

General Motors Rear Wheel Drive Eight Speed Automatic Transmission

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ABSTRACT

General Motors shall introduce a new rear wheel drive eight speed automatic transmission, known as the 8L90, in the 2015 Chevrolet Corvette. The rated turbine torque capacity is 1000 Nm.

This transmission replaces the venerable 6L80 six speed automatic. The objectives behind creation of this transmission are improved fuel economy, performance, and NVH. Packaging in the existing vehicle architecture and high mileage dependability are the givens. The architecture is required to offer low cost for a rear drive eight speed transmission while meeting the givens and objectives.

An eight speed powerflow, invented by General Motors, was selected. This powerflow yields a 7.0 overall ratio spread, enabling improved launch capability because of a deeper first gear ratio and better fuel economy due to lower top gear N/V capability, relative to the 6L80. The eight speed ratios are generated using four simple planetary gearsets, two brake clutches, and three rotating clutches. The resultant on-axis transmission architecture utilizes a squashed torque converter, an off-axis pump and four close coupled gearsets. The three rotating clutches have been located forward of the gearsets to minimize the length of oil feeds which provides for enhanced shift response and simplicity of turbine shaft manufacturing.

The transmission architecture features a case with integral bell housing for enhanced powertrain stiffness. A unique pump drive design allows for off-axis packaging very low in the transmission. The pump is a binary vane type which effectively allows for two pumps in the packaging size of one. This design and packaging strategy not only enables low parasitic losses and optimum priming capability but also provides for ideal oil routing to the controls system, with the pump located in the valve body itself. The transmission controller is externally mounted, enabling packaging and powertrain integration flexibilities. The controller makes use of three speed sensors which provide for enhanced shift response and accuracy.

Utilization of aluminum and magnesium components throughout the transmission yields competitive mass. The dedicated compensator feed circuit, used in GM six speed designs, has been supplanted by a lube-fed design in order to simplify oil routing and enhance shift response. Packaging is within that of the GM 6L80 design, allowing for ease of application integration.

The overall result is a robust, compact, and cost effective transmission which offers significant fuel economy and performance benefit, over its six speed counterpart, and shall provide an attractive balance of overall metrics in the automatic transmission market.

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INTRODUCTION

The motivation for undertaking a new eight speed automatic transmission is to improve vehicle efficiency, performance, and overall customer driving experience. Extra ratios allow for better matching of road load to engine torque during key operating conditions.

The success of the General Motors six speed rear wheel drive family has proven a difficult act to follow. Nevertheless, the new GM eight speed takes advantage of opportunities left unclaimed by the six speed design and delivers many benefits in the same package size.

POWERFLOW SELECTION STRATEGY

In order to deliver an eight speed transmission in the same package as the current six speed, the kinematic content must be kept to an absolute minimum. Total kinematic content can be described as the number of torque transmitting devices plus the number of planetary gearsets. Based on this definition, the incumbent GM six speed has a kinematic content of eight. That being the sum of three planetary gearsets and five clutches (note that the 1-2 Freewheeler in the GM six speed is a redundant device).

Although it is theoretically possible to achieve eight forward speeds and one reverse using this content, no competitive solutions have been found in this space. An additional clutch or gearset is, therefore, required. GM first set about inventing powerflows with three gearsets and six clutches. This could be executed by adding a clutch and making some modifications to the existing six speed rear wheel drive. Completely new three gearset six clutch options were also considered. All such three gearset powerflows were found to be suboptimal in terms of gearmesh efficiency and ratio flexibility. None of these solutions were found to meet the program targets. A search for a four gearset powerflow commenced.

Many effective powerflows were invented by GM in this rich search space. After an intensive search and tradeoff study, GM engineers selected a powerflow lever which has four gearsets, three rotating clutches, and two grounding clutches.

