

DELIVERING THE GOODS

INTRODUCING THE TOYOTA AC60E

**TOYOTA'S
6-SPEED SAGA CONTINUES...
WITH FEWER PARTS!**



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Since front-wheel-drive vehicles are a better choice for fuel efficiency, rear-wheel-drive vehicles are becoming less popular. With the added weight of a differential assembly, drive-shaft, and support components, there is really no way for a rear-wheel-drive vehicle to win the pole position in fuel economy. However, in truck and performance sports car applications, rear-wheel drive is the choice for reliability, durability, and overall torque handling capacity.

Like most other OEM manufacturers, Toyota has maintained a line of rear-wheel-drive transmissions, especially for truck applications. The A760E and the AB60E have been the medium and heavy-duty applications, respectively. In 2015, Toyota released the AC60E. It is designated as a light to medium duty transmission. It is similar to the A760E but very different. Let's look at what's different inside this new unit.

VEHICLE AND ENGINE APPLICATIONS

In the US, the AC60E is found in the Toyota Tacoma behind the Inline 4-cylinder and the V-6 engines. Since Toyota supplies vehicles in numerous markets around the world, other applications using this transmission may never show up in the US (figure 1).

The AC60E designation indicates a 2-wheel-drive unit, while AC60F represents the 4-wheel-drive version. There is also a light-duty and heavy-duty application. The difference is in the number of friction plates that are used inside the individual clutch packs. This would also coincide with the rated torque output of the engine: where the V-6 and diesel applications require the heavy-duty unit. The gear train components are identical in all AC60E applications.

Unit identification will allow you to cross-reference the transmission part number to the Toyota parts catalog. With some research, you can determine what version unit you are working with. The tag located on top of the main transmission case will give you the information you need (figure 2). You can use the tag numbers, or the QR (Quick Read) label.

WHAT'S DIFFERENT?

The theme of this unit is doing the more with less. The AC60E is a much simpler unit inside. There are two rotating clutches, three brake clutches, and one low mechanical clutch (sprag) (figure 3). When compared to the four rotating clutches, four brake clutches, and four one-ways in the A760E, the difference is huge!

Toyota	
2019-present	Land Cruiser V6
2015-present	Tacoma 2.7L gas
2015-present	Prado 150 Series
2015-present	Fortuna GUN Series
2015-present	Hilux 2.4L (gas and diesel)
2019-present	Hiace 2.8L diesel
2019-present	Commuter 2.8L diesel
2015-present	Innova
2015-present	Cresta
2015-present	(Isuzu) D-Max TF Series 2

Figure 1

By harnessing advances in computer control algorithms, electromechanical and hydraulic management has taken the place of one-ways and extra clutch packs.

The clutch apply chart also shows its simplicity (figure 4). One special notation is the reverse application. The clutch apply chart shows the B2 and B3 brakes applied, but no driving clutch applied. We learned that in order to have an output from any planetary set, we must drive a component and hold another. For reverse, the driving

member comes through the C2 drum, being mechanically connected to the input sun shell. Both the C1 and C2 drums are connected directly to the input shaft. Therefore, in reverse, the input comes from a mechanically driven input sun gear.

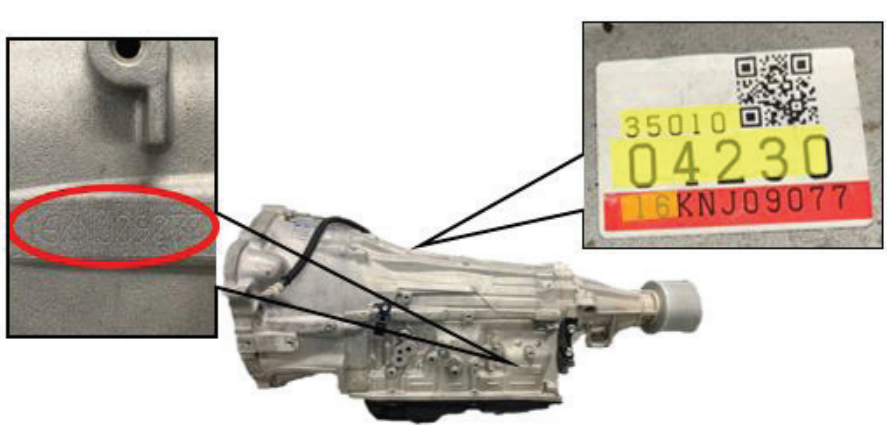
Another noteworthy difference is the valve body. First, there are fewer solenoids (figure 5). Toyota uses a hydraulic control system that puts the solenoid in direct control of the fill rate and exhaust of each clutch. Solenoids S1 through S4 are full flow, linear design. Line pressure is fed directly to the solenoid, where the computer uses pulse width modulation to control the apply and release rate of the clutch. They are noticeably larger to handle the necessary volume of fluid needed to perform their duties.

