

# ***Jatco***

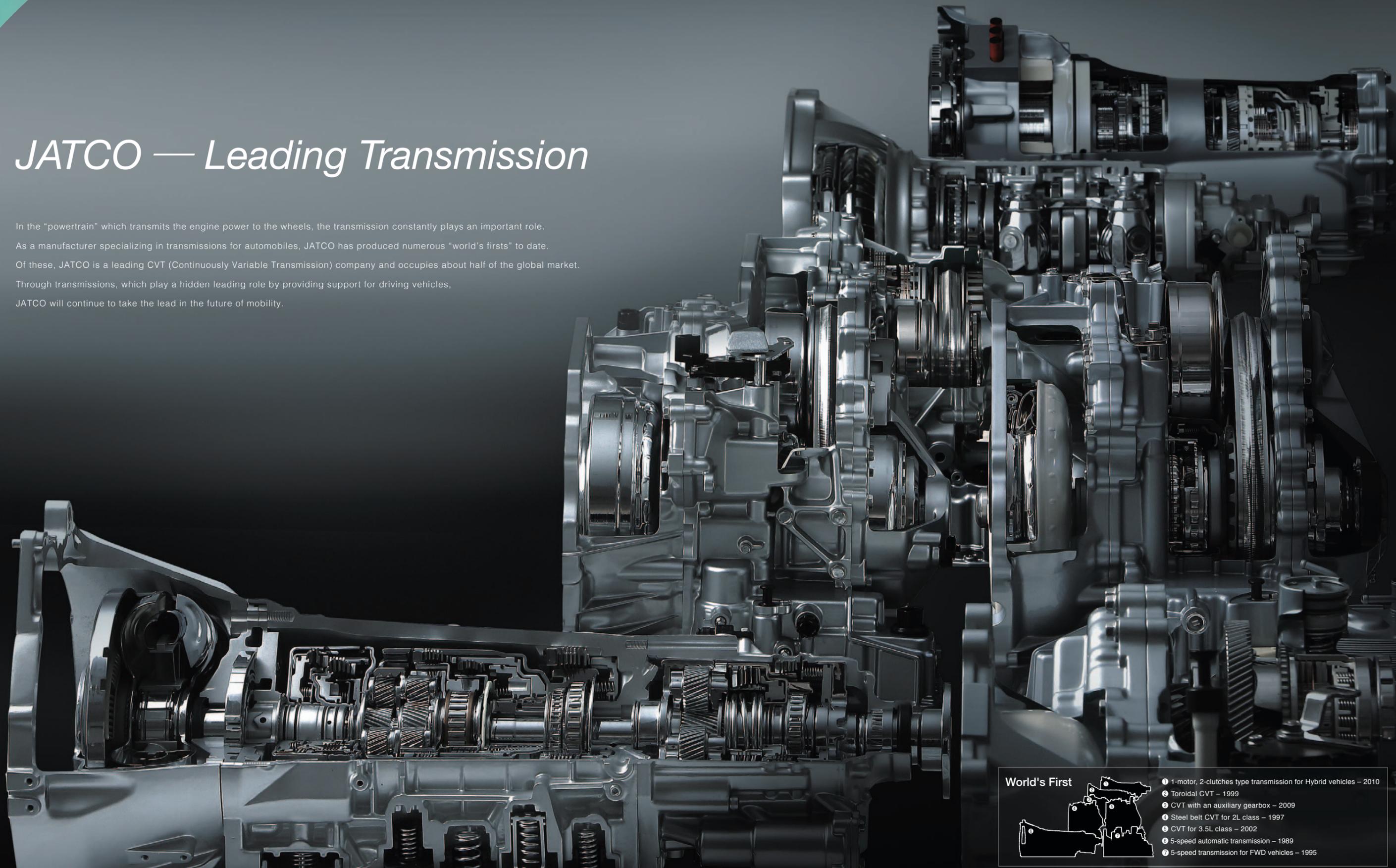
***JATCO Ltd Product Profile***

***Jatco***  
*The mission is passion.*

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# JATCO — Leading Transmission

