

Development of the Third Generation 100% Electric Drive Hybrid Powertrain for Compact SUV

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The third-generation e-POWER system was newly developed for a compact SUV to achieve superior fuel economy, quietness, driving performance, and EV-like driving feel. The compact SUV segment represents the largest vehicle category in the Japanese market, and strong competitiveness in both fuel economy and driving performance is required. To satisfy these requirements, a new powertrain system consisting of a dedicated power-generation engine, a 5-in-1 electric powertrain, a high-performance battery, and advanced energy management technologies was developed.(Fig. 1, Table 1)

The power-generation system employs an optimized 1.4 L dedicated engine (HR14DDe). The engine output was improved by 20% compared to the previous generation while expanding the high-efficiency operating area through a long-stroke design, higher compression ratio, direct-injection combustion, and high-rate EGR. In addition, a newly developed 5-in-1 electric powertrain integrating the motor, generator, inverter, speed-up gearbox, and reducer achieved a 14% weight reduction and improved vibration performance through a 20% increase in powertrain rigidity.

The battery specification was optimized as a design variable according to vehicle requirements. By balancing battery output requirements and increased engine generation capability, the number of cells was reduced by 17%, contributing to lower cost and weight. Battery cooling performance was improved through airflow optimization and cooling fan control, which expanded the applicable range of energy management and power management controls.

To enhance EV-like driving characteristics, engine operating frequency during urban driving was significantly reduced. Increased constant-point generation output, regenerative brake coordination, and adoption of an electric brake booster expanded EV driving opportunities and reduced engine start frequency by 75% in urban driving conditions.(Fig. 2) In addition, engine start vibration was reduced by applying a previously developed torsional vibration suppression control together with optimized flywheel damper characteristics, enabling a smoother and quieter engine start.

For highway driving, a new energy management strategy was introduced. The expanded high-efficiency operating region of the dedicated engine enabled operation along the engine high-efficiency operating line. Direct power supply from the generator to the traction motor reduced energy conversion losses, battery heating, and acceleration delay during re-acceleration.(Fig. 3) Furthermore, engine speed rise characteristics were optimized using the increased torque of the 1.4 L engine, reducing the so-called rubber-band feeling and improving acceleration feel. As a result, the third-generation e-POWER achieved an 11% improvement in fuel economy while delivering competitive acceleration performance, quietness, and an EV-like driving experience for compact SUVs.

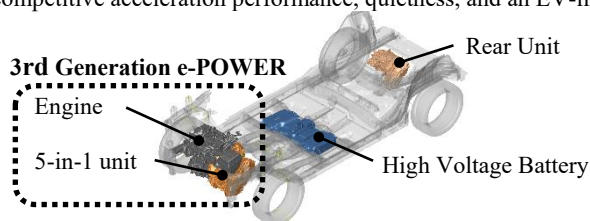


Fig. 1 Configuration of Third-Generation e-POWER System

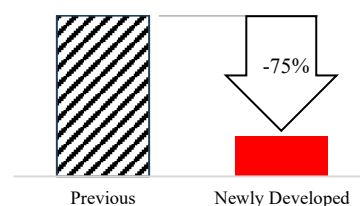


Fig. 2 Reduction of Engine Start Frequency at WLTC Urban

Table 1 New hybrid system specifications			
		Newly developed Compact SUV	Previous Compact SUV
Drive		2WD/4WD	2WD/4WD
Vehicle weight		1480 kg/1590 kg	1360 kg/1480 kg
Destination		Global	Global
Front	3rd Generation		2nd Generation
	Engine Type	Gasoline L3 1.4 L DIG e-POWER Dedicated	Gasoline L3 1.2 L MPI
		72 kW	60 kW
	Motor	105 kW/315 Nm	100 kW/280 Nm
	Gear ratio	7.922	7.388
Rear	Motor	50 kW/140 Nm	50 kW/100 Nm
	Gear ratio	7.282	7.282
High voltage battery		Li-ion 80 cell	Li-ion 96 cell

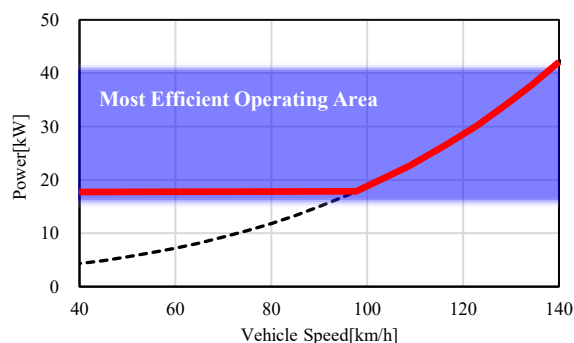


Fig. 3 Power Generation Control under High-speed Condition