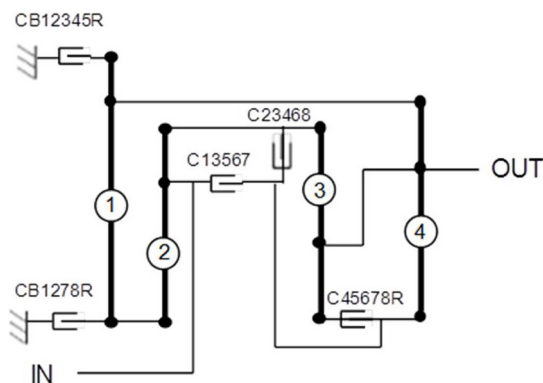


Figure 1. GM 8L90 lever diagram

This powerflow was selected in favor of other similar candidates because it offers a combination of benefits that are unique. Firstly, it can be effectively executed using all simple gearsets (unlike the incumbent six speed powerflow) which provides for improved gearmesh efficiency, low pinion count, and increased flexibility in pinion count. Secondly, all three rotating clutches attach to a single node of the transmission which provides for simple and effective rotating clutch oil feed options. Thirdly, it exhibits relatively low carrier speed ratios which keep pinion bearing g-loads to a minimum. Finally, it offers a high reverse-to-first gear ratio unlike some of the other powerflows considered.

ARCHITECTURE SELECTION STRATEGY

With the powerflow selection finalized, the architecture selection phase followed. With no close-coupled gearsets, there are twenty four different permutations of gearset order alone. All potential arrangements were considered. The final selection reflects an architecture with which GM Powertrain Engineering is highly experienced. Much like the incumbent six speed design, the selected architecture locates the grounding clutches rearward of the middle of the structure outside the gearsets. However, unlike GM six speeds, this new eight speed design features grounding clutches which are splined to the case thus eliminating the center support and reducing both mass and cost. Additionally, this enables the rearmost clutch, CB12345R, to utilize a piston housing which is packaged inside of the rear case extension. This, in turn, allows for use of a case with integral bell housing that is short enough to machine in equipment previously used on GM six speeds (which do not have an integral bell). This architecture further features a turbine shaft node which reaches to the outside of the barrel, enabling easy execution of a high resolution magnetic speed sensor. The turbine shaft itself is very short, keeping oil channel drill lengths to a minimum. The rotating clutches are all located close to the front of the transmission with short oil feed channels. This allows for very fast shifts which was a directive of the 8L90 project.

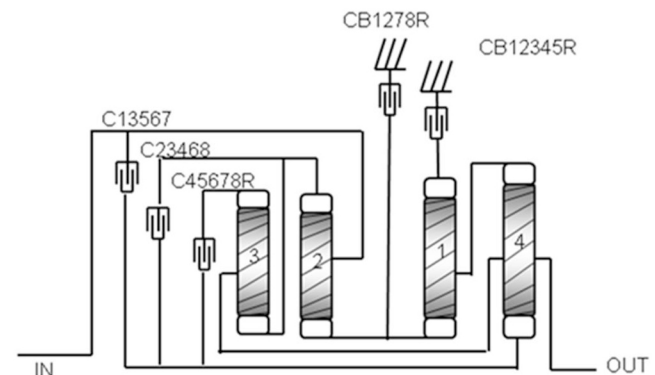


Figure 2. GM 8L90 stick diagram

CLUTCH COMPENSATION

Unlike the GM six speed rear wheel drive transmissions, the 8L90 makes use of clutch compensators that are fed by lubrication oil, rather than a dedicated and regulated feed. This offers two benefits. The first being the reduction of one oil channel between the valve body and the rotating clutches. This reduces the number of rotating oil seals and oil channels within the turbine shaft. The second benefit is realized in the ability of this system to provide for a rapid exhaust of the compensator volumes during clutch apply. Sealed compensators (like those of the GM six speeds) have the benefit of being filled at a high priority but can result in control challenges when the circuit encounters restriction during shift events. The 8L90 design avoids any such concerns by discharging the compensators