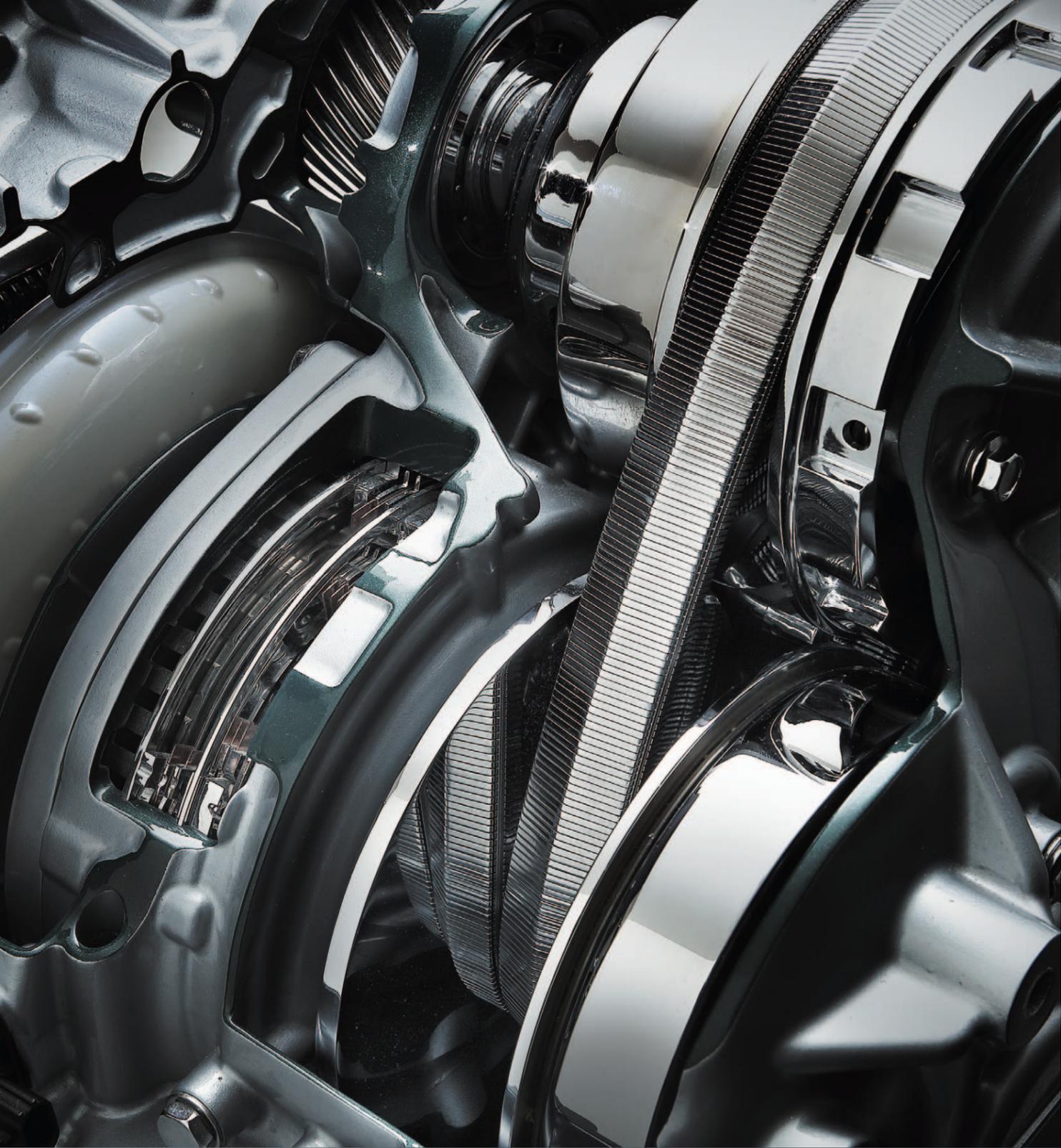
In the "powertrain" which transmits the engine power to the wheels, the transmission constantly plays an important role.  
As a manufacturer specializing in transmissions for automobiles, JATCO has produced numerous "world's firsts" to date.  
Of these, JATCO is a leading CVT (Continuously Variable Transmission) company and occupies about half of the global market.  
Through transmissions, which play a hidden leading role by providing support for driving vehicles,  
JATCO will continue to take the lead in the future of mobility.



## World's First



- 1 1-motor, 2-clutches type transmission for Hybrid vehicles – 2010
- 2 Toroidal CVT – 1999
- 3 CVT with an auxiliary gearbox – 2009
- 4 Steel belt CVT for 2L class – 1997
- 5 CVT for 3.5L class – 2002
- 6 5-speed automatic transmission – 1989
- 7 5-speed transmission for FWD vehicles – 1995



## CVT for FWD Medium and Large vehicles

# Jatco CVT8



JF016E/JF017E



### Front housing

The flexibility of the layout is improved through the use of a specially designed ultra-flat torque converter. The low rigidity lock-up damper locks up at low speeds, thereby improving fuel performance and sense of directness of the drive. Furthermore, hybrid specifications can be achieved just by retrofitting the motor unit in the space of the torque converter.



### Clutch for moving forward/reversing and planetary gear for decelerating

Planetary gear used to switch between moving forward and reversing has been incorporated into the position connected to the torque converter to enable deceleration and the switching of the direction of rotation.



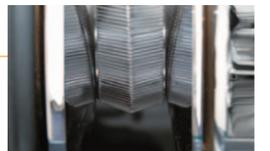
### Adding "flavor" to a vehicle's drive through control technology

A vehicle drives and performs in accordance with the intentions of the driver by harnessing various forms of vehicle information, such as accelerator position and vehicle speed. Our transmissions provide fine and precise shift control. For example, when the accelerator is turned off, the gear ratio is held unchanged in preparation for the next departure; in cases where the braking G is high when braking during a turn, the gear ratio is reduced slightly, and the engine brake is put into operation.



### Variator

The variator of the JF016E with torque capacity of 250Nm uses a steel belt while the large-capacity JF017E with torque capacity of 380Nm uses a chain belt. A distinction is made in the type of belt used corresponding with the characteristics of the transmission system.



The shape of the elements are reviewed to make the belt position more stable.

## Jatco CVT8, completed in relentless pursuit of wide range and high efficiency for fuel and driving performance of a CVT, even in high engine displacement vehicles

A steel belt CVT for 2-liter class vehicles and the world's largest CVT for 3.5-liter class vehicles. JATCO, always leading technologies of CVTs for high-torque vehicles, was strongly determined to integrate CVTs for medium and large-sized vehicles and to make it a standard for the next generation CVT. The Jatco CVT8 (hereafter, CVT8) was developed as a unit with the ability to cover vehicles up to a torque capacity of 380Nm.