The full flow linear solenoids do not use a relay valve in series with the clutch feed from the solenoid, which means that there are fewer valves in the valve body. Direct solenoid to clutch feed also means that the hydraulic circuits are less complex. The valve body has no check balls! In the place of check balls, it has check valves. Overall, the valve body is less complex than earlier 6-speed units.

HOW IT WORKS

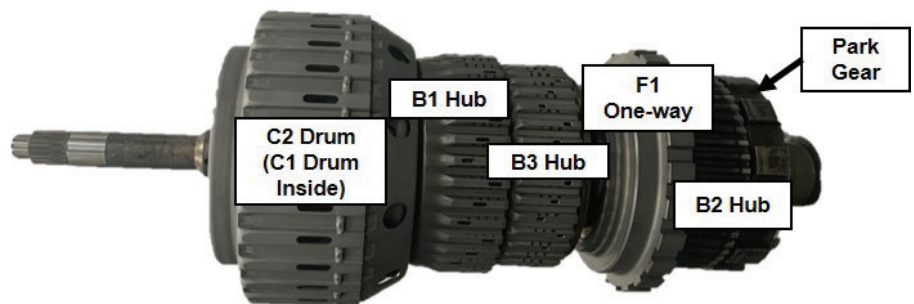
Precise computer management is key to the operation of this transmission. Like previous models, a power train control module (PCM) is used to send commands to solenoids and receive feedback from sensors inside the transmission. Engine management data is also used for shift scheduling and torque converter operation. ADAS, ABS, and other sensor data are transmitted via the CAN bus system and used for power train management inputs as needed. Engine torque management, combined with solenoid modulation, ensures the best shift quality under all driving conditions.

The computer strategy is designed to respond to component failures as well. Since the mechanical operation of the shift solenoids is critical to the application and release of the



This number will always identify the correct transmission from the dealer. The first 12 digits are the unit part number. You can use a QR label reader software to get this information as well. There is also a serial number located on the left, rear area of the case.

Figure 2



The clutch layout is more simple than any other Toyota 6-speed. Notice that there is only one one-way clutch.

Figure 3

Clutch Apply Chart

Gear Position	C1	C2	B1	B2	B3	F3
1st	ON*					ON
2nd	ON*		ON			
3rd	ON*				ON	
4th	ON*	ON				
5th		ON			ON	
6th		ON	ON			
Man 1	ON			ON		ON
Reverse				ON	ON	

* = Modulated release for off-throttle freewheel in D, modulated partial apply for engine braking in S mode.

Figure 4: Two elements must be applied to have power flow through the unit. Note that 2 brakes are applied for reverse with no input clutch apply. The design of the gear train allows for use of a mechanical input through the C2 drum that is splined to the #1 sun gear.

individual clutch packs, mechanical failures would be catastrophic without a fail-safe operation strategy. Each solenoid has its own fail-safe strategy programmed into the PCM. If the solenoid fails “stuck on,” certain gears will not operate based on the failure (figure 6).

There are 2 transmission temperature sensors attached to the valve body that have separate duties. Temperature sensor No.1 is used for hydraulic pressure control. This sensor is used to revise the apply pressure to clutches and brakes in the transmission for smooth shift quality. Temperature sensor No.2 is

used as a basis for modifying the shift timing control when the transmission fluid temperature is high. It is also used for the ATF temperature warning light. If either temperature sensor fails, shifts to 5th and 6th gears will be prohibited.

Speed sensors are used to monitor gear train operation. The input speed sensor is called the Transmission Revolution sensor NT (or ISS). The output speed sensor is referred to as the Transmission Revolution sensor SP2 or OSS. They provide feedback for the PCM to determine shift quality and provide diagnostic data for trouble codes. They are polarity sensitive hall-effect sensors. A 12-volt reference is fed to the sensor where a current fluctuation from 4 to 12 mA is observed when a reluctor or magnet is passed near it. They are interchangeable too.

