FW6A-EL Introduction

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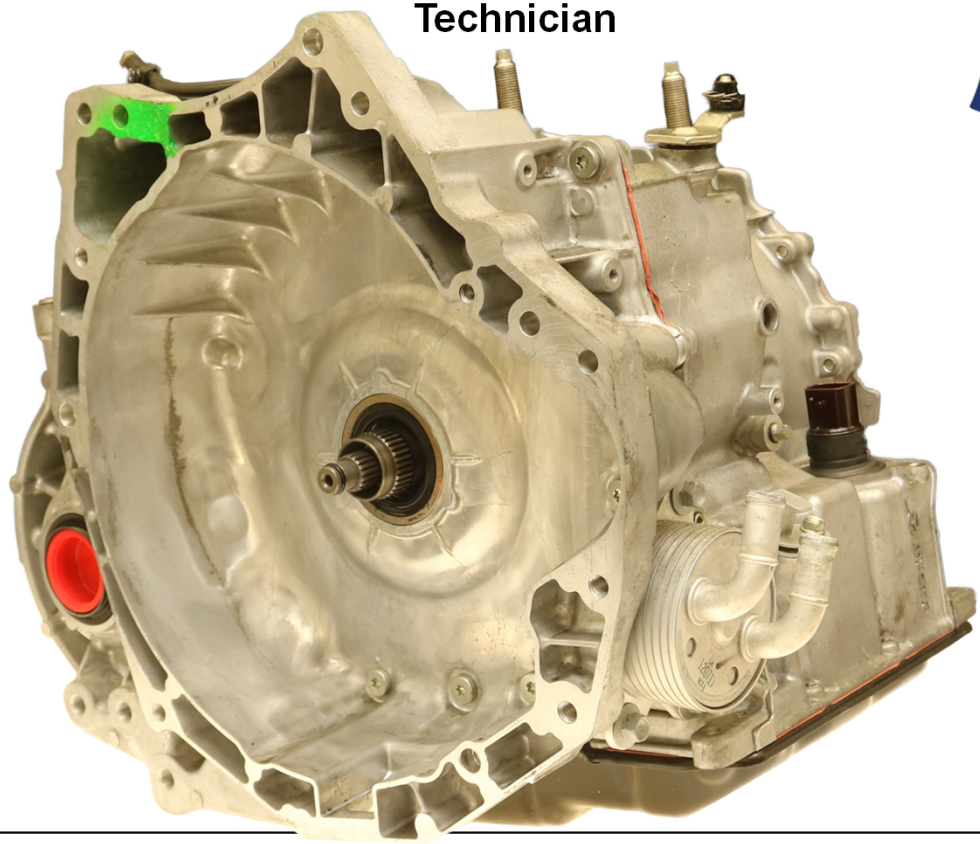

The Mazda FWD 6 speed is a Mazda in house design. In this webinar we will introduce the unit and its major components. We will also discuss some basic principals of operation. Solenoid and clutch apply charts will be discussed as well.

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FW6A-EL Introduction

Application

2012- present Mazda 3i 2.0L – 2.5L
2014- present Mazda 6 2.5L
2013- present Mazda CX-5 2.0L – 2.5L

FW6A-EL / FW6AX-EL for SKYACTIV-Gas engines
GW6A-EL / GW6AX-EL for SKYACTIV-Diesel engines

