Learning Objectives:

1. Identify the purpose and function of the sequential manual transmission.
2. Identify and describe the operation of the following sequential manual transmission components:
   a. Hydraulic Power Unit
   b. Gear Shift Actuator
   c. Shift lever
   d. Shift Lever Switches
   e. Transmission Control ECU
   f. ECM
   g. System Warning Light
   h. Gear Position Indicator
   i. Stop Light Switch
   j. Shift Lock Solenoid
3. Revolution Sensor
4. Describe normal system operation:
   a. Starting the system
   b. Start
5. Describe diagnostic equipment and tests for sequential manual transmissions, including:
   a. Diagnostic Tester
   b. Pinpoint Tests
   c. ECU Relearning
Introduction
The sequential manual transmission is based on the C Series five-speed manual transaxle, and was introduced on the 2002 MR2 Spyder. The clutch pedal and master cylinder have been replaced with an actuator that is electronically controlled. When the driver presses shift switches on the steering wheel or moves the shift lever forward or rearward to shift gears, the engine speed is electronically controlled, the actuator operates the clutch and shifts gears.

When the vehicle comes to a stop, the transaxle automatically shifts to 1st gear so it can start off again without having to operate the shift lever or shift buttons. On the six speed transaxle introduced in 2003, the automatic downshift occurs to 2nd gear below 18 mph and 1st gear below 5 mph.

Components
The sequential manual transmission contains a Hydraulic Power Unit (HPU) assembly, Gear Shift Actuator (GSA), electronic throttle, dedicated shift lever, transmission control ECU and sensors, in addition to the conventional transaxle.
Transmission Control ECU

The Transmission Control ECU controls the hydraulic power unit and the gear shift actuator assembly to engage or disengage the clutch and shift the gears based on signals from the ECM, sensors, and switches. Additionally, the Transmission Control ECU requests the ECM to control the ETCS-i throttle control motor during gear changes.

Hydraulic Power Unit (HPU)

The Hydraulic Power Unit (HPU) assembly generates hydraulic pressure for the shift operating system and the clutch release cylinder. It is located in the engine compartment and mounted to the vehicle body. The pump draws the sequential M/T fluid from the reservoir tank and provides high pressure to the accumulator. The pressure sensor monitors accumulator pressure and provides input to the transmission control ECU. The hydraulic power unit is connected to the gear shift actuator through three high-pressure hoses.
Hydraulic Power Unit (HPU)

The Hydraulic Power Unit assembly generates hydraulic pressure for the shift operating system and the clutch release cylinder.

Gear Shift Actuator (GSA)

The Gear Shift Actuator (GSA) assembly engages or disengages the clutch and selects gears based on signals from the transmission control ECU. It is mounted to the side of the transaxle case, and attaches to the shift and select lever shaft. The actuator clutch cable attaches to the transaxles clutch release fork.

The select solenoid valve provides hydraulic pressure to move the select shaft. The select shaft positions the shift inner lever and shift fork lock over the shift fork heads of the transaxle shift and select assembly. The shift solenoid valve provides hydraulic pressure to rotate the select shaft that moves the shift inner lever to engage the desired gear. The clutch solenoid valve provides hydraulic pressure to the clutch release cylinder and moves the clutch cable to engage or disengage the clutch.
The gear shift actuator houses three sensors that monitor the shift stroke and select stroke of the shift and select lever shaft assembly as well as the clutch stroke. These sensors provide input to the ECU on the clutch and select shaft positions.

**Stroke Sensors**

The gear shift actuator houses three sensors that monitor the shift stroke and select stroke of the shift and select lever shaft assembly, and the clutch stroke.

![Stroke Sensors Diagram](image)

**Gear Shift Actuator Link Fixing Plate**
The gear shift actuator link fixing plate SST is required to keep the shift actuator link in a neutral position whenever the gear shift actuator is removed or a new unit is installed. Failure to use the SST may result in the inability to shift the transmission.