### Expanding ratio coverage

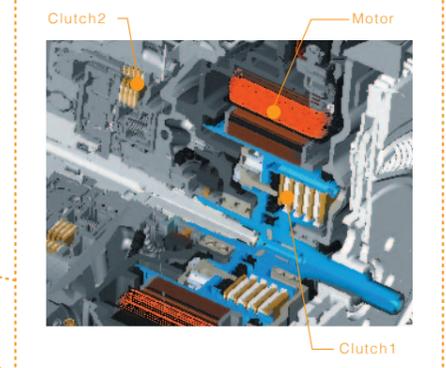
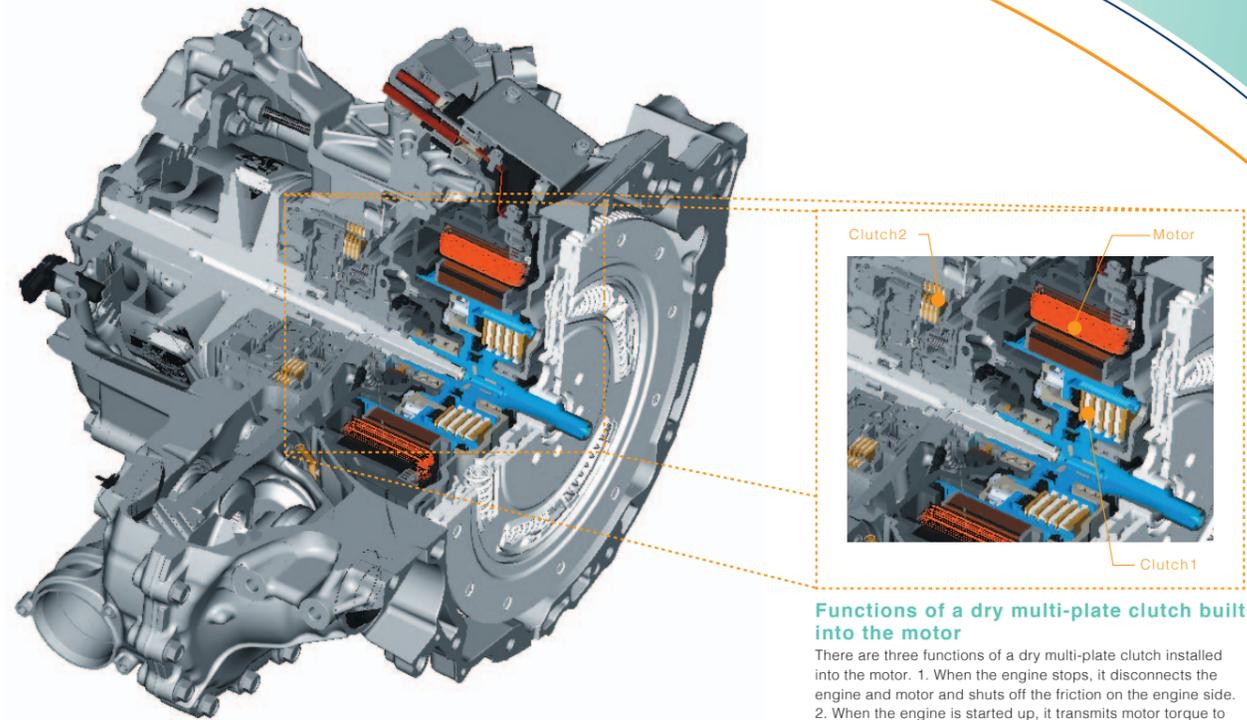
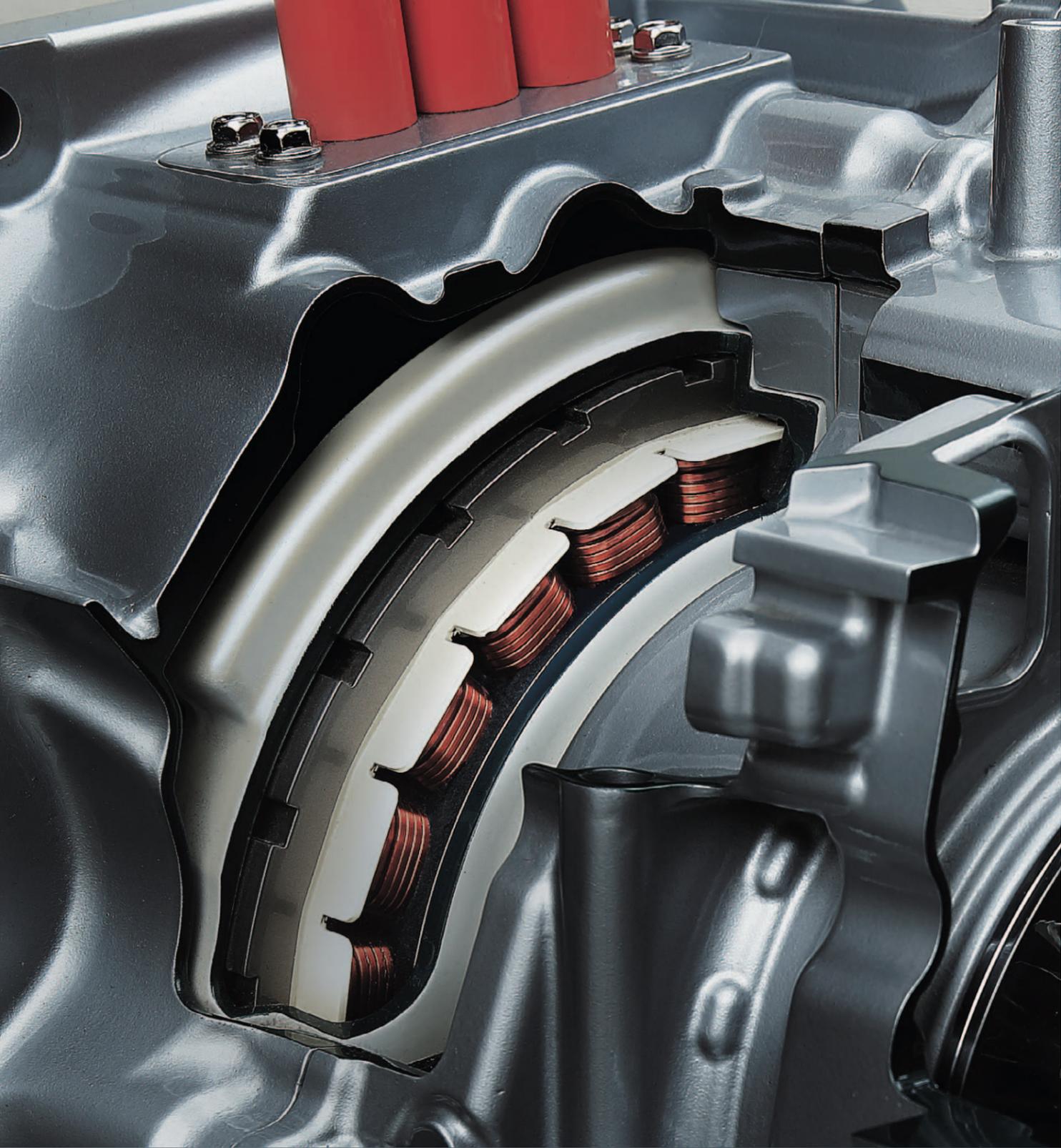
The first issue was expanding ratio coverage (transmission gear ratio width). Although it would be possible to expand ratio coverage simply by increasing the diameter of the pulley, the overall size of the CVT would increase, and vehicle-mounting performance would decline. Conversely, we focused on the inside of the pulley and explored methods for expanding ratio coverage. First, we reduced the shaft diameter