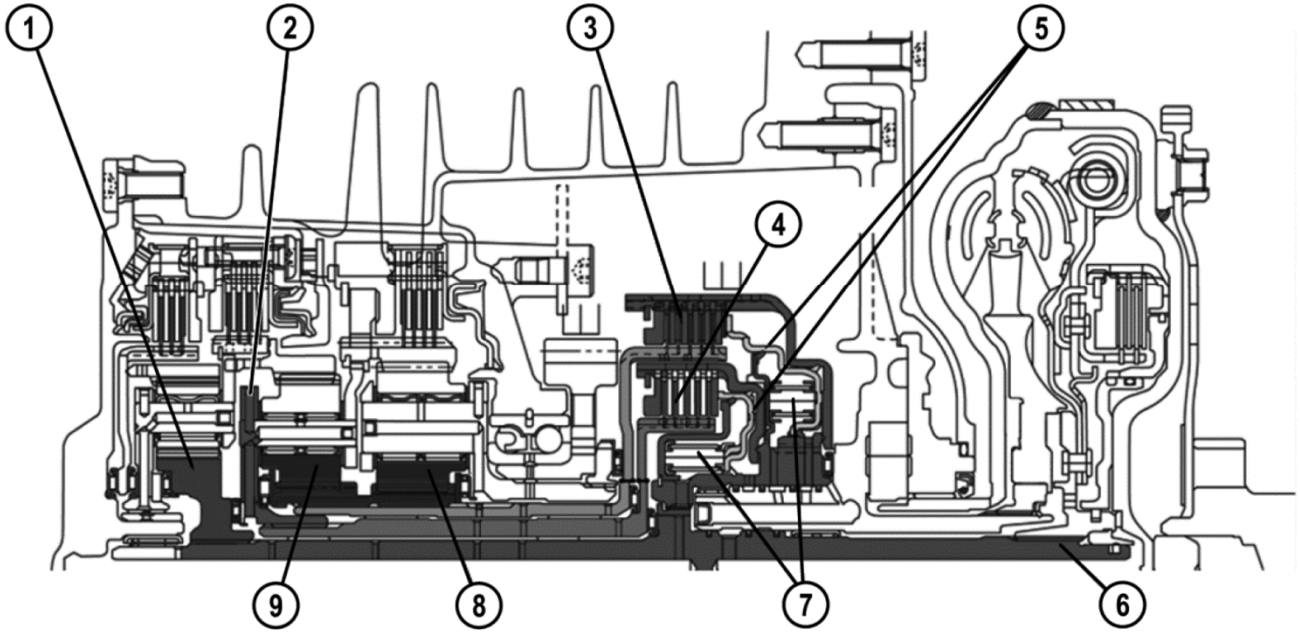
FW6A-EL Introduction

SKYACTIV-DRIVE Automatic Transaxle

- The newly developed SKYACTIV-DRIVE automatic transaxle with cable operation, 6 forward gears and 1 reverse gear and internal TCM (Transaxle Control Module) has been introduced.
- SKYACTIVE-DRIVE combines all the advantages of conventional automatic transmissions, continuously variable transmissions, and dual-clutch transmissions.
- A dramatically widened lock-up range improves torque transfer efficiency and realizes a direct driving feel that is equivalent to that of a manual transmission while achieving a 4…7 percent improvement in fuel economy compared to the current transmission.
- The SKYACTIV-DRIVE automatic transaxle comes in two basic variants. Differences are to be found in gear ratios and number of friction plates used to tune the transaxles to match respective engine power and torque characteristics:

FW6A-EL Introduction

Cutaway View



1	Reduction sun gear	6	Turbine shaft
2	Rear planetary carrier	7	Centrifugal balance chamber
3	Low clutch	8	Front sun gear
4	High clutch	9	Rear sun gear
5	Piston		

FW6A-EL Introduction

SKYACTIV-DRIVE Automatic Transaxle Specifications

Transaxle type			FW6A-EL / FW6AX-EL	GW6A-EL / GW6AX-EL
Application			SKYACTIV-G	SKYACTIV-D
Gear ratio		1GR	3.552	3.487
		2GR	2.022	1.992
		3GR	1.452	1.449
		4GR	1.000	1.000
		5GR	0.708	0.707
		6GR	0.599	0.600
		Reverse	3.893	3.990
Final gear ratio			4.367	4.130
ATF	Type		**Genuine ATF FZ**	
	Capacity (Approx. quantity)		7.8 L	8.0 L
Stall torque ratio			1.82	1.88
Weight (kg)			86	
ATF	Added amount if ATF is drained from drain plug (approx. quantity)		3.5 ... 4.9 L	
	Added amount if transaxle is overhauled (approx. quantity)		5.0 L	
Hydraulic components		Clutch	2	
		Brake	3	
Solenoid valve		Linear/Duty	5/0	
		ON/OFF	1	
Line pressure (kPa)	Idle	D, M (1GR)	330 ... 470	
		R	500 ... 700	
	Stall	D, M (1GR)	970 ... 1,170	
		R	1,790 ... 2,100	
Stall speed (rpm)		D range	1,900 ... 2,600	2,100 ... 3,100
		M range		
		R range	1,700 ... 2,200	1,800 ... 2,400

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Clutch Apply Chart

FW6AEL Clutch Apply Chart								
Range	Gear Position	Lock up	Low clutch	High clutch	Low&Rev brake	2-6 brake	R-3-5 brake	One-way clutch
P					X			
R					X		X	
N					X			
D/M	1st	X	X					X
	2nd	X	X			X		
	3rd	X	X				X	
	4th	X	X	X				
	5th	X		X			X	
	6th	X		X		X		

FW6A-EL Introduction

FW6AEL Solenoid Apply Chart								
Range	Gear Position	Lock up solenoid	Low clutch Solenoid	High/low & Rev solenoid	2-6 brake solenoid	R-3-5 brake solenoid	On/Off solenoid	Line Pressure solenoid
P						X		PWM
R								PWM
N						X		PWM
D/M	1st	X	X			X		PWM
	2nd	X	X		X	X	X	PWM
	3rd	X	X				X	PWM
	4th	X	X	X		X	X	PWM
	5th	X		X			X	PWM
	6th	X			X	X	X	PWM

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Solenoid Desciption	
Lock Up Solenoid	Normally-closed type; when it is ON, it opens its hydraulic passage to activate the lock up clutch.
Low Clutch Solenoid	Normally-closed type; when it is ON, it opens its hydraulic passage to activate the Low clutch.
2-6 Brake Solenoid	Normally-closed type; when it is ON, it opens its hydraulic passage to activate the 2-6 brake.
3-5-R Brake Solenoid	Normally-closed type; when it is OFF, it opens its hydraulic passage to activate the 2-6 brake.
Low/Rev/High Clutch Solenoid	Normally -open type: when it is OFF, it opens its hydraulic passage to activate the Low & reverse brake or the high clutch. Whether it is Low & Reverse brake or the highclutch depends on the status of the ON/OFF solenoid.
ON/OFF solenoid	Normally open type: when it is OFF, Low & reverse brake is activated. When it is ON, High clutch is activated.
Line Pressure Control Solenoid	Normally-closed type; when it is ON, it opens its hydraulic passage to control line pressure rise.

FW6A-EL Introduction

Torque converter

- SKYACTIV-DRIVE starts to mechanically couple the torque converter cover (pump impeller) and Turbine runner at extremely low vehicle speed (approximately 7 km/h).
- To improve fuel economy and direct feel, it is indispensable to overcome the disadvantages of fluid coupling. Widening the lock-up range where the pump impeller and turbine runner is mechanically coupled would be the means of solving this problem.
- Because of such a wide range of lock-up operation, the torque converter requires a responsive torque converter clutch without sacrificing clutch torque capacity.
- Also it is required for the torque converter to be equipped with an enhanced damper mechanism to prevent shift shock due to torque converter clutch engagement at low speed.
- SKYACTIV-Drive made it possible to meet all the requirements above by using multiple-disc torque converter clutch.
- In contrary, the range which the torque converter hydraulically transmits the power from the pump impeller to the turbine runner is reduced. It is mainly used for start-up.
- As a result, the torque converter is downsized for the space for a newly designed multi-disc torque converter clutch and contributes to downsizing the ATX itself and reducing weight.
- Due to optimized blade design, the torque converter for SKYACTIV-DRIVE exerts high performance in torque multiplication. This contributes to ensuring good startup performance.
- The damper spring is designed to suppress NVH effectively. Two springs are used in combination (inner spring and outer spring). They are different in diameter, winding pitch and wire thickness.