![Gear Shift Actuator Link Fixing Plate](image)
The sequential manual transmission uses a control-by-wire type shift mechanism that detects the movement of the shift lever based on the combination of four switches; this shift mechanism is integrated into the shift lever position sensor. The three ranges are R for reverse, N for neutral and S for sequential range. Shift lever position is maintained by spring-loaded detents, which provide shift feedback to the driver.

**Shift Lever**

The sequential manual transmission uses a control-by-wire type shift lever.

**Shift Lever Switches**

The shift position and the movement of the shift lever are detected through the combination of the four switches integrated into the shift lever position sensor. Switch positions are determined by the shift lever arm and the two position sensor links. The operating conditions of the switches are detected and the signals are sent to the transmission control ECU.
Steering Wheel Shift Switches

Steering wheel switches (optional equipment) are available and are located on the steering wheel. Two switches are located on each steering wheel spoke; the two facing the driver provide for downshifts and the two switches facing away from the driver provide for upshifts.

Stop Light Switch

The stop light switch detects when the brake pedal is applied. The ECM must see the brake pedal signal before it allows the engine to start.

Transmission Revolution Sensor

The transmission revolution sensor detects input shaft speed so the ECU can disengage the clutch when shaft speed reaches a predetermined speed threshold. The ECU matches input shaft and engine speed when shifting with the pedal released.

Gear Position Indicator

The gear position indicator is located in the combination meter and shows the gear position of the transmission. The indicator blinks if the shift lever position and the gear position become mismatched.

System Warning Light

The System Warning Light activates to alert the driver when the transmission control ECU detects a malfunction in the sequential manual transmission.

Gear Position Indicator & System Warning Light

The gear position indicator can be found in the combination meter as well as the system warning light, which illuminates when the transmission control ECU detect an error in the sequential manual transmission.
The courtesy light switch is located on the driver’s door to indicate the driver’s entry to the vehicle. This input to the ECU starts the HPU to build hydraulic pressure for actuator operation.

Throttle position is determined by the accelerator pedal position sensor input and the ECM. The throttle opening is controlled by the ECM’s signal to the throttle motor. The ECM matches engine speed to the transmission input shaft speed for proper gear engagement.

A shift lock mechanism locks the shift lever when the ignition switch is turned to OFF or ACC. Since there is no mechanical linkage, this mechanism prevents the shift lever position and the transmission gear position from becoming mismatched.

The shift lock mechanism contains:

- Shift lock solenoid
- Stopper plate
- Lock plate (integrated with No. 2 lever)

The lock plate and No. 2 lever move in unison with the shift lever when shifting between ranges. The lock plate has holes for R, N, and S, so that it can be locked in any range. When the ignition is switched OFF, the stopper plate rotates due to the movement of the shift lock solenoid, causing the protrusion on the plate to engage with the hole in the lock plate.

A shift lock override button is accessible under the cover in the top of the center console. Pressing the button causes the linkage to disengage the stopper plate from the lock plate.

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**Shift Lock Mechanism**

A shift lock mechanism locks the shift lever when the ignition switch is turned to OFF or ACC.
Shift Lock Solenoid

The shift lock solenoid locks the movement of the shift lever when the ignition switch is turned to OFF or ACC and prevents the lever position and gear position from becoming mismatched.

System Operation

When the driver’s door is opened, the signal from the courtesy light switch activates the transmission control ECU, causing the hydraulic power unit to operate, creating hydraulic pressure for gear shift actuator operation.

When the ignition switch is turned on, the shift lock mechanism unlocks, enabling the driver to operate the shift lever. The ECM allows the starter to crank the engine only when the brake pedal is pressed, the shift lever is in the N range and the transmission is in neutral.

When the transmission is shifted to 1st, 2nd, or reverse gear and the accelerator pedal is pressed, the ECU engages the clutch by controlling the clutch solenoid valve and the clutch release cylinder.