of the pulley and secured space closer to the center for winding the belt. After that, we reviewed the shape of the belt element and adopted a belt that would transmit torque efficiently when wound around a small diameter. This was because transmission efficiency would decline if the winding angle became too small. Through these measures, we succeeded in expanding ratio coverage from the previous 6.0 to 7.0, thereby contributing significantly to striking a balance between powerful drive at low speeds (low gear ratio) and low fuel consumption and quietness at high speeds (high gear ratio).

### Hydraulic control system with numerous improvements

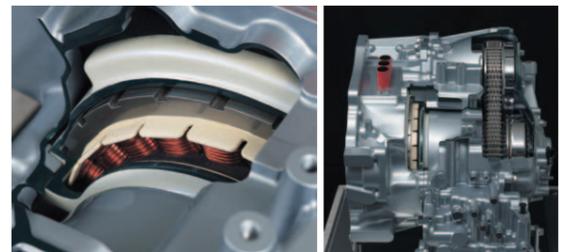
In a mechanism that operates pulleys for shift change, the mechanical loss of the seal ring is reduced and further changed from a step motor type to a direct acting type through hydraulic

pressure. The mechanism for switching between moving forward and reversing was changed to a variable hydraulic system. As a result of thorough efforts to optimize the oil passage in the control valve body, the three-tiered structure was converted to one with two-tiers while the number of spool valves was reduced from 12 to 8. Furthermore, by reviewing the clearance of the spool valves and other measures, oil leakage within the control valve was suppressed as far as possible. As a result of all these efforts, it became possible to provide coverage with a small-discharge oil pump. In addition, by reviewing the lubrication system around the differential gear and raising a baffle plate, we succeeded in eliminating the condition whereby the gear is constantly immersed in oil. As a result, friction was reduced by 40% in total, contributing significantly to fuel efficiency improvement.



**Functions of a dry multi-plate clutch built into the motor**

There are three functions of a dry multi-plate clutch installed into the motor. 1. When the engine stops, it disconnects the engine and motor and shuts off the friction on the engine side. 2. When the engine is started up, it transmits motor torque to the engine to kick off the engine. 3. It transmits power from the engine to the transmission. In addition, this dry multi-plate clutch optimizes the position of pushing the piston in order to prevent uneven abrasion of the friction material. It also has a structure that efficiently discharges abrasion powder to the outer perimeters direction by analyzing airflow.



**Adding a motor while minimizing the extension of overall length**

A unique 1-motor, 2-clutches system has been adopted. In this system, the driving/regenerative motor and the dry multi-plate clutch, which disconnects the engine and motor, are placed into the space previously occupied by the torque converter. This helps to minimize the impact on the mounting space in the car.

**Dedicated electric oil pump for cooling the clutch used to start up the vehicle**

SUVs in North America are often driven over sand or used to tow trailers and boats. The transmission controls driving force while sliding the clutch used for starting up the vehicle under such tough conditions. In order to cool down the heat that is generated during this sliding operation, a dedicated electric oil pump has been installed. This minimizes the damage to the clutch even under driving situations that impose a strong burden on the transmission systems.

**Jatco CVT8 HYBRID\*, the transmission for hybrid vehicles applying 1-motor, 2-clutches system**

When developing a hybrid version of a certain model, it would not be necessary to make significant revisions to the car if the size of the transmission (in particular, its length) could be maintained at the same level. In the Jatco CVT8 HYBRID (hereafter, CVT8 HYBRID), the torque converter is simply taken out of the Jatco CVT8, originally developed for medium and large-sized vehicles, and a driving and regenerative motor as well as the dry multi-plate clutch that connects the engine with the motor is placed into that space in a compact manner.

RWD hybrid vehicles that was developed before CVT8 HYBRID utilized a dry single-plate clutch, transmission for FWD vehicles should be more compact to fit into a narrower mounting space. Not only does the CVT8 HYBRID consist of a simple arrangement of the motor and the clutch, it also succeeds in minimizing the length of the axial direction by placing a dry multi-plate clutch inside the hollow portion of the donut-shaped motor.

sliding the clutch. If this continues for a long time, a large amount of heat would be generated, and the clutch surface temperature would rise gradually. With regard to the CVT8 HYBRID, efforts have been made to place a dedicated electric oil pump on the exterior and improve cooling performance, with a view to using this transmission in medium-class SUVs and other vehicles to be sold in the North American market. It comprises a system that cools down the starting-up clutch effectively where necessary and has been finished as a tough transmission that can stand even in long periods of high-load operations.

**Driving/regenerative motor and intermittent clutch of the engine**

To disconnect the engine and motor, a dry multi-plate clutch (Clutch 1) has been adopted instead of a wet clutch that tends to increase drag torque to a larger extent when the range of speed is lower. This is the first in the world for hybrid systems. Although the transmission for

**Use the clutch for switching between forward and reverse as the clutch for starting up**

In CVT8 as the base unit, the clutch positioned in front of the pulley takes the role of switching between moving forward and reversing. This clutch has been diverted for use as a clutch for starting up (Clutch 2). However, this system has an issue to be solved. In this system, the required start-up torque is secured through