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The converter clutch is a clutch drum like any other clutch drum in this unit.

FW6A-EL Introduction

TCC engagement

- A current signal is sent from the TCM to the TCC control solenoid during TCC engagement. At the same time, the TCC piston engagement pressure is gradually increased.
- As a result, the TCC piston is frictionally engaged to the TCC clutch slowly to perform smooth TCC engagement.

TCC release

- A current signal is sent from the TCM to the TCC control solenoid during TCC release. At the same time, the TCC piston engagement pressure is gradually drained.
- As a result, the TCC piston releases the TCC clutch slowly to release the TCC smoothly.

Inhibition of TCC control

- If any one of the following conditions is met, the torque converter clutch control is inhibited.
  - TCC solenoid malfunction
  - ATF temperature is too low
  - Engine speed signal is too low
  - Turbine shaft speed is too low
  - Other than D/M position

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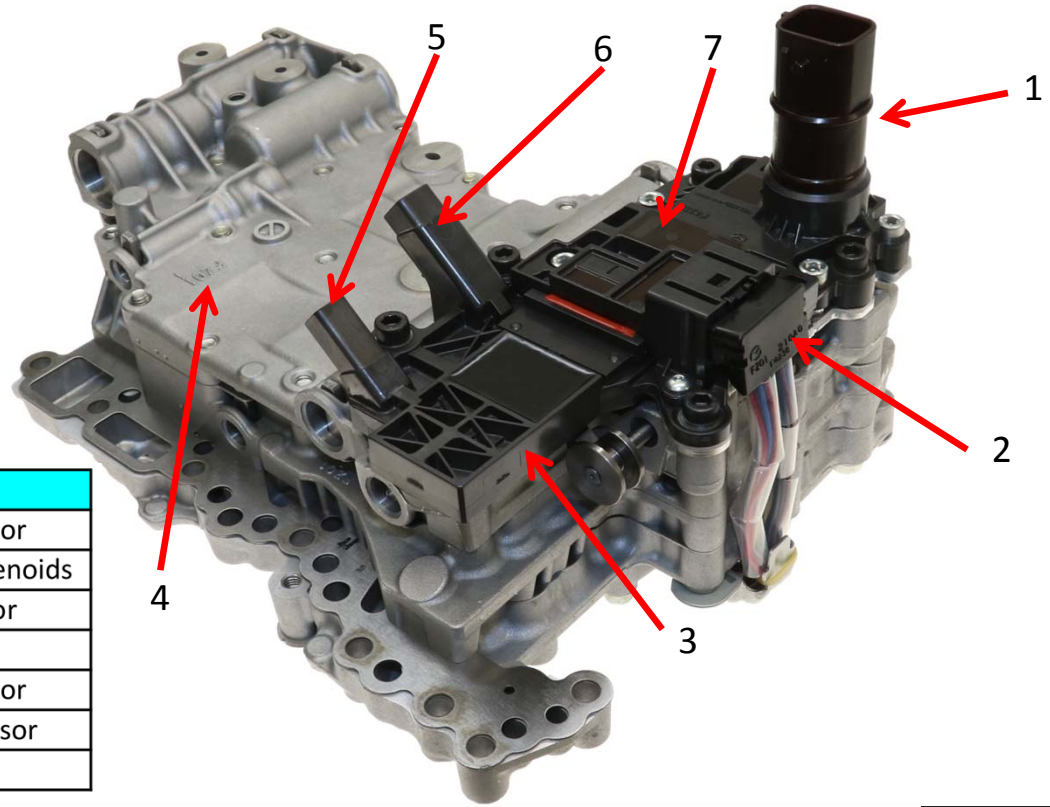
TCM

The input devices and output devices are connected by the lower harness located in the ATX or integrated in the TCM. These input and output devices and their connectors are not accessible from outside the ATX. This design and arrangement contributes to reducing the wiring and enhances reliability.



TCM	
1	TCM Electrical Connector
2	Harness Connector for Solenoids
3	Transaxle Range Sensor
4	Control Valve Body
5	Input Shaft Speed Sensor
6	Output Shaft Speed Sensor
7	TCM

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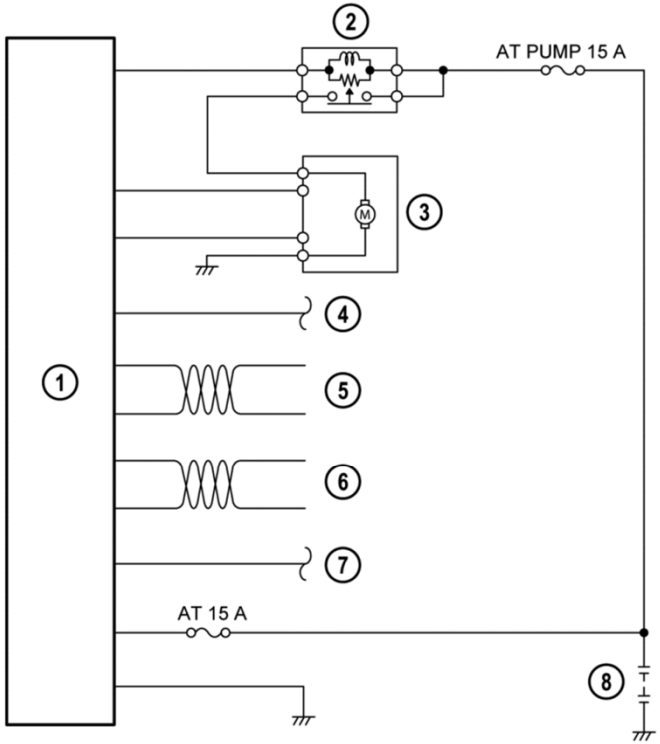
This is a typical wiring diagram for a Mazda 6 speed. This model is an i-stop version. The engine automatically shuts off and a stop.
This means if there are any solenoid or speed sensor cides the tcm must be replaced.



