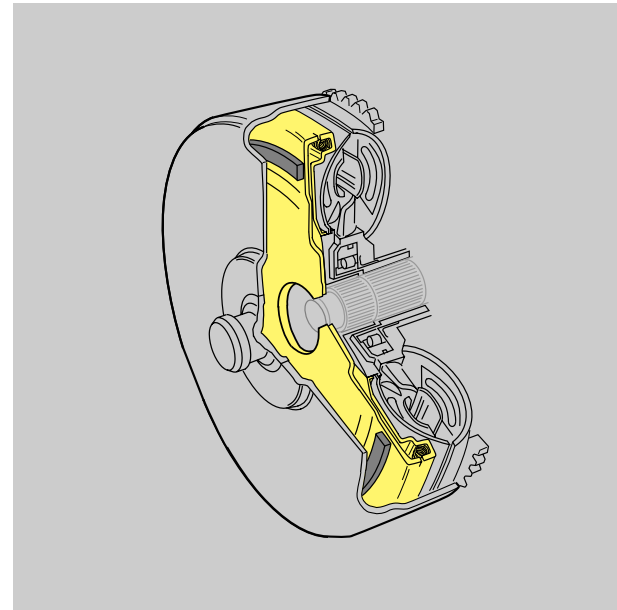


# The 01V and 01L Automatic Transmissions



## Design and Function

Audi of America, Inc.  
Learning and Transformation  
Printed in U.S.A.  
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Course Number 951902

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Always check Technical Bulletins and the Audi Worldwide Repair Information System for any information that may supersede any information included in this booklet.

Diagnostic Procedure .....	1
Road Testing .....	11
5HP-19 Scan Tool Diagnosis .....	25
5HP-24 Scan Tool Diagnosis .....	51
VAG 1598/20 Circuit Diagnosis .....	67

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# A Logical Diagnostic Procedure

# A LOGICAL DIAGNOSTIC PROCEDURE

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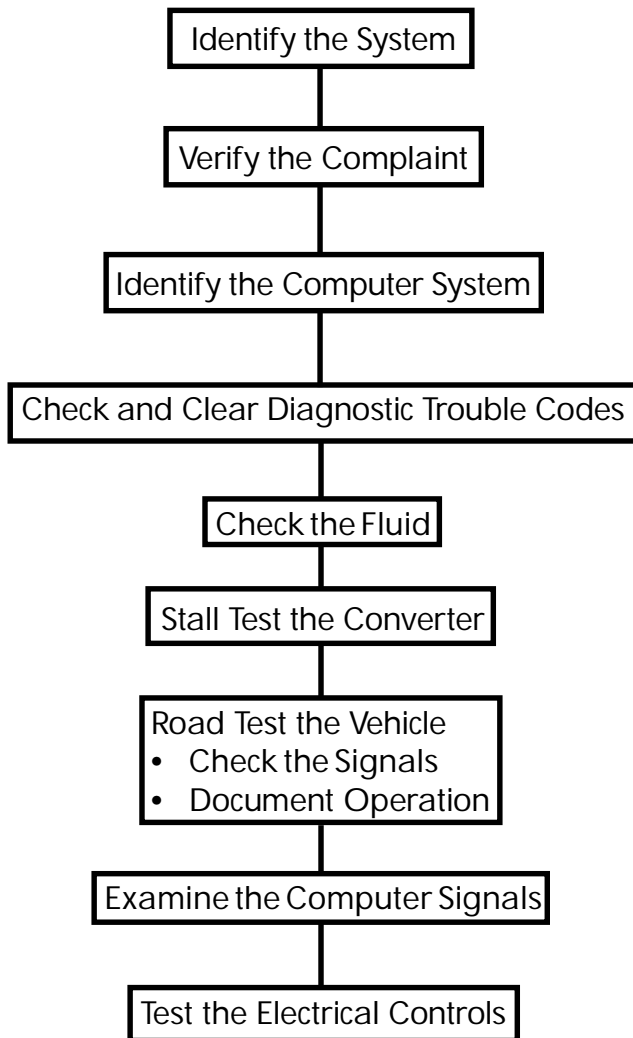
In this module, you will learn:

- The importance of following a diagnostic procedure from start to finish
- How to use a common diagnostic procedure to identify failures in the transmission or system
- How to use a diagnostic procedure sheet to back up your recommendations or repairs
- How to verify customer complaints as part of transmission diagnosis

By the end of the module, you will be able to:

- Follow a logical diagnostic and repair procedure

## Following a Logical Procedure



The key to any good repair is following a logical diagnostic procedure from beginning to end. Technicians often find this difficult to accept, because, very often, the more common diagnostic procedures become second nature to them.