Transmission for FWD Hybrid vehicles



JF018E/JF019E

\*Jointly developed by Nissan Motor Co. Ltd. and JATCO Ltd

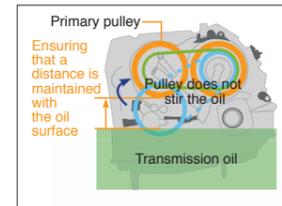


## CVT for FWD Mini and Small vehicles

# Jatco CVT7



JF015E

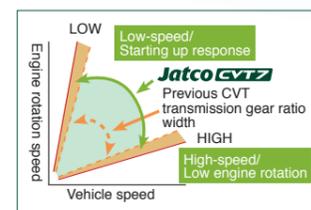
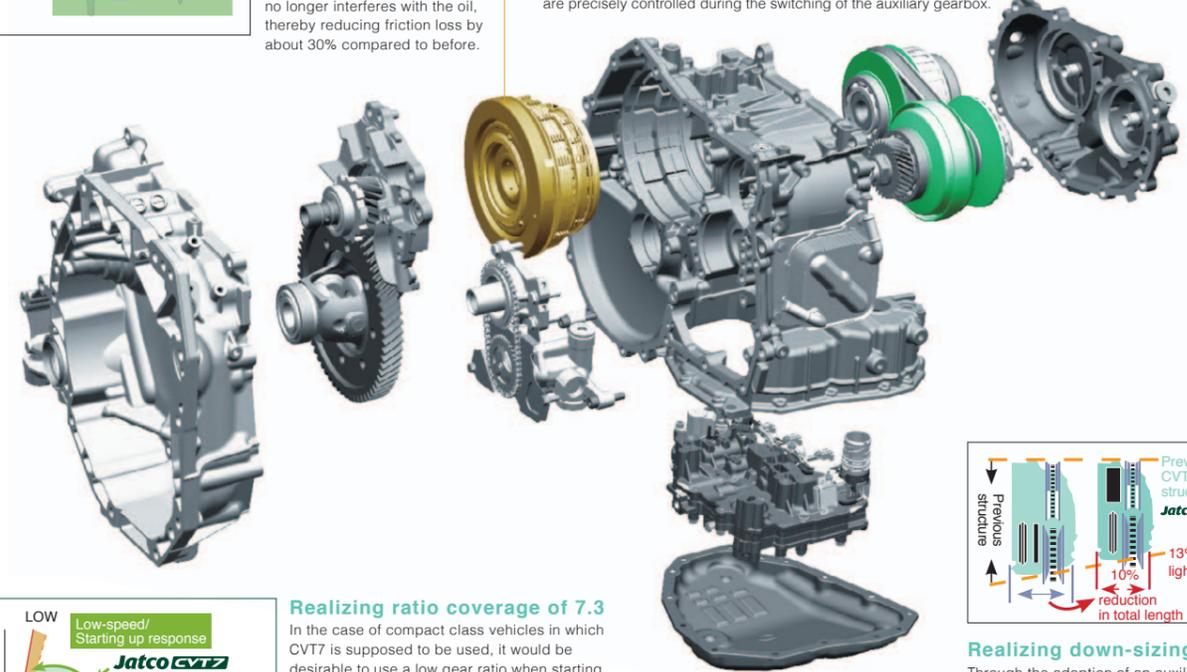


### Reducing the stirring resistance of the transmission oil

The idler gear is used to move the primary pulley one level higher. The pulley, part of which is immersed in oil, significantly reduces stirring resistance as it no longer interferes with the oil, thereby reducing friction loss by about 30% compared to before.

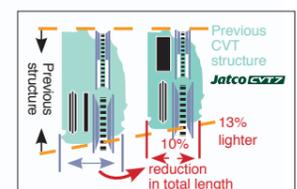
### Auxiliary gearbox that utilizes the planetary gears used for switching between moving forward and reversing

A function of two-step output, namely a direct and reduction ratio of 1.8, is applied to the planetary gear, which is responsible for switching between moving forward and reversing in response to output from the secondary pulley. In order to prevent shift shock during the switching of the auxiliary gearbox, the gear shift is controlled by the connection and release of the multi-plate clutch. Also, the rotating speed of the pulley and the gear ratio are precisely controlled during the switching of the auxiliary gearbox.



### Realizing ratio coverage of 7.3

In the case of compact class vehicles in which CVT7 is supposed to be used, it would be desirable to use a low gear ratio when starting and accelerating the car in order to compensate the inadequate engine torque. However, if a gear ratio is lowered without expanding ratio coverage, fuel performance may be influenced if the engine rotation speed is not reduced during high-speed drives. Conventional CVTs face limitations with regard to increasing pulley diameter, making it impossible to increase the ratio coverage above a certain level. However, through the use of an auxiliary gearbox, the CVT7 has achieved a ratio coverage of 7.3, significantly exceeding previous figures.



### Realizing down-sizing

Through the adoption of an auxiliary gearbox, the outer diameter of the pulley is reduced. Thus the length of the unit is reduced by 10% and the weight by 13%. For compact FWD vehicles with less space in the engine room, reduction of the transmission size causes a huge benefit.

## “Columbus’ egg” idea Jatco CVT7, an auxiliary gearbox expands the potential of a CVT

When starting a vehicle and accelerating, we want to shift the gear ratio toward the low end and gain powerful driving force. During high-speed cruising, we want to shift the gear ratio toward the high end and achieve quiet driving with good fuel performance. The lower displacement and less powerful the engine is, the greater the role of the transmission is, and the greater the required range of ratio coverage (transmission gear ratio width) is. However, generally, if the ratio coverage was expanded, the size of the transmission would increase. As a result, a transmission does not fit into a small engine room. “Columbus’ egg” solves the issue. The Jatco CVT7 (hereafter, CVT7) was born with an auxiliary gearbox for the first time in the world.

### Expanding the ratio coverage of CVT in a two-step AT

Wide ratio coverage is even more vital for compact vehicles with low engine displacement and low torque. On the other hand, the simplest way to expand ratio coverage in a CVT is to increase the diameter of the pulley. However, this does not resolve the issue of available mounting space for the CVT in the car. “If we were to

combine a two-step AT (auxiliary gearbox) with a compact CVT, it would be possible to expand ratio coverage.” This idea became the starting point for developing the CVT7.