1	TCM	5	HS-CAN
2	Electric AT oil pump relay	6	Local CAN between TCM and PCM
3	Electric AT oil pump	7	To PCM (start inhibit)
4	To IG1 relay	8	Battery

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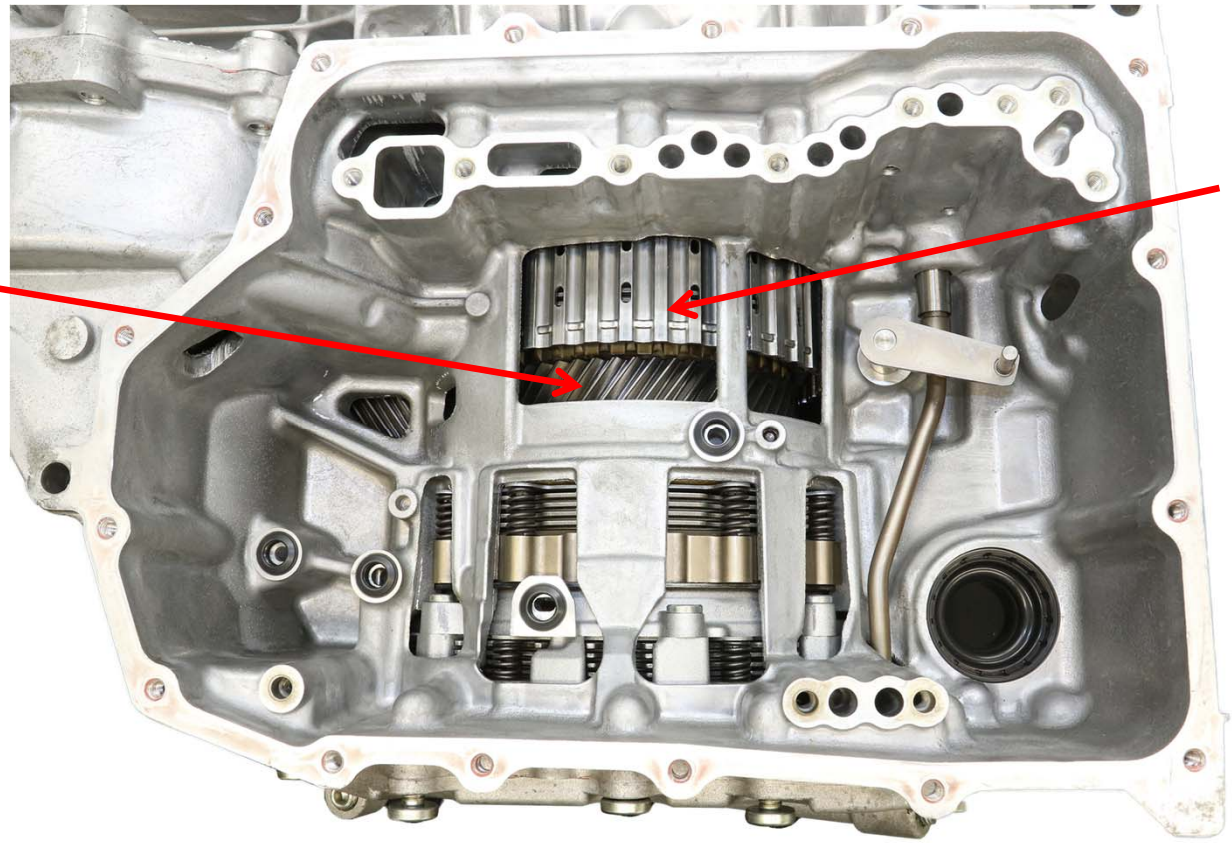
The OSS reads the speed of the output gear.