When an up-shift or downshift signal, generated by the operation of the shift lever or the transmission shift switches, is input to the transmission control ECU, the control ECU disengages the clutch. The control ECU shifts gears by controlling the shift solenoid and the select solenoid in the gear shift actuator assembly. When the shift is completed, the shift stroke sensor and the select stroke sensor send signals to the ECU that engages the clutch while controlling clutch application speed.

The clutch is disengaged when the vehicle is stopped with the engine running.
To park the vehicle with the transmission in reverse or 1st gear, place the shift lever in R or S before the key is turned off. The ECU engages the clutch approximately one second after the key is turned off.

The Diagnostic Tester is a very useful tool when diagnosing electronic control transmission problems. It can be used to:

- Retrieve Diagnostic Trouble Codes (DTCs).
- View freeze-frame data.
- Display and monitor sensor and actuator data.
- Display data graphically.
- View oscilloscope waveforms.
- Perform actuator function tests.
- Record and recall data using the snapshot feature.
- Print data lists, graphs, scope displays and test results.
- Perform ECU relearning.

**System Diagnosis**

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**Diagnostic Tester**

The Diagnostic Tester provides access to large quantities of information from a conveniently located diagnostic connector.

---

Fig. 7-13  
T302713
The Diagnostic Tester provides access to large quantities of information from a conveniently located diagnostic connector rather than performing tedious pin checks with a DVOM.

A Diagnostic Tester allows a “quick check” of sensors, actuators, and ECM calculated data. Scan data allows you to quickly compare selected data to repair manual specifications or known good data.

When checking intermittent fault conditions, it provides an easy way to monitor input signals while wiring or components are manipulated, heated or cooled.

Serial data is electronically coded information, which is transmitted by one computer and received and displayed by another computer. The transmitting computer digitizes the data sensors, actuators and other calculated information and receives and displays it as an analog voltage, temperature, speed, time or other familiar unit of measurement.

When attempting to diagnose certain types of problems using serial data, it is important to remember serial data is processed information, not a live signal. It represents what the ECM “thinks” it is seeing rather than the actual signal measured at the ECM terminal. Serial data can also reflect a “default” ECM signal value, rather than the actual signal.

The vehicle’s onboard computer lights up the MIL on the instrument panel when the computer detects a malfunction in the transmission control ECU or in the drive system components that affect the vehicle emissions. In addition, diagnostic trouble codes are recorded in the ECU's memory.

If the malfunction does not reoccur in three trips, the MIL goes off but the DTC remains recorded in the ECU memory. Although there may be no MIL light on, there may be stored codes to help in the diagnosis.

The diagnostic system operates in the normal mode during normal vehicle use, and also has a check mode for technicians to simulate malfunction symptoms and perform troubleshooting. Most DTCs use 2-trip detection logic to prevent erroneous detections. By switching the ECM to the check mode when troubleshooting, a technician can cause the MIL to light up for a malfunction that is only detected once or momentarily.

When the diagnostic system is switched from the normal mode to the check mode, all DTCs and freeze frame data recorded in normal mode will be erased. So before switching modes, always check the DTCs and freeze frame data, and note them down.
2-Trip Detection Logic  When a logic malfunction is first detected, the malfunction is temporarily stored in the ECM memory. If the same malfunction is detected again during the second drive test, the second detection causes the MIL to light up (2nd trip). However, the ignition switch must be turned OFF between the 1st trip and 2nd trip.

Freeze Frame Data  Freeze frame data records the sequential transmission condition when a malfunction (first malfunction only), is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, etc., at the time of the malfunction.

Verify Customer Complaint  Communication between the customer and the technician is essential to verifying the complaint. The technician is frequently isolated from the customer and receives his information third-hand from the Service Writer. To bridge this gap, a customer interview sheet is strongly recommended to ensure the technician has as much information as possible to begin his diagnostic effort. The more details that are available, the more likely the condition can be found quickly. A sample Customer Problem Analysis Check Sheet can be found in Appendix E.

If the complaint cannot be verified, it may be necessary to speak with the customer and have him/her accompany you on the road test to identify their concern.