### Utilization of the gear for switching between moving forward/reversing as auxiliary gearbox

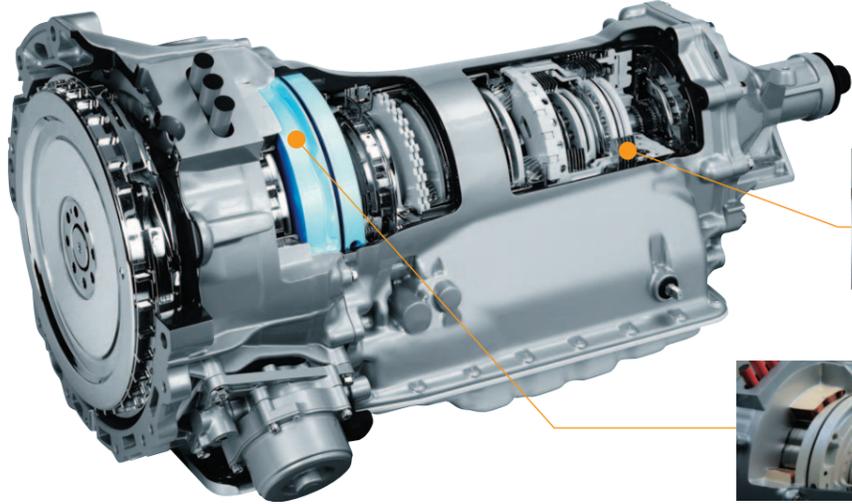
CVTs originally have planetary gears used for switching between moving forward and reversing. Those gears are utilized as an auxiliary gearbox through adding two-step shift transmission elements. On top of the original CVT function of shifting from low gear to high gear, this new function makes it possible to shift from first speed to second speed while driving. In order to ensure that the driver does not experience any discomfort by shift shock, the pulley controls shift change to minimize gear ratio variance before and after shifting. This high level of control technologies for carrying out smooth two-step shift change is one of the important advancements CVT with an auxiliary gearbox. JATCO’s high level of control technologies and knowhow cultivated over many years makes this new product possible.

### Reducing oil stirring resistance

In the CVT7, an effort has also been made to optimize the axis layout. As the input axis of the primary pulley has conventionally been placed in a low position, it stirs the oil during a drive, resulting in unnecessary loss by friction. Installing an auxiliary gearbox and reducing the diameter of the pulley increase the flexibility of the layout. Therefore, the primary pulley is successfully kept away from the oil pan by locating the input axis at a higher position with the idler gear. In this way, the oil stirring resistance is significantly reduced, and thus the friction loss is reduced by 30% compared to before.

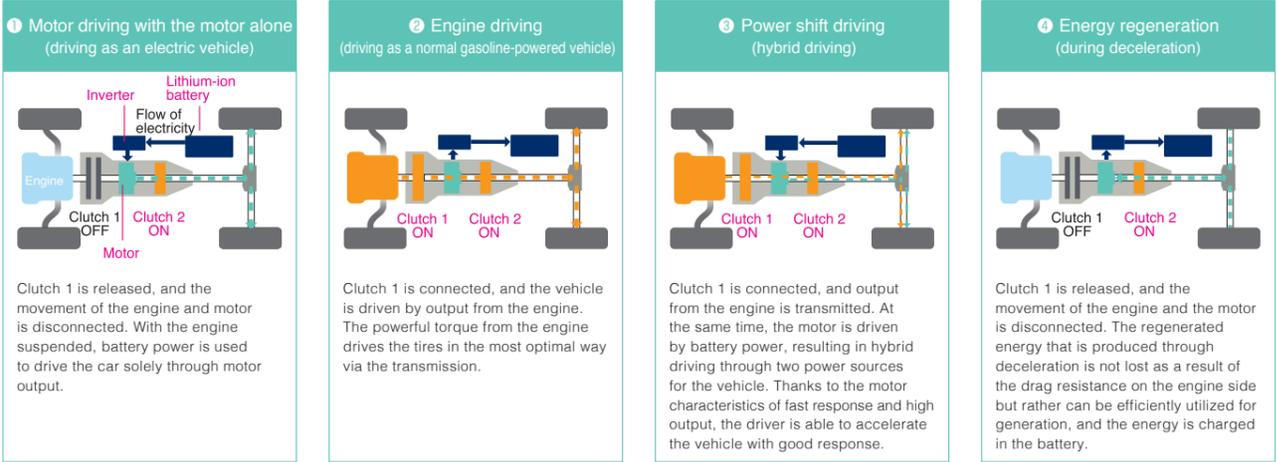
### Optimal CVT7 for compact vehicles

The CVT7, which has a wide ratio coverage despite being compact and lightweight, is the perfect transmission system for compact cars and light vehicles that require a very high level of fuel performance. With its excellent mounting performance, it has been adopted by various automobile manufacturers and is a best-selling transmission system for JATCO.



Clutch 2 serves the same role as the transmission clutch of the 7-speed AT for RWD vehicles, which its development was based on.

The engine and the motor are connected and disconnected through the first clutch, which comes in a dry single-plate structure. Efficiency is enhanced during motor driving and other instances through the complete disconnection of the engine and the motor by the clutch.



**JR712E\*, the transmission for RWD hybrid vehicles installed a 1-motor, 2-clutches system without changing the transmission size**

The JR712E, the transmission for RWD hybrid vehicles, represents the culmination of JATCO's knowhow and control technology. If we were to pursue new packaging for a hybrid system from the beginning, the production cost would not meet the expected cost for the vehicles. Conversely, an easier method would be to replace the existing torque converter in the transmission with a motor. However, this method offers limited benefits for a hybrid transmission system. JATCO has pursued the ideal balance between the two by taking the perspective of the users.

The JR712E holds the motor and clutch in the space created by removing the torque converter from the existing 7-speed AT for RWD vehicles. It is the world's first 1-motor, 2-clutches transmission for hybrid vehicles, with the newly added clutch serving as Clutch 1 and the original gearshift clutch in the 7-speed AT serving as Clutch 2. Originally, a torque converter plays the roles of increasing torque width when the vehicle is started up and accelerating and of easing shift shock. The issue of inadequate torque when the vehicle is started up, which arises as a result of the omission of the torque converter, is countered through a newly added electric motor. In addition, shift shock is absorbed through the more advanced control of the gearshift operation of Clutch 2 that comes after motor output. The ability to execute timely connection and release of the two clutches (switch shifting) is a result of the shift control technology for step ATs that JATCO has developed to date.