The TSS reads the speed of the Hi/Low drum which is splined to the input shaft

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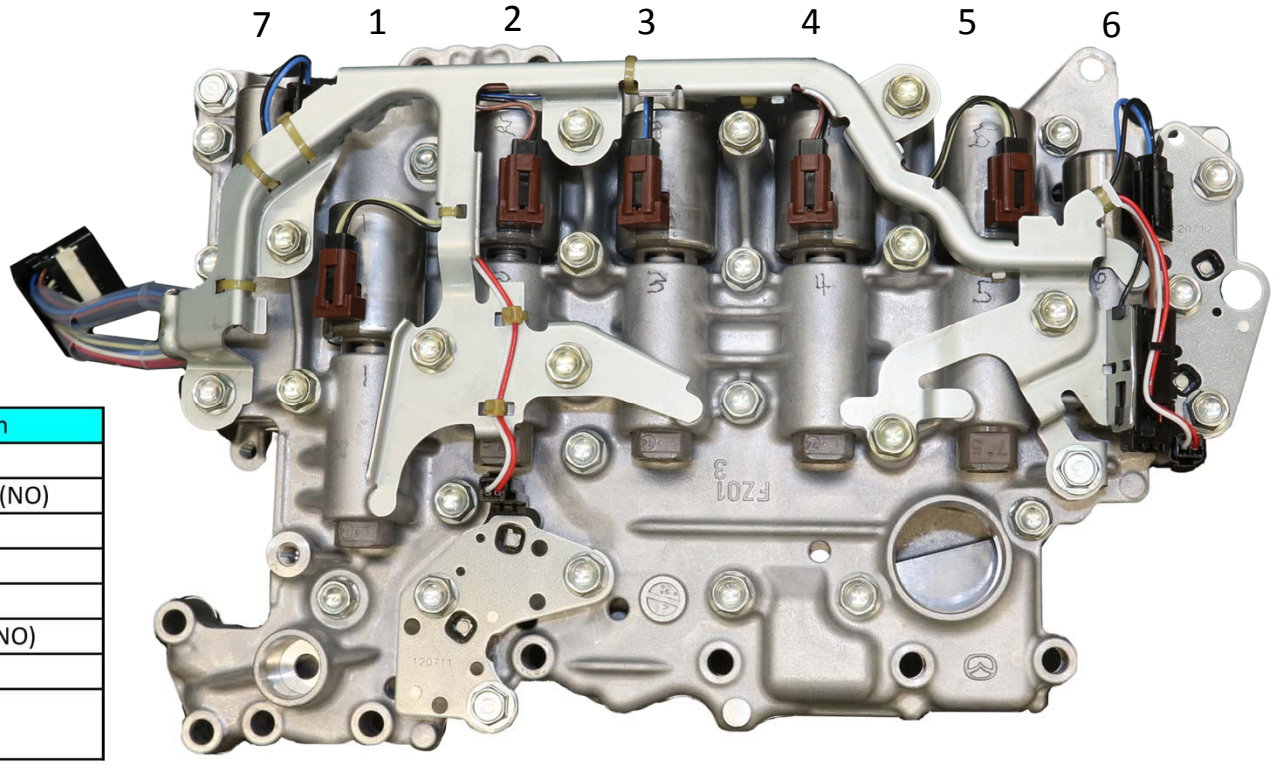
Solenoid Identification



Solenoid Identification/Function	
1	SS1/low clutch (NC)
2	SS4/low&reverse-high clutch (NO)
3	TCC Control (NC)
4	SS2/2-6 brake (NC)
5	SS3/R-3-5 brake (NO)
6	Pressure Control Solenoid (NO)
7	On/Off Solenoid (NO)
NO = Normally Open NC = Normally Closed	

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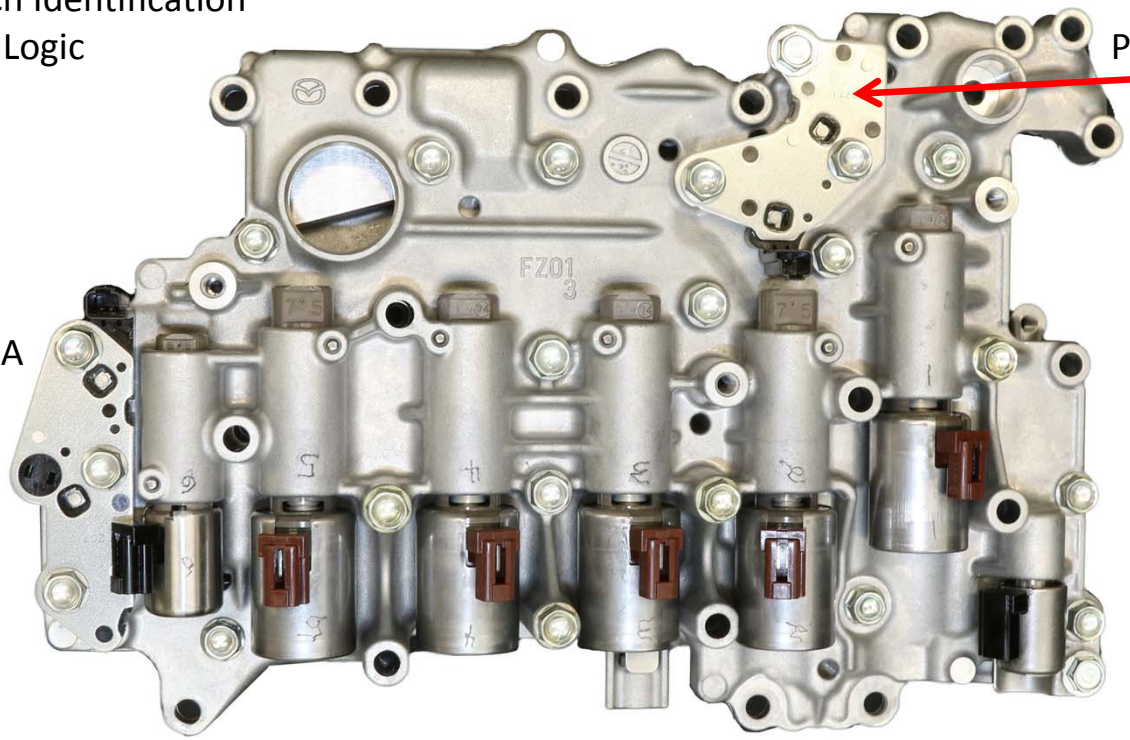
Pressure Switch Identification and Logic



Oil Pressure Switch and Associated Friction Elements								
Oil Pressure Switch		Fiction Element	1GR	2GR	3GR	4GR	5GR	6GR
A	No.2	2-6 Brake		On				On
	No.3	R-3-5 Brake			On		On	
B	No.1	Low Clutch	On	On	On	On		
	No.4	High Clutch				On	On	On

