

New RWD 10 Speed Automatic Transmission for Passenger Vehicles

Tomohide Suzuki, Hiroyuki Sugiura, Atsushi Niinomi, and Shingo Maezuka
Aisin AW Co., Ltd.

Terufumi Miyazaki and Yohei Habata
Toyota Motor Corp.

ABSTRACT

Aisin AW (AW) and Toyota Motor Corporation (TMC) have developed a new rear wheel drive (RWD) 10-speed automatic transmission, AWR10L65 (TMC name: AGA0), suitable for RWD/AWD luxury passenger cars and sports cars. This 10-speed automatic transmission provides enhanced drivability leading to outstanding driver satisfaction. This has been accomplished using a close ratio gear train with optimized gear steps for rhythmic shift changes and quick acceleration. Low rpm lock-up and highly responsive shift changes result in a direct shift feel. This automatic transmission contributes to improved fuel economy by having higher efficiency and lower mass than current 8-speed RWD automatic transmissions.

CITATION: Suzuki, T., Sugiura, H., Niinomi, A., Maezuka, S. et al., "New RWD 10 Speed Automatic Transmission for Passenger Vehicles," *SAE Int. J. Engines* 10(2):2017, doi:10.4271/2017-01-1097.

INTRODUCTION

The first development priority for the new automatic transmission was "Driving pleasure" suitable for luxury passenger cars and sports cars. AW and TMC thoroughly considered which characteristics are needed for the automatic transmission to realize "Driving pleasure" for all drivers. AW and TMC understood that the new automatic transmission needed to realize Rhythmic, Smooth and Direct shift changes for quick and outstanding feeling. AW and TMC have long worked to improve the shift characteristics of existing models; however, the results were limited by hardware design factors. Therefore, AW and TMC decided to develop a brand-new automatic transmission to provide the No1 shift characteristics in the world.

To improve vehicle dynamics and fuel economy, mass reduction and increased efficiency compared to competitor's automatic transmissions were top level design targets. As a result, AWR10L65 realizes lower mass and improved efficiency compared to current 8-speed automatic transmissions.

In this paper, the development details for AWR10L65 (AGA0) are described.

GEAR RATIO SELECTION

To select a gear train structure, AW and TMC performed many case studies of ideal gear ratios to realize "Driving pleasure". After several discussions, AW and TMC concluded that the following characteristics are needed for outstanding and pleasurable driving feel.

- Rhythmic and smooth shift change (Fig. 1)
 - Uniform shift interval, Continuous acceleration
- Quick acceleration during high speed driving
 - Direct response from throttle pedal, Quick shift change

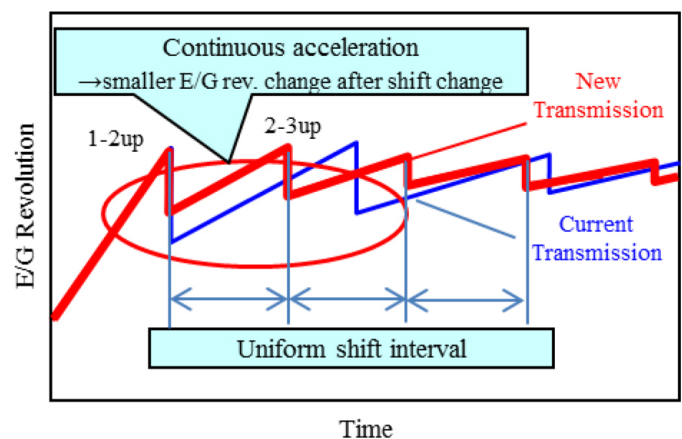


Figure 1. Rhythmic and smooth shift change

To realize these characteristics, the following gear ratio settings were chosen (Table 1). AW and TMC used optimization programs to investigate gear train systems. Several plans were selected from this analysis and it was finally judged that the 10-speed transmission gear system is optimum to achieve "Driving Pleasure".

Table 1. Optimum gear ratio setting for “Driving pleasure”

Item	Optimum Condition
Optimum Gear Step (Engine rev. change)	2-3shift : 1.35
	3-4shift : 1.25
	4-5shift or above : around 1.2
2nd gear total gear ratio (Driving force)	8 to 9
Overdrive gear ratio (Acceleration at high speed)	Total gear ratio: 1.91 to 2.64
Top gear ratio (Lower engine rev.)	Top gear total gear ratio: around 1.5

Fig.2 shows the AWR10L65 (AGA0) gear ratios. The gear step for the 2-3 shift is 1.34, for the 3-4 shift is 1.25 and for the 4-5 shift is 1.29. These optimized cross steps realized rhythmic shift changes. Starting acceleration ability is improved because the 1st gear ratio is 7% lower. The 2nd gear ratio is 9.260 and this lower gear ratio supplies enough driving force to allow for a full lock-up condition from 2nd gear. This helps AWR10L65 (AGA0) provide a direct response feeling to pedal position. The top gear total gear ratio is 1.756 and it is 13% higher

than current 8-speed automatic transmissions. This contributes to improved efficiency and quietness at highway speeds. Due to the 10-speeds, this gear train boasts both close gear steps and a wide overall spread to realize “Driving pleasure”.