**Reason for using two clutches**  
 Of course, there is a significant reason for adding not only the motor but also the clutch. In typical hybrid driving modes, such as "motor driving" or "energy regeneration in deceleration," if the engine remains connected, energy would be lost as a result of excessive drag resistance. With an additional clutch, the engine would be disconnected when necessary to realize an even more efficient hybrid system.

**Birth of this packaging realized by an ideal balance between production cost and performance**  
 "We want to keep production costs lower and allow as many people as possible to enjoy the benefits of a hybrid system." This desire became the starting point for the concept. If we were able to maintain the mountability for vehicles, we would be able to minimize the change of the

**Transmission for RWD Hybrid vehicles**

**JATCO JR712E**



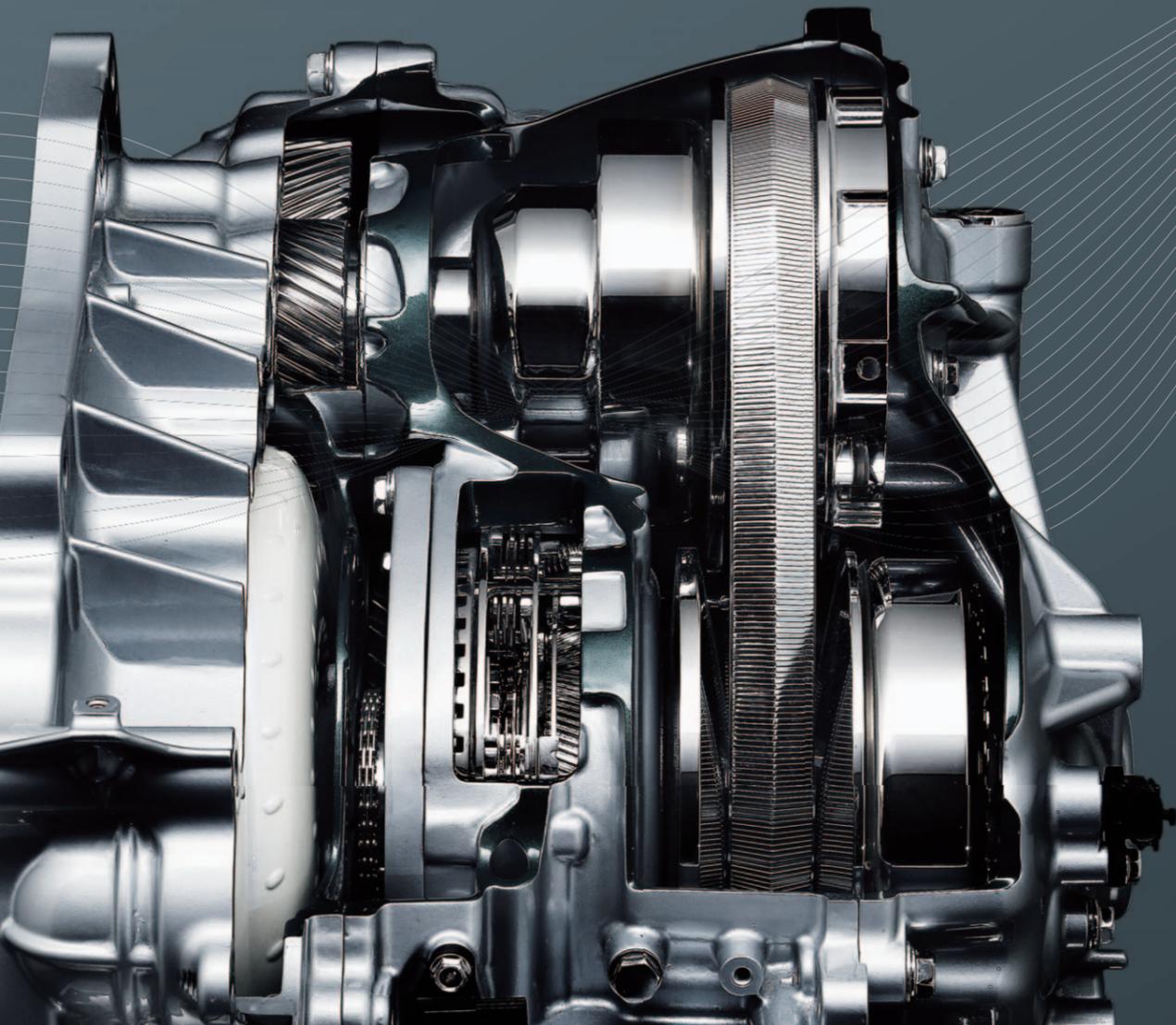
\*Jointly developed by Nissan Motor Co, Ltd. and JATCO Ltd

# Continuously Variable Transmission

## Continuously evolving JATCO CVTs

The evolution of CVTs, such as ratio coverage expansion and friction reduction, enables a balance between excellent fuel performance and comfortable driving at an even higher level.

The high potentiality has been recognized, and JATCO's CVTs are spreading across markets around the world.