For example: Suppose a vehicle comes in with a battery problem. You would probably start by performing a quick visual check, to look for anything obvious. Then, you would check the battery, and charge it if necessary. Next, you would check the charging system, the starting system and look for any signs of an electrical draw on the system.

If you found a problem, you would identify that, and then move on to the next level, until you have checked everything that could cause a battery problem. Then you would analyze the results of your tests, and make the necessary recommendation to the customer.

You probably never thought about it, but when you performed these checks, you were following a logical diagnostic procedure for the battery and charging system. Each check was designed to show you one more facet of system operation, until you had a complete picture of what was going on, so you could isolate and identify the specific failure.

Of course, charging and starting systems are very common, and most experienced technicians can check those systems without a written diagnostic procedure. That's the real difference between this type of check and checking a transmission problem: Familiarity. Once you become familiar with the checks necessary to diagnose a transmission problem, they will be as second nature to you as diagnosing a battery problem.

# A LOGICAL DIAGNOSTIC PROCEDURE

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In most cases, the steps recommended in this procedure are designed to help you isolate specific failures, using the easiest and most direct procedures first. While it's often useful to gather as much data as possible, there's no reason to pull the valve body if you find an obvious multifunction switch problem in the second check. Once you find and repair the failure, there's no real reason to continue along through the rest of the checks.

The later steps are there to help you identify specific failures that don't jump out at you. Using them, you should be able to determine the specific failure that took place inside of the transmission.

By following these procedures regularly, you will learn more about transmission operation, until transmission diagnosis becomes as natural as ...well, checking a battery.

## NOTES:

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This basic transmission diagnostic worksheet, designed to help you work your way through a transmission diagnosis in a logical, orderly fashion. As you will see, much of the information requested is very obvious and easy to answer. We will go over each step in this process, one step at a time, so you will become comfortable with each test procedure.

	Helpline Consultant's Name: _____	ZF Authorization Number: ZF _____																												
<b>ZF Automatic Transmission Report</b>																														
Return to the Audi Helpline via Fax # 800 839 5499		Date: _____																												
<b>Transmission Data:</b>	Trans. Serial Number: _____	Trans. Code Letters: _____																												
	TCM Part Number: _____	TCM Coding: _____																												
		TCM Data Level: _____																												
<b>Vehicle Data:</b>	COMPLETE VIN (17 digits) _____																													
	Vehicle Mileage: _____																													
	Vehicle Model: _____	Delivery Date: _____																												
	ECM Part Number: _____	ECM Coding: _____																												
		ECM Data Level: _____																												
<b>Dealer Data:</b>	Dealer Name: _____	Technicians Name: _____																												
	Dealer Location: _____	Dealer Phone #: _____																												
		Dealer Fax #: _____																												
COMPLAINT: _____																														
_____																														
_____																														
ATF-Level O.K.?    yes <input type="checkbox"/> no <input type="checkbox"/> Condition _____																														
Failure Codes TCM: _____    ECM: _____																														
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 40%;">Diagnosis</th> <th style="width: 20%;">Date:</th> <th style="width: 40%;">Measures to be taken:</th> </tr> </thead> <tbody> <tr> <td>ZF: .....</td> <td></td> <td> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Problem solved: <input type="checkbox"/></td> <td style="width: 40%;">not solved: <input type="checkbox"/></td> </tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </table> </td> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>	Diagnosis	Date:	Measures to be taken:	ZF: .....		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Problem solved: <input type="checkbox"/></td> <td style="width: 40%;">not solved: <input type="checkbox"/></td> </tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </table>	Problem solved: <input type="checkbox"/>	not solved: <input type="checkbox"/>																						
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# A LOGICAL DIAGNOSTIC PROCEDURE

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The first step in any good diagnostic procedure is to collect vehicle information. Much of this is just background information. This information will be very important for analyzing your results, and for identifying updates that are already there. Don't skimp on this information - it really is very important.