After verifying the customer’s complaint, consult TIS for additional information and check Technical Service Bulletins, which may be related to the vehicle condition.

Customer Interview Sheet

The Customer Interview Sheet is a form found in the Repair Manuals and has also been included as Appendix E in this handbook. Utilizing this form insures that correct and accurate data is received.
Warning Light Check

Turn the ignition switch ON and check that the warning light goes off after 5 seconds.

If the warning light does not light up, check the sequential manual transmission warning light circuit. If the light does not go off, check for a DTC.

---

**Check Sequential Manual Transmission Warning Light**

If the warning light does not light up or does not go off, check the sequential manual transmission warning light circuit.

---

**Prepare the Diagnostic Tester**

To prepare the Diagnostic Tester:

1. Connect the Diagnostic Tester to the DLC3 at the lower left portion of the instrument panel.
2. Turn the ignition switch ON and press the ON button.
3. Check the DTCs and freeze frame data; note them down.
4. See the diagnostic section of the MR2 Repair Manual to confirm the details of the DTCs.

---

**Using the Diagnostic Tester**

To check the DTCs, connect the Diagnostic Tester to the DLC3 of the vehicle.
Diagnostic Trouble Codes (DTC) retrieved using the Diagnostic Tester indicate that a malfunction has occurred. The left column of the DTC chart directs you to the proper page to begin a circuit diagnosis and provides a description of the trouble code.

Using the chart in figure 7-17, DTC P0820 refers you to the circuit diagnosis on page DI-284 of the MR2 Repair Manual. The item detects a Shift Lever Switch malfunction. The components to check are the switch, circuits and ECU.
Circuit Diagnosis

The circuit diagnosis in the Repair Manual contains a description, the electrical diagram, inspection procedures, and the appropriate steps for diagnosing the concern. Testing the circuit may now be required.

Circuit Diagnosis

This is a the Circuit Diagnosis page for the DTC P0820 from the Repair Manual. It contains a DTC description and the electrical diagram for the circuit.

CIRCUIT DESCRIPTION

<table>
<thead>
<tr>
<th>DTC No.</th>
<th>DTC Detection Condition</th>
<th>Trouble Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0820</td>
<td>8 switches inside shift lever switch are improperly combined.</td>
<td>+ Shift lever switch + Open or short in LSW1 – LSW4 signal circuit + Open or short in LSI – LS4C signal circuit + Transmission control ECU</td>
</tr>
</tbody>
</table>

WIRING DIAGRAM

[Diagram of the Gear Lever X-Y Position Sensor Circuit]

Fig. 7-18
T302718
The inspection procedure in the Circuit Diagnosis section of the Repair Manual describes the steps to take to determine the cause of the system malfunction. In this case, the Diagnostic Tester is used to check the shift lever switch and circuit. If the check fails, a pin check of the switch narrows the cause to the switch, circuit, or transmission ECU.

**Inspection Procedure**

In this example of the inspection procedure from the Circuit Diagnosis section of the Repair Manual, the Diagnostic Tester is used to check the shift lever switch and circuit.

**HINT:**
Read freeze frame data using hand-held tester or OBD II scan tool, as freeze frame data records the engine conditions when a malfunction is detected. When troubleshooting, it is useful for determining whether the vehicle was running or stopped, the engine was warmed up or not, etc. at the time of the malfunction.

**PREPARATION:**
(a) Start the engine and warm it up.
(b) Connect the hand-held tester to the DLC3.

**CHECK:**
Read the value of the shift lever switch by using the hand-held tester.

**OK:**

<table>
<thead>
<tr>
<th>Shift lever position</th>
<th>Tester display</th>
<th>Shift SW SIC1</th>
<th>Shift SW SIC2</th>
<th>Shift SW SIC3</th>
<th>Shift SW SIC4</th>
<th>Shift CHECK SIG1</th>
<th>Shift CHECK SIG2</th>
<th>Shift CHECK SIG3</th>
<th>Shift CHECK SIG4</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>N</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>S</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>-</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>+</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

**OK**
Replace transmission control ECU.

**NG**
The Problem Symptom Table in the Repair Manual provides access to the diagnostic test procedure if a malfunction occurs and no DTCs are present. An example is shown in figure 7-20: The symptom is found in the left column, the suspect components are listed in the second column, and the page reference is located in the column to the right of the components.