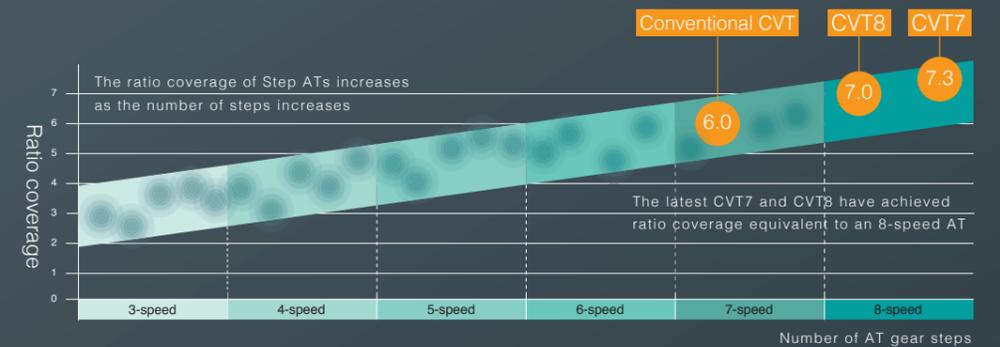
## Ratio coverage comparison between step AT and CVT

In order to realize start-up and acceleration at even lower gear ratios, as well as quietness and low fuel consumption at high gear ratios, the ratio coverage (width of transmission gear ratio) of step ATs has been expanded through an increase in the number of steps. In the case of CVTs, differently from step ATs, the ratio coverage can be increased without increasing the number of parts because of a basic structure for shifting speed through a belt and two pairs of pulleys. Despite no big change in appearance, CVTs are steadily evolving.

## Ratio coverage comparison: step AT and CVT

Taking reference from the benchmark for step ATs in the market, ratio coverage is expanded through an increase in the number of steps, from 4-speed to 5-speed, and to 6-speed. If we were to plot the ratio coverage of JATCO's CVTs against this, it would be clear that the conventional CVTs were equivalent to 7-speed step ATs while the latest CVT7 and CVT8 have a ratio coverage that is even wider than that of an 8-speed AT.

\*Based on investigations conducted by JATCO



## The CVT recognized by global markets

In the beginning, a CVT's performance was particularly noted in urban areas, where drivers had to repeatedly start up and accelerate their vehicles. Thus, CVTs were getting popular in the Japanese market first and are now well accepted by automobile users in global markets including North America, where environmental regulations are stringent, and China, where chronic congestion and air pollution are becoming increasingly serious in urban areas. JATCO's three overseas production bases produce CVTs, and this proves that CVTs have been recognized in the global market.

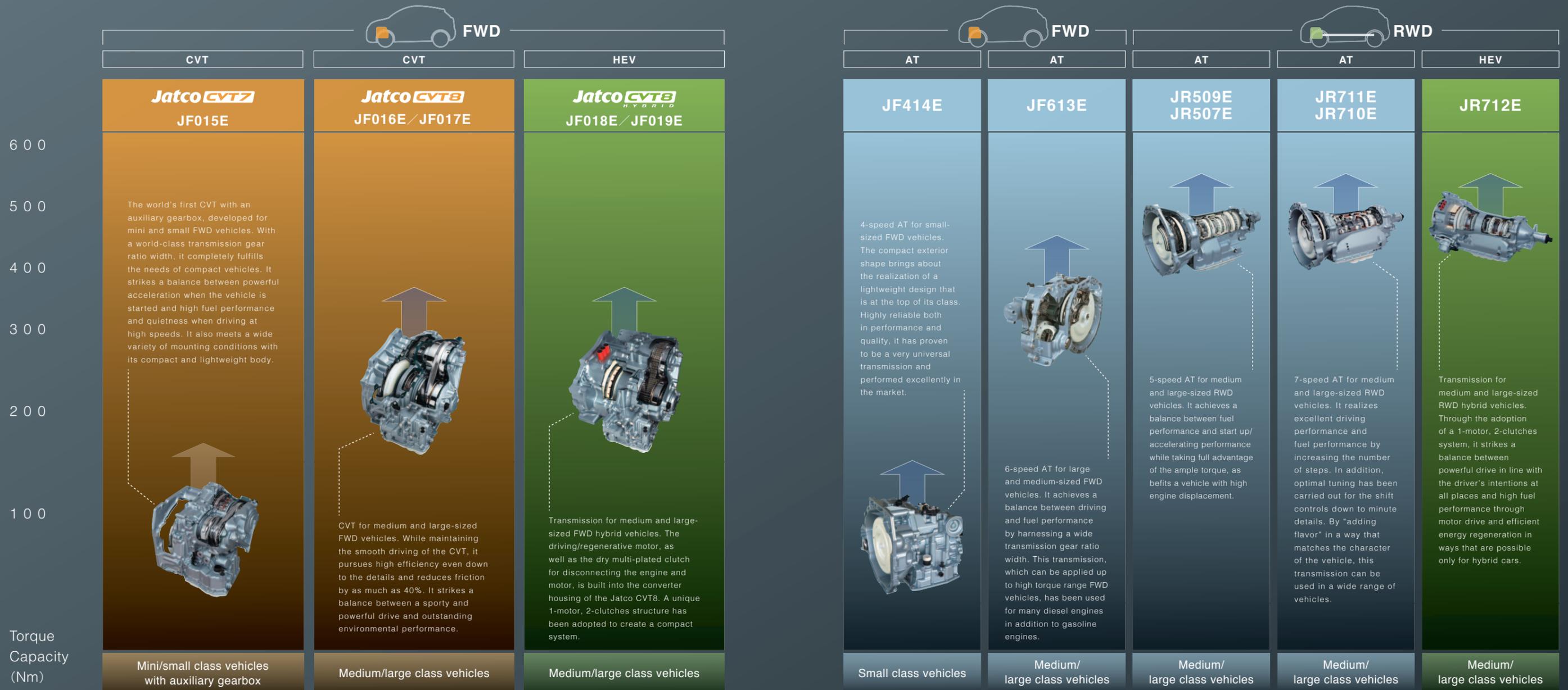


# JATCO

## Transmission Lineup

Taking the global lead with a wide and unique product line-up as a manufacturer specializing in the production of transmissions

JATCO's CVTs have the highest market share in the world. JATCO is the only CVT manufacturer in the world to cover vehicles from mini to 3.5-liter class vehicles. In addition, it offers a rich line-up of conventional step ATs. Various vehicles that are manufactured around the world today are mounted with JATCO products, and JATCO has won the strong support and high appraisal of many customers. As a manufacturer that specializes in transmissions, JATCO aims to be the global leader going forward.



● There are other products besides the transmissions featured in this brochure. For details, please inquire with JATCO staff or refer to the company's website.