NOTES:

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		Helpline Consultant's Name:		ZF Authorization Number:	
				ZF _____	
<b>ZF Automatic Transmission Report</b>					
Return to the Audi Helpline via Fax # 800 839 5499				Date:	
<b>Transmission Data:</b>		Trans. Serial Number:		Trans. Code Letters:	
		TCM Part Number:		TCM Coding:	
				TCM Data Level:	
<b>Vehicle Data:</b>		COMPLETE VIN (17 digits)			Vehicle Mileage:
		Vehicle Model:		Delivery Date:	
		ECM Part Number:		ECM Coding:	ECM Data Level:
<b>Dealer Data:</b>		Dealer Name:		Technicians Name:	Dealer Phone #:
		Dealer Location:		Dealer Number:	Dealer Fax #:

1. Use your name as the technician.
2. Use your dealership information to fill out the blocks that request it.
3. Use today's date for the date.
4. The transmission type is "ZF5HP\_\_" (enter the correct type for the transmission in the vehicle being used in your class).
5. Use one of the demonstration cars in the shop to provide the vehicle information.

If you have more than one demonstration car in your shop, remember which one you are using - you should try to continue working on that car through the remainder of the class. If you have time, and there aren't too many other students in the class, feel free to fill out additional forms, and perform the test procedure on the other cars, too.

Don't worry about the transmission numbers yet; we'll cover them in the next module.

“Time - When does the condition occur, or how often does it occur?”

Distance - How far do you have to drive before the condition occurs?

Maneuver - Does the condition require a specific series of events to occur?”

Now we're ready to move on to the customer complaint. This is a very important step in the diagnostic process; very often, customers become aware of a problem before it reaches the point of becoming a failure. That's because they're used to driving their cars, each and every day. When it starts acting different, they are the first ones to recognize it.

On the other hand, sometimes the customer may be complaining about something that isn't a problem - they are just unfamiliar with the normal operation of that vehicle. A common example is a car starting in second gear. While that isn't normal on most vehicles, there are a few where second gear starts are normal. And those second gear starts are a common cause for complaints, because most people are unaware that can be a normal condition.

Try to get as much detail as you can from the customer, with specific attention to *time*, *distance* and *maneuver*.

Time - When does the condition occur, or how often does it occur?

Distance - How far do you have to go before the condition occurs?

Maneuver - Does the condition require a specific series of events to occur?

Once you have that detail, you're ready to verify the complaint.

Sometimes verifying the complaint is easy: The customer says the car doesn't move, so you start the engine and put the transmission in gear...and the customer's right - it doesn't move.

But there's more to verifying the complaint than just seeing whether they were right or not. For example, suppose the car doesn't move when you put it in drive. What about low? Very often the customer doesn't think about trying a different gear range. That's okay...*you* should.

If the car doesn't move in drive, but it *does* move in low, that indicates a very specific problem: The freewheeling clutch probably isn't holding when you put the transmission into drive. In low, the G1 brake overrides the freewheeling clutch, so the car moves in manual low.

But that isn't the only possibility you should check. What about reverse? Will the vehicle roll in neutral? Does park hold the vehicle? If the complaint is that the vehicle doesn't upshift, will it upshift manually? These are just a few of the ways that you can verify the customer's complaint, and help narrow the parameters of your diagnosis.

If possible, have the customer go along with you to verify the complaint. It may even be helpful to have the customer drive the vehicle; that way you'll know for sure that you and the customer are looking at the same problem. That eliminates confusion later. And, it's very useful for those problems that mysteriously disappear when the car gets into your shop - by having the customer there when you first examine the vehicle, you eliminate any mistrust that can arise when you have to explain there's nothing wrong with the vehicle...for now.



# Road Testing

# ROAD TESTING AND DIAGNOSIS

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In this module, you will learn:

- The importance of a carefully planned road test for diagnosing transmission problems
- How to read and interpret a clutch application chart, and how to use it to analyze transmission problems
- How to read and interpret the signals from the computer to the transmission
- How to perform a stall test, and analyze the results
- How to analyze the results of your road test, and use it to pinpoint likely failure areas

By the end of this module, you will be able to:

- Perform an effective test drive to verify customer complaints and evaluate the condition of the transmission
- Determine probable failures from the clutch and solenoid application charts
- Identify problems with fluid level and condition
- Properly set fluid level according to specifications



When driving or riding in airbag equipped vehicles, never hold test equipment in your hands or lap when the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.