### Problem Symptoms Table

If no DTC is displayed during the DTC check, use the Problem Symptoms Table to proceed to the relevant troubleshooting page.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Symptoms Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>If no DTC is displayed during the DTC check, use the Problem Symptoms Table to proceed to the relevant troubleshooting page.</td>
<td></td>
</tr>
</tbody>
</table>

#### DTC Symptom Table

If a normal code is displayed during the DTC check but the problem still occurs, check the problem symptom in the order given in the table below and proceed to the relevant troubleshooting page.

**NOTICE:**
When replacing the transmission control ECU or sensor, turn the ignition switch OFF and close the driver's door, and after replacing the transmission control ECU, make the transmission control ECU learn characteristics (See page D-136, step 8).

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Suspected Area</th>
<th>See page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Transmission</td>
<td>SM-9</td>
<td></td>
</tr>
<tr>
<td>4. Clutch disc</td>
<td>CL-1</td>
<td></td>
</tr>
<tr>
<td>5. HPU (Master solenoid)</td>
<td>D-382</td>
<td></td>
</tr>
<tr>
<td>6. HPU (Accumulator)</td>
<td>D-338</td>
<td></td>
</tr>
<tr>
<td>7. HPU (Accumulator pressure sensor)</td>
<td>D-338</td>
<td></td>
</tr>
<tr>
<td>8. HPU (Motor pump)</td>
<td>D-328</td>
<td></td>
</tr>
<tr>
<td>9. HPU (Clutch solenoid)</td>
<td>D-304</td>
<td></td>
</tr>
<tr>
<td>10. GSA (Shift solenoid)</td>
<td>D-332</td>
<td></td>
</tr>
<tr>
<td>11. GSA (Select solenoid)</td>
<td>D-312</td>
<td></td>
</tr>
<tr>
<td>12. GSA (Master pressure sensor)</td>
<td>D-321</td>
<td></td>
</tr>
<tr>
<td>13. GSA (System hoses)</td>
<td>SM-67</td>
<td></td>
</tr>
<tr>
<td>14. Shift lever</td>
<td>SM-91</td>
<td></td>
</tr>
<tr>
<td>15. BMT lever switch</td>
<td>D-294</td>
<td></td>
</tr>
<tr>
<td>16. Input shaft speed sensor</td>
<td>D-263</td>
<td></td>
</tr>
<tr>
<td>17. Input shaft speed sensor circuit</td>
<td>D-263</td>
<td></td>
</tr>
<tr>
<td>Transmission control ECU</td>
<td>–</td>
<td></td>
</tr>
</tbody>
</table>

**SMT warning light defective.**

1. SMT warning light circuit | D-262 | –
2. Transmission control ECU | – | –

**DTC check cannot be performed.**

1. SMT warning light circuit | D-262 | –
2. TC terminal circuit | D-200 | –

**Transmission control ECU buzzer does not sound when a mode operation occurs.**

1. Door courtesy switch circuit | D-287 | –
2. Stop light switch circuit | D-293 | –
3. Transmission control ECU | – | –
Service Procedures

Reducing Accumulator Pressure

There are a number of procedures specific to the sequential manual transmission that may need to be performed when servicing.

Before removing any of the parts listed below, the hydraulic power unit accumulator pressure must be reduced using the Diagnostic Tester and the procedure listed in the Diagnostics section of the Repair Manual.