Trouble code list

DTC	Description
P0218:00	Automatic transaxle protection control
P0500:00	Vehicle speed signal circuit malfunction
P0666:00	ECU internal temperature sensor circuit(s) malfunction
P0667:00	ECU internal temperature sensor two-range/performance problem
P06B8:00	NVRAM malfunction
P0705:00	Transaxle range sensor circuit malfunction
P0706:00	Transaxle range sensor range/performance problem
P0711:00	TFT sensor range/performance problem
P0712:00	TFT sensor circuit low input
P0713:00	TFT sensor circuit high input
P0716:00	Turbine/input shaft speed snesor range/performance problem
P0717:00	Open circuit in turbine/input shaft speed sensor circuit
P0721:00	Output shaft speed sensor rnage/performance problem
P0722:00	Open circuit in output shaft speed sensor circuit
P0729:00	6GR incorrect ratio
P0731:00	1GR incorrect ratio
P0732:00	2GR incorrect ratio
P0733:00	3GR incorrect ratio
P0734:00	4GR incorrect ratio
P0735:00	5GR incorrect ratio
P0736:00	Gear reverse incorrect ratio
P0741:00	TCC control solenoid stuck off
P0743:00	TCC control solenoid circuit malfunction
P0746:00	Pressure control solenoid stuck off
P0748:00	Pressure control solenoid circuit malfunction
P0751:00	Shift solenoid No. 1 stuck off
P0752:00	Shift solenoid No. 1 stuck on
P0753:00	Shift solenoid No. 1 circuit malfunction
P0756:00	Shift solenoid No. 2 stuck off
P0757:00	Shift solenoid No. 2 stuck on
P0758:00	Shift solenoid No. 2 circuit malfunction
P0761:00	Shift solenoid No. 3 stuck off
P0762:00	Shift solenoid No. 3 stuck on
P0763:00	Shift solenoid No. 3 circuit malfunction
P0766:00	Shift solenoid No. 4 stuck off
P0767:00	Shift solenoid No. 4 stuck on
P0768:00	Shift solenoid No. 4 circuit malfunction
P0771:00	On/off solenoid stuck off
P0772:00	On/off solenoid stuck on
P0773:00	On/off solenoid circuit malfunction

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Trouble code list (continued)

DTC	Description
P0780:00	Gear shifting malfunction
P079A:00	Shift solenoid No. 3 stuck off/On/off solenoid stuck on
P0819:00	M position switch/Up switch/Down switch signal error
P0842:00	Oil pressure switch No. 1 stuck on
P0843:00	Oil pressure switch No. 1 stuck off
P0847:00	Oil pressure switch No. 2 stuck on
P0848:00	Oil pressure switch No. 2 stuck off
P0872:00	Oil pressure siwtch No. 3 stuck on
P0873:00	Oil pressure switch No. 3 stuck off
P0877:00	Oil pressure switch No. 4 stuck on
P0878:00	Oil pressure switch No. 4 stuck off
P0882:00	TCM power supply voltage low
P0883:00	TCM power supply voltage high
P1728:00	Clutch slippage
P1738:00	Automatic transaxle internal malfunction
P1784:00	Hi cut valve stuck off/R-3-5 cut valve stuck on
U0073:00	CAN system communication error (HS CAN)
U0074:00	CAN system communication error (local CAN between TCM and PCM)
U0100:00	Communication error to PCM (HS CAN)
U0115:00	Communication error to PCM (local CAN between TCM and PCM)
U0121:00	Communication error to DSC HU/CM
U0141:00	Communication error to BCM
U0155:00	Communication error to instrument cluster
U0442:00	Invalid data received from PCM (local CAN between TCM and PCM)

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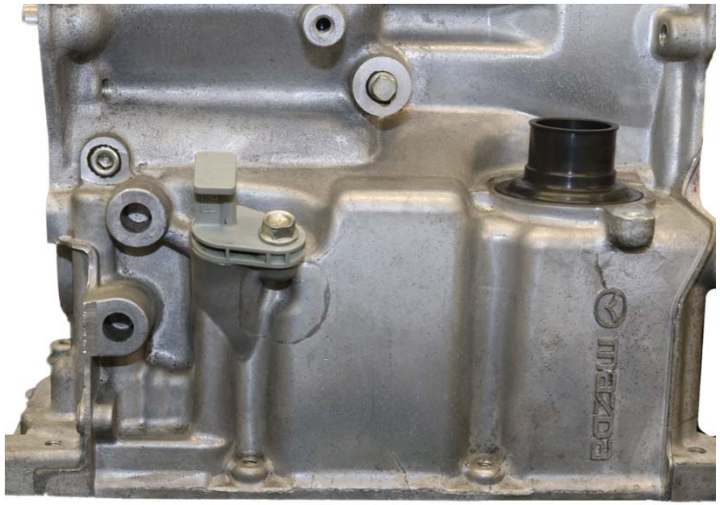
Fluid Level Check

- The SKYACTIVE-DRIVE FW6A-EL (GW6A-EL) automatic transaxle is filled for lifetime with 7.8 litre (8.0 litre) of the new Mazda genuine special automatic transaxle fluid (ATF FZ).
- For checking the ATF level, there is a dipstick with an "L" (low) and an "F" (full) mark on it. The dipstick is secured with a bolt. For checking, the ATF temperature should be 50° C. This can be verified using a scan tool.
- Remove the dipstick and wipe the ATF off using a rag while leaving the engine idling.
- Insert the dipstick and pull it out again.
- Verify that ATF is adhering to the central marker area on the dipstick.
- If ATF is not adhering to the central marker area on the dipstick, adjust the ATF level to the central marker area.



FW6A-EL Introduction

Road Test

ROAD TEST [FW6A-EL]

WARNING:
When performing a road test, always verify the safety of the surrounding area before performing the test.

