

Comprehensive Engineering and Repair Guide for AW60-40LE and AW60-41SN Automatic Transmissions

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The **AW60-40LE** (also known as the **AF13**) and its successors, the **AW60-41SN (AF17)** and **AW60-42LE**, represent a significant milestone in the evolution of compact automatic transaxles. Designed by **Aisin Warner**, these 4-speed electronically controlled transmissions have been integrated into a diverse range of vehicles across global markets, including those produced by **General Motors (Opel/Vauxhall, Chevrolet)**, **Suzuki**, **Daihatsu**, and **Fiat**. As a staple in sub-compact and compact car engineering, understanding the intricacies of these systems is vital for automotive engineers, master technicians, and fleet maintenance specialists.

The Engineering Evolution of the AW60 Series

The AW60 series was engineered to meet the demand for a lightweight, high-efficiency transmission that could fit within the tight engine bays of front-wheel-drive (FWD) vehicles. Its architecture focuses on minimizing mechanical loss while maximizing shifting smoothness through the use of sophisticated **Electronic Control Units (ECUs)** and pulse-width modulated (PWM) solenoids. Unlike its purely hydraulic predecessors, the AW60-40LE utilizes an integrated approach where hydraulic pressure is finely tuned by electronic inputs based on throttle position, engine load, and vehicle speed.

The Transition from AF13 to AF17

The progression from the AW60-40LE (AF13) to the AW60-41SN (AF17) introduced improvements in torque capacity and shifting logic. The "SN" designation often refers to a shift in solenoid configuration and internal hydraulic routing, allowing for more precise control over the **clutch-to-clutch** transitions. While the basic mechanical layout remains similar—utilizing a **Simpson planetary gear set**—the AF17 variant was optimized for the higher torque outputs of modern 1.6L and 1.8L Ecotec engines found in the Opel Astra and Zafira lines.

Core Technical Specifications and Dimensions

To perform a successful overhaul or diagnostic procedure, technical professionals must be aware of the physical and operational parameters of these units. The AW60 series is characterized by its compact 4-speed forward and 1-speed reverse configuration.

Feature	AW60-40LE (AF13)	AW60-41SN (AF17)	AW60-42LE
Max Torque Capacity	Approx. 150 Nm	Approx. 190 Nm	Approx. 170 Nm
Fluid Type	JWS 3309 / Dexron III	JWS 3309 / Type T-IV	Dexron III / VI
Dry Weight	~68 kg	~72 kg	~70 kg
Control Type	Electronic/Hydraulic	Electronic/Hydraulic	Electronic/Hydraulic
Application	1.3L - 1.6L Engines	1.8L Engines	1.5L - 1.6L Engines

Gear Ratio Analysis

The gear ratios of the AW60-40LE are calculated to balance fuel economy with low-end acceleration. The standard ratios typically include:

- 1st Gear: 2.810:1
- 2nd Gear: 1.549:1
- 3rd Gear: 1.000:1 (Direct Drive)
- 4th Gear: 0.703:1 (Overdrive)
- Reverse: 2.296:1

The **overdrive ratio (0.703)** is critical for highway efficiency, reducing RPM at high speeds, which subsequently lowers thermal load on the transmission fluid and increases the lifespan of the internal components.

Hydraulic and Electronic Control Mechanisms

The heart of the AW60-40LE is its **valve body**. This complex maze of hydraulic channels regulates the flow of **Automatic Transmission Fluid (ATF)** to the various clutch packs and brake bands. The valve body houses several critical solenoids:

Solenoid Functionality

1. Shift Solenoid No. 1 (S1) and No. 2 (S2): These are on/off solenoids that dictate the gear selection by routing pressure to the shift valves.
2. TCC (Torque Converter Clutch) Solenoid: This solenoid controls the engagement of the lock-up clutch within the torque converter. Proper engagement is essential for eliminating "slip" at cruising speeds and improving thermal management.
3. EPC (Electronic Pressure Control) Solenoid: This is a linear solenoid that adjusts the line pressure based on torque demand. A failure in this component often results in harsh shifts or complete slippage.

Pressure Testing Points

Technicians must utilize the pressure taps located on the transmission casing to diagnose hydraulic integrity. Standard line pressure should range from **55-80 PSI at idle** and can climb to **160-200 PSI at stall speed**. Deviations from these values indicate internal leaks, pump wear, or a malfunctioning EPC solenoid.