STRUCTURE

In this section, a basic composition and operation of AWR10L65 (AGA0) are described.

As shown on Fig. 3, a flat torque converter is utilized at the front of the transmission. An off-axis oil pump is chosen because of efficiency improvement and shorter transmission length. The gear train is made up of three planetary gear sets (Fr: Ravigneaux, Mid: Single, Rr: Single), four clutches (C-1, C-2, C-3, C-4), and two brakes (B-1, B-2) (Fig. 4). As shown on Fig. 5, 10-speeds were achieved using the same number of shift elements when compared to 8-speed automatic transmissions. This transmission does not use a one way clutch for the 1-2 shift. Table 2 is the operation chart of AWR10L65 (AGA0). All gear ratios are made using 3 engaged elements and 3 disengaged elements.

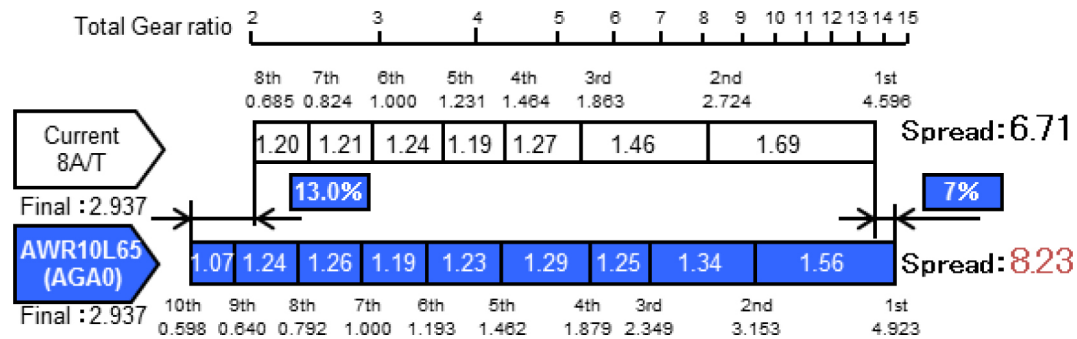


Figure 2. Close step gear ratio

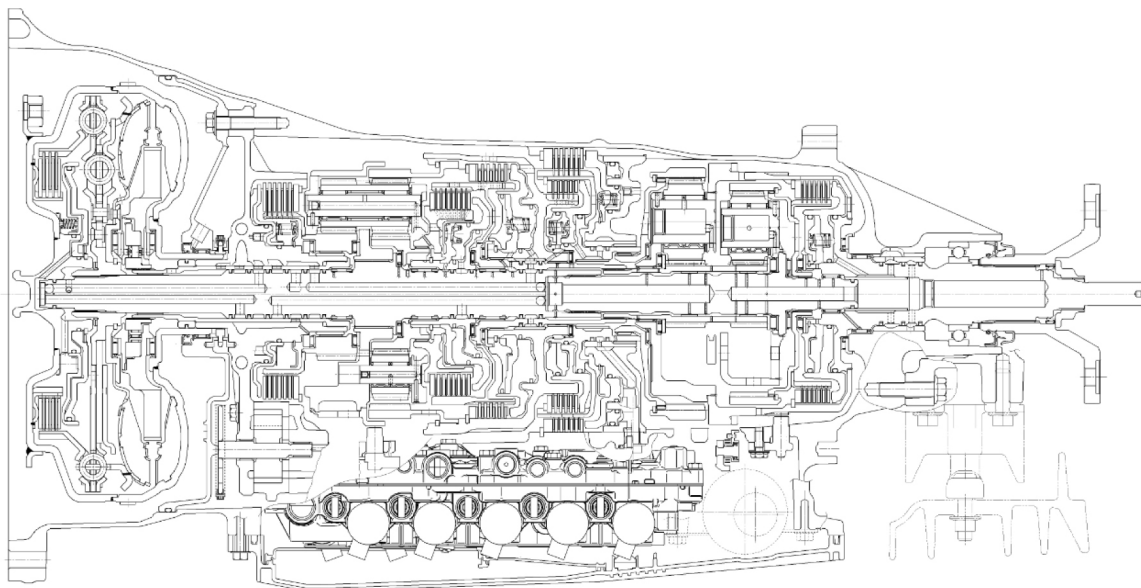


Figure 3. Cross Section of AWR10L65 (AGA0)