In the event that a transmission speed sensor signal is lost, the ECU will default to a different sensor for reference to continue operating the transmission. Note that adaptive functions and TCC strategies will be frozen until the signal is restored. If the Transmission Revolution sensor (NT) (ISS) fails, shift control is performed based on the transmission revolution sensor (SP2) signal. If the Transmission Revolution sensor (SP2) (OSS) fails, shift control is performed based on the wheel speed sensor signal through the ABS system.

UNIT ISSUES

These units seem to be holding up to some rather severe conditions around the world with few issues and complaints. However, with new technology comes some growing pains. Most of the related issues with the AC60E are cured by updating the powertrain control software to the latest version. Complaints such as shifting into high gear too soon, engine lugging, gear hunting, and surging all fall under this category.

In markets that have diesel engine applications, there are some issues concerning B2 clutch failure. The B2 clutch is the Low/Reverse Clutch. Severe clutch burn and/or complete disc failure are noted. The failures seem to be occurring in heavy use and commercial applications. More information is needed to determine the

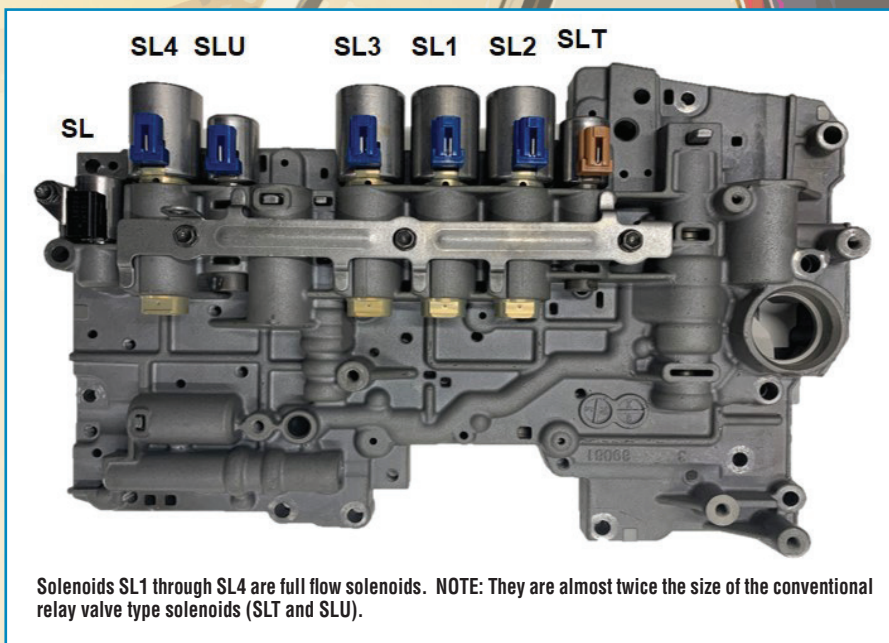


Figure 5

Solenoid Mechanical Failure Apply Chart						
Failure Mode	1st	2nd	3rd	4th	5th	6th
SL1 stuck on	X	X	X	X		
SL1 stuck off					X	X
SL1 stuck off*			X		X	
SL2 stuck on				X	X	X
SL2 stuck off	X	X	X	X		
SL2 stuck off*		X	X			
SL3 stuck on		X	X	X	X	X
SL3 stuck off	X		X	X	X	
SL3 stuck off*			X			
SL4 stuck on				X	X	X
SL4 stuck off**	X	X		X		X
SL4 stuck off*		X				

* = Computer selected gears with fail safe strategy active.
 ** = Actual shift pattern is: 1-2-1-4-Neutral-6.

Figure 6: The transmission computer strategy activates when a shift solenoid is mechanically stuck off only. There is no active strategy for a solenoid 'stuck on' condition.

exact cause, however, it also is related to repeat, loaded use in reverse. If you encounter this type of failure, attempt to find out as much as possible about the operating conditions (repeat use in reverse and/or manual low, etc.) as well as vehicle load (relative to maximum rated capacity).

Given the compact design and torque handling capabilities of this unit, the AC60E is poised to be a popular unit in many medium to light-duty rear-wheel-drive applications. Although you

may not see one of these in your shop tomorrow, you will see them soon. So, now's the time to learn more about this transmission!

If you want to learn more about the AC60E transmission, I invite you to join ATRA at the virtual EXPO 2020. Here, I will showcase the unit in its entirety, and host a question and answer session. For details on how to attend, go to www.atra.com!