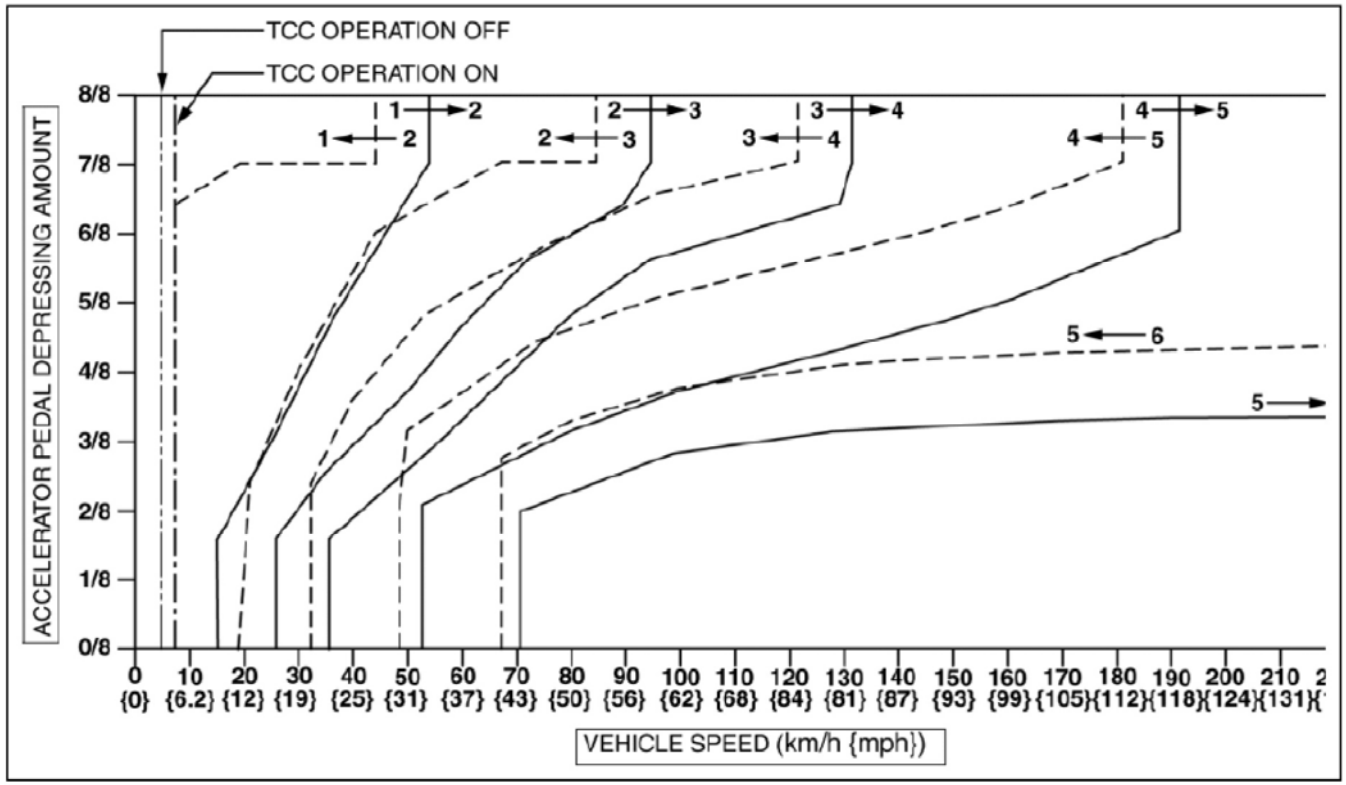
NOTE:
When performing a road test requiring speeds which exceed the legal speed limit, use a dynamometer.

Road Test Preparation
1. Inspect the engine coolant level.
2. Inspect the engine oil level.
3. Inspect the ATF level. Inspect the ignition timing. Inspect the idle speed. Verify that no DTCs are stored.
4. Inspect the ignition timing.
5. Inspect the idle speed.
6. Verify that no DTCs are stored

Road Test (continued)

FW6A-EL Introduction

Shift Diagram (D position, normal mode)



FW6A-EL Introduction

Road Test (continued)

D Position Test

1. Perform road test preparations. (See Road Test Preparation.)
2. Warm up the transaxle.
3. Select D position.
4. Inspect the shift point for the D position in normal mode.
    - If there is any malfunction, refer to symptom troubleshooting and verify the malfunction symptom.

a. Depress the accelerator pedal and start the vehicle, and verify that the gears shift from 1st to 2nd, 2nd to 3rd, 3rd to 4th, 4th to 5th, and 5th to 6th. In addition, verify that the vehicle speed corresponds to the shift point when shifting.

b. Release the accelerator pedal while driving in 6th gear, and verify that the gears shift from 6th to 5th, 5th to 4th, 4th to 3rd, 3rd to 2nd, and 2nd to 1st. In addition, verify that the vehicle speed corresponds to the shift point when shifting. **NOTE:**

- When the accelerator pedal is fully released quickly, shifting is not performed according to the shift pattern because the gear being used may be maintained.
- When decelerating by strongly depressing the brake pedal, shifting is not performed according to the shift pattern because the shift-down point may be at high vehicle speed.

c. Kick down while driving in 6th, 5th, 4th, 3rd, and 2nd gears, and verify that the gears shift from 6th to 5th, 5th to 4th, 4th to 3rd, 3rd to 2nd, and 2nd to 1st. In addition, verify that the vehicle speed limit for kicking down corresponds to the shift point.

d. Verify that the shift shock is minimal, shifting is smooth and timely, and there is no abnormal noise or slip

Road Test (continued)