- Hydraulic power unit assembly
- Gear shift actuator assembly
- Shift stroke sensor
- Select stroke sensor
- Sub-wire harness
- Clutch stroke sensor
- Transmission assembly or transmission component parts
- Clutch disc or related components

Use the Diagnostic Tester to access the REDUC ACCM PRS in the active test menu. The amount of accumulator pressure will be displayed on the screen when the procedure is complete. The pressure should be zero.

Hydraulic Power Unit Fluid Level Check

After the fluid pressure has been reduced to zero, the fluid level in the hydraulic power unit must be checked with the hydraulic power unit and gear shift actuator hoses connected.

The vehicle should be parked on a level surface with the park brake set. The vehicle air cleaner box must be removed to access the fluid reservoir that is protected by a plastic cover. The level can be viewed through a check window on the reservoir tank.

The required fluid type is Toyota’s Sequential M/T Fluid.
ECU Relearning The Diagnostic Section of the Repair Manual as well as the latest Technical Service Bulletins should be consulted when performing ECU relearning. Since the ECU monitors a number of sensors and controls the shift, clutch and throttle functions with precision, the ECU must be able to learn the values of each sensor to compensate for both manufacturing tolerances and mixing new parts with existing parts when repairs are made. ECU relearning should be performed whenever any of the following parts are replaced:

- Hydraulic power unit assembly
- Gear shift actuator assembly
- Shift stroke sensor
- Select stroke sensor
- Clutch stroke sensor
- Transmission assembly or transmission component parts
- Clutch disc or related components

NOTE Because the ECU will be looking for events to occur in a specific order, it is important to follow the procedure in the order listed, and that both the time and speed requirements be precisely met.

Vehicle Staging Before beginning the relearning procedure ensure the following steps are taken:

- Stop the vehicle
- Close the driver’s side door (door courtesy light switch provides a ground for the transmission control ECU)
- Shift lever into the N position
- Verify the ignition switch is OFF

Diagnostic Tester Use Follow the procedure in the repair manual by installing the diagnostic tester to DLC3.

- Access PARTS EXCHANGE through the OBD/MOBD Diagnostic menu because Enhanced OBD II is not supported on the SMT MR2
- Follow the screen prompts, and when prompted turn the key OFF for 15 seconds or more, then turn it ON.

The N position indicator light should light up. If the light comes ON steady, then relearning is NOT required.
Relearn Procedure If the N light does not light up or it flashes, do the following:

- Turn the ignition switch OFF and remove the key
- Disconnect the battery negative cable for at least one minute
- Make sure the transmission shift and select rod is in the neutral position (hole pointing straight up and down)
- Turn the wheels slowly so the gears rotate in the transmission allowing the synchronizers and gears to align properly while doing the following:
  - Connect the negative battery terminal
  - Insert the key and turn the ignition switch to ON
  - Wait about one minute for the gear shift actuator to actuate various gear positions and the N light to come ON

The gear position indicator may display S5, S4, S3, S2, and S1 consecutively before the N light comes ON.

**NOTE**

During the relearn procedure, the gear position indicator may display S5, S4, S3, S2, and S1 consecutively before the N light comes ON.

- Move the select lever to the S position and drive up to 20 mph in 1st gear
- When the vehicle runs above 3 mph or more the sequential indicator light lights up for one second. ECU learning is complete
ECU Replacement

When replacing the SMT transmission control ECU be sure to follow the specific procedure outlined in Technical Service Bulletin TC003-02. Highlights include:

- Remove the key from the ignition when turning the ignition OFF.
- Remove the four retaining bolts from the transmission control ECU mounting flanges before removing the electrical connector.
- Attach the electrical connector before securing the transmission control ECU with the retaining bolts.
- Visually confirm that the electrical connector attaching hook is properly engaged under the transmission control ECU pin when reconnecting.
- Visually confirm that the connectors are properly aligned, and that the metal arm can easily be fully closed.
- Swing the wire harness electrical connector in a single, fluid motion into the transmission control ECU connector.

ECU Replacement

Swing the wire harness electrical connector in a single, fluid motion into the Transmission control ECU connector.