Detailed Master Repair Kit Components

When a unit exhibits significant failure—such as burnt friction plates or metal contamination—a full rebuild is required. A **Master Repair Kit** (often referenced in trade data as T11502A or K115900A) is the gold standard for

restoration. These kits are typically categorized into three levels of depth:

1. Overhaul Kit (Basic)

Includes all "soft" parts: **paper gaskets, O-rings, metal clad seals, and rubber seals**. These are essential for preventing external leaks and maintaining internal pressure seals between the case and the clutch drums.

2. Banner Kit

Includes everything in the Overhaul Kit plus a complete set of **friction plates**. These plates are lined with specialized composite materials designed to withstand high friction and dissipate heat into the ATF.

3. Master Kit (Comprehensive)

The Master Kit includes the Banner Kit components plus **steel plates**. Over time, the steel plates that sandwich the friction discs can warp or develop hot spots (blueing). Replacing them ensures a perfectly flat surface for clutch engagement, preventing future chatter and erratic shifting.

Internal Mechanics: Clutch Packs and Planetary Sets

The AW60-40LE operates using a combination of five major friction elements: the **Forward Clutch (C1)**, **Direct Clutch (C2)**, **Reverse Clutch (C3)**, **Second Brake (B2)**, and **Low/Reverse Brake (B3)**. Understanding which component is active in each gear is essential for troubleshooting.

- 1st Gear: C1 Engaged, B3 Engaged (or One-Way Clutch).
- 2nd Gear: C1 Engaged, B2 Engaged.
- 3rd Gear: C1 Engaged, C2 Engaged.
- 4th Gear: C2 Engaged, B2 Engaged.
- Reverse: C3 Engaged, B3 Engaged.

If a vehicle loses 3rd and 4th gear simultaneously, the technician can isolate the **Direct Clutch (C2)** as the likely point of failure, either due to burnt friction material or a failed piston seal within the C2 drum.

Common Failure Modes and Troubleshooting

The AW60-40LE is a robust unit, but like all mechanical systems, it has predictable failure points. These are often categorized into electrical, hydraulic, and mechanical issues.

Harsh Engagement (P-D or N-R)

This is frequently caused by high line pressure resulting from a faulty **EPC solenoid** or a sticking **primary regulator valve** in the valve body. In some cases, the rubber dampers within the accumulators may have hardened, losing their ability to cushion the shock of engagement.

Flare on 2-3 Shift

A "flare" occurs when the engine RPM increases momentarily during a shift, indicating a brief period of neutral. On the AF13/AF17, this is often traced to wear in the **servo bore** or a leak in the **C2 clutch circuit**. If the friction plates are not the culprit, the valve body should be vacuum tested to identify bore wear.

Transmission Overheating

The AW60 series relies heavily on its external cooling circuit. If the radiator-integrated cooler becomes restricted, the ATF temperature can exceed 120°C (248°F), leading to rapid oxidation of the fluid and hardening of internal seals. Adding an auxiliary transmission cooler is a common "field fix" for vehicles operating in hot climates or high-

traffic environments.

Step-by-Step Rebuild Procedure: Best Practices

Rebuilding an AW60-40LE requires a clean-room environment and precision tools. Contamination is the primary cause of post-rebuild failure.

Disassembly Phase

1. Fluid Inspection: Analyze the old fluid for metallic shavings (indicates gear/bearing failure) or clutch material (indicates friction wear).
2. Valve Body Removal: Remove the oil pan and carefully disconnect the solenoid wiring harness. Store the valve body in a lint-free environment.
3. End-Play Measurement: Before complete teardown, measure the input shaft end-play. This helps determine if the thrust washers are excessively worn.

Cleaning and Inspection

All metal components must be cleaned in a solvent tank and dried with compressed air. Inspect the **planetary gear carriers** for any play in the pinions. Inspect the **sun gear** and **ring gear** for pitting or chipped teeth.

Reassembly and Sealing

When installing new pistons, use a specialized transmission assembly lube (like Trans-Gel) to prevent the new O-rings from rolling or tearing during installation. **Air-checking** each clutch pack after assembly is mandatory. Apply compressed air into the feed holes to ensure the pistons move freely and the seals hold pressure.

The Role of Maintenance: Fluid Capacity and Type

Proper maintenance is the most effective way to extend the life of the AW60-40LE. The transmission typically has a **total capacity of 5.5 to 6.3 liters**, though a standard drain-and-fill only replaces about 2.5 to 3.0 liters.