FW6A-EL Introduction

Shift Point Chart

Position/mode		Accelerator pedal depression amount	Shift	Vehicle speed (km/h {mph})	Turbine rotation speed (rpm)
D	NORMAL	8/8	$D_1 \rightarrow D_2$	53—59 {33—36}	5,800—6,400
			$D_2 \rightarrow D_3$	93—100 {58—62}	5,800—6,250
			$D_3 \rightarrow D_4$	130—139 {81—86}	5,750—6,150
			$D_4 \rightarrow D_5$	189—199 {118—123}	5,800—6,050
		4/8	$D_1 \rightarrow D_2$	28—36 {18—22}	3,000—3,950
			$D_2 \rightarrow D_3$	44—62 {28—38}	2,750—3,800
			$D_3 \rightarrow D_4$	58—82 {36—50}	2,600—3,650
			$D_4 \rightarrow D_5$	100—139 {62—86}	3,100—4,250
		0/8	$D_6 \rightarrow D_5$	64—69 {40—42}	1,200—1,250
			$D_5 \rightarrow D_4$	46—51 {29—31}	1,000—1,100
			$D_4 \rightarrow D_3$	29—35 {18—21}	900—1,050
			$D_3 \rightarrow D_2$	11—16 {7—9}	500—700
			$D_2 \rightarrow D_1$	4—10 {3—6}	250—600
		Kickdown (8/8)	$D_5 \rightarrow D_4$	177—187 {110—115}	3,850—4,050
			$D_4 \rightarrow D_3$	118—127 {74—78}	3,600—3,850
			$D_3 \rightarrow D_2$	81—88 {51—54}	3,600—3,950
			$D_2 \rightarrow D_1$	41—47 {26—29}	2,550—2,900

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M Position Test

1. Perform road test preparations. (See Road Test Preparation.)
2. Warm up the transaxle.
3. Select the M position.
4. Inspect the shift point for the M position.
    - If there is any malfunction, refer to symptom troubleshooting and verify the malfunction symptom.

a. Perform the shift operation while driving and verify that the gears can be shifted.

b. Release the accelerator pedal while driving in 6th gear, and verify that the gears shift from 6th to 5th, 5th to 4th, 4th to 3rd, 3rd to 2nd, and 2nd to 1st. In addition, verify that the vehicle speed corresponds to the shift point when shifting.

c. Release the accelerator pedal while driving and verify that the engine braking operates in all gears.

d. Verify that the shift shock is minimal, shifting is smooth and timely, and there is no abnormal noise or slip.

Position/mode	Accelerator pedal depression amount	Shift	Vehicle speed (km/h {mph})	Turbine rotation speed (rpm)
M	0/8	$M_6 \rightarrow M_5$	64—69 {40—42}	1,200—1,250
		$M_5 \rightarrow M_4$	50—56 {31—34}	1,100—1,200
		$M_4 \rightarrow M_3$	29—35 {18—21}	900—1,050
		$M_3 \rightarrow M_2$	11—16 {7—9}	500—700
		$M_2 \rightarrow M_1$	5—10 {4—6}	300—600

Road Test (continued)

FW6A-EL Introduction

5.Inspect 2nd gear fixed mode.

a. While the vehicle is stopped or the vehicle speed is **10 km/h {6.2 mph} or less** , operate the selector b. lever toward + to shift to 2nd gear.

c. Verify that the gear is fixed in 2nd gear.

d. Release the accelerator pedal while driving and verify that the engine braking operates.

e. Perform the shift operation while driving and verify that the gears can be shifted.

P Position Test

1. Park the vehicle on a gentle slope and shift the selector lever to the P position.
2. Release the brake and verify that the vehicle does not move.
   - If there is any malfunction, inspect the parking mechanism in the transaxle

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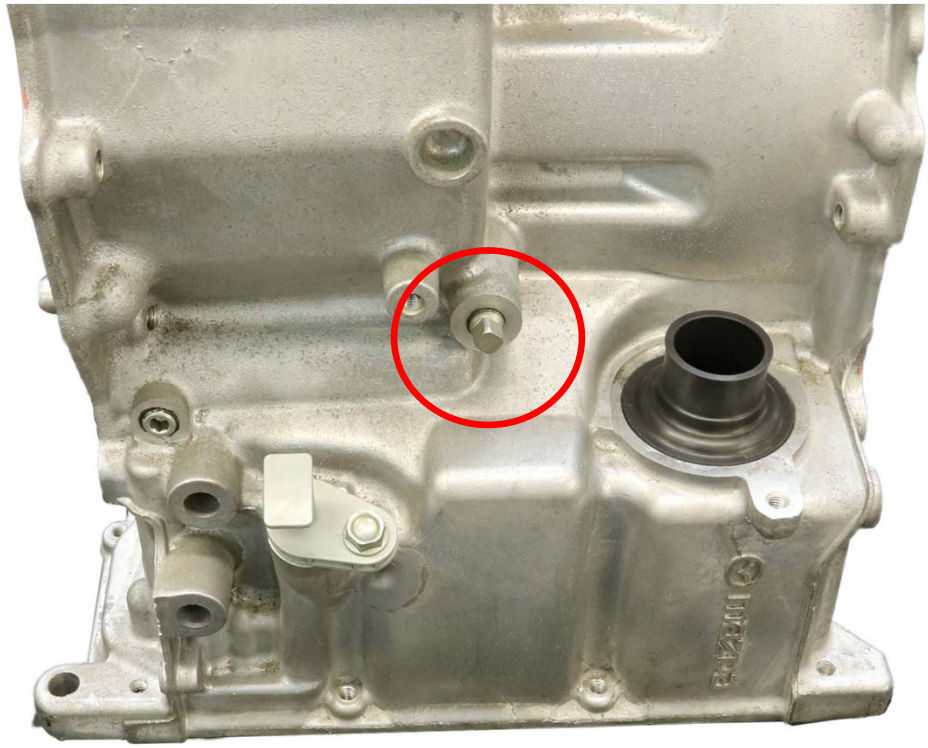

Line Pressure Test		
Idle	D Range or M ranges (1GR)	50 - 70 psi
	R range	70 - 100 psi
Stall	D Range or M ranges (1GR)	140 - 170
	R range	260 - 300 psi

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