proper valve train behavior, increasing friction as well as reducing roller life. To overcome these disadvantages, a new 3-rocker coaxial synchronizing pin system including a concentric expanding inner pin was developed.

When the engine demands high RPM valve lift, only the high rocker arm needs to be connected to the mid rocker arm. However, when this happens the low rocker arm could not be controlled without a high lost motion spring force. To avoid this additional spring force, all three rocker arms are connected during high engine RPMs. This is possible without valve spring force increase due to the low inertia weight of the rocker arm. Achieving stabilized valve train behavior at high RPM without valve spring force increase keeps the friction low. Figure 6 shows the 3-rocker coaxial synchronizing pin system.



Figure 6. 3-Rocker coaxial synchronizing pin structure

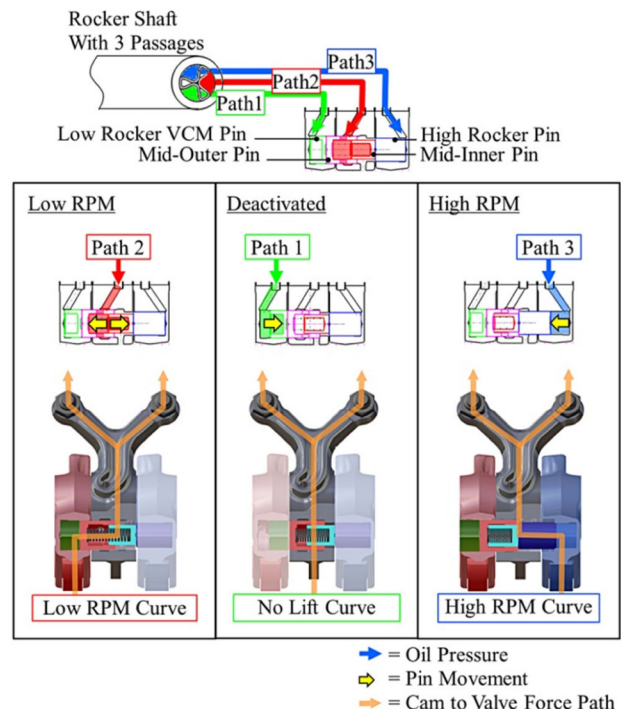


Figure 7. 3-Rocker oil path

Figure 7 shows the oil path changeover condition while VTEC and VCM are operating. Under the default condition,