Fluid Compatibility Matrix

Condition	Action Required	Interval
Normal Driving	Fluid Check	Every 15,000 km
Severe Service	Fluid Replacement	Every 40,000 km
High Mileage (>150k km)	Filter and Fluid Change	Every 30,000 km

Using the correct fluid is non-negotiable. While many modern fluids claim universal compatibility, the AW60-41SN (AF17) is particularly sensitive to friction modifiers. Using a fluid without the **JWS 3309** specification can lead to TCC shudder and improper shift timing.

Case Study: Suzuki Swift and Opel Astra Failure Patterns

In a technical analysis of fleet data for the **Suzuki Swift** (equipped with the AW60-40LE), a recurring issue was identified involving the failure of the **input speed sensor**. The ECU would lose the signal for input shaft RPM, causing the transmission to enter "Limp Home Mode," locking the unit in 3rd gear to prevent mechanical damage. Replacing the sensor and clearing the **Diagnostic Trouble Codes (DTCs)** usually restored full functionality.

Conversely, in the **Opel Astra (AF17)**, the most common failure was the **coolant-to-ATF leak**. The internal heat exchanger inside the radiator would fail, allowing engine coolant to mix with the transmission fluid. This creates a "strawberry milkshake" substance that destroys friction material almost instantly. In such cases, a complete Master Kit rebuild and a new radiator are required.

Practical Field Guide: Diagnostic Codes

When the "Check Gearbox" or "Service Vehicle Soon" light illuminates, the following DTCs are frequently encountered in the AW60-40LE systems:

- P0730: Incorrect Gear Ratio (Check for clutch slip).
- P0751: Shift Solenoid A Performance/Stuck Off.
- P0756: Shift Solenoid B Performance/Stuck Off.
- P0741: TCC System Performance/Stuck Off (Lock-up issue).
- P1700: Transmission Control Module (TCM) Requested MIL Illumination.

Electrical diagnostics should always begin with the **harness connector**. Corrosion in the multi-pin connector can cause intermittent signals that mimic catastrophic mechanical failure.

Future-Proofing the AW60-40LE Transmission

For vehicles still in operation, longevity can be improved through several engineering upgrades. Installing a **Shift Kit** can modify the valve body to provide firmer, faster shifts, which reduces the duration of friction-on-friction contact, thereby lowering heat. Furthermore, replacing the stock 10-micron filter with a high-flow synthetic media filter can improve hydraulic response in cold starts.

The AW60-40LE and its variants remain a testament to Aisin Warner's ability to produce reliable, high-density power transmission solutions. By adhering to strict rebuild protocols, using high-quality master repair kits, and ensuring the use of specified ATF, these transmissions can easily exceed a service life of 300,000 kilometers. For the technical professional, the key lies in the details: from the vacuum testing of the valve body to the precision of

the clutch stack-up clearances. As automotive technology moves toward electrification, the lessons learned from the hydraulic logic and electronic integration of the AW60 series continue to inform the design of modern drivetrain systems.

Baca Juga (Artikel Terkait)

- [Comprehensive Technical Guide to Hyundai Sonata Maintenance: Systems Diagnostics, Repair Manuals, and Engine Management](#)

URL: <http://alaskawriters.com/hyundai-sonata-technical-repair-diagnostic-guide.pdf>

- [Comprehensive Technical Analysis and Maintenance Guide for the First-Generation Hyundai Tucson \(2004–2010\)](#)

URL: <http://alaskawriters.com/hyundai-tucson-first-generation-technical-repair-guide.pdf>

- [Comprehensive Technical Guide to BMW 7 Series F01/F02: Workshop Manuals, Engineering Analysis, and Maintenance Protocols](#)

URL: <http://alaskawriters.com/bmw-7-series-f01-f02-workshop-manual-technical-guide.pdf>

- [Comprehensive Technical Service Guide for 2008–2010 Dodge Grand Caravan: Maintenance, Repair, and Systems Analysis](#)

URL: <http://alaskawriters.com/dodge-grand-caravan-2008-2010-technical-repair-guide.pdf>

Tags: #AW60 40LE #AF13 Transmission #Transmission Rebuild #Aisin Warner #AF17 AF13 Repair #Automatic Gearbox Maintenance