One of the most valuable diagnostic procedures there is for diagnosing transmission operation is a road test. A road test gives you an opportunity to verify the customer's complaint, and allows you to determine the specific failures and conditions taking place.

There's a lot more to a road test than just going for a drive. A road test consists of examining exactly how the transmission behaves, while performing a carefully planned series of maneuvers and driving conditions. Each step in the procedure is designed to help you identify a specific condition or failure. And, by the end of the road test, you should have a good idea of exactly where the problem should be.

To get the most out of your road test, you must be aware of the conditions that take place in the transmission to develop each gear range. This information appears in your shop manual, in the form of a clutch application chart. The clutch application chart can help you pinpoint the most logical area for a transmission problem, by showing you when each clutch or brake applies.

At the same time, you should be aware of the electrical commands that signal each shift. Remember, electronic transmissions won't shift on their own. They require a set of electrical signals to shift from one gear to the next. By examining the signals to the transmission, and comparing them to the transmission's performance, you can establish whether your problem is inside of the transmission, or if you have an electronic control failure.

In this section, you'll learn how to perform a road test, and how to use the results of the road test to analyze the transmission's operation. You'll learn how to read and interpret clutch application charts, and how to use them to diagnose the most likely cause of a problem.

## ROAD TESTING AND DIAGNOSIS

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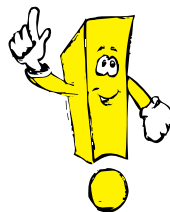
Two of the most useful tools you have for diagnosing transmission operation are the solenoid and clutch application charts. The charts appear in AESIS.

The solenoid application charts show you which solenoids are energized for each gear. The clutch application charts show you which clutches are applied for each gear. Here's how to use the charts to identify the problem.

Suppose you have a 5HP19 transmission that's slipping in reverse. There are no other problems. The solenoid application chart shows shift solenoid N88 is energized. We can rule out solenoid N88 as the cause since it's also energized in 1st, 2nd and 5th gears. These gears are okay. When we look at the clutch application chart, we see that clutches B,D and G are energized, However, clutch B is energized only in reverse. This would be the most likely cause of the problem.

If a solenoid is inoperative electrically, a code will set and the system will go into fail-safe. If a solenoid fails mechanically, the computer may not set a code and shifting problems will occur.

As you can see, by analyzing the information provided by the solenoid and clutch application charts, you can focus your road test and improve your diagnostic accuracy.



*The TCC lockup has three states. Open is when the lock-up clutch is off. Control is when the lock-up clutch is applied partially. Closed is when the lock-up clutch is closed completely. The duty cycle signal to the TCC is never allowed to go over about 60%. This prevents excessive pressure in the TCC.*

01V / 5 HP 19							
SOLENOID LOGIC							
POSITION	SOLENOIDS			PRESSURE CONTROL VALVES			
	N88	N89	N90	N91	N92	N93	N94
R = REVERSE	X	-	-	X	-	X	-
N = NEUTRAL	X	X	-	X	-	X	-
D, 1ST GEAR	X	X	-	X	-	X	-
D, 2ND GEAR	X	X	-	X	X	X	-
D, 3RD GEAR	-	X	X - X	X	X	-	-
D, 4TH GEAR	-	-	X - X	X	-	-	-
D, 5TH GEAR	X	-	X - X	X	X	-	-
2, 2:1 DOWNSHIFT	X	-	-	X	-	X	-
D, 5-4 DOWNSHIFT	X	-	X	X	X	-	X
Torque Converter Clutch	-	-	-	-	-	-	X

01V / 5 HP 19								
CLUTCH LOGIC								
POSITION	CLUTCH				BRAKE			FREEWHEEL
	A	B	E	F	C	D	G	1st Gear
R = REVERSE		X				X	X	
N = NEUTRAL				X -			X -	
D, 1ST GEAR	X						X	X
D, 2ND GEAR	X				X		X	
D, 3RD GEAR	X*			X	X			
D, 4TH GEAR	X		X	X				
D, 5TH GEAR			X	X	X			
2, 2:1 DOWNSHIFT	X					X	X	X
D, 5-4 DOWNSHIFT	(X)		X	X	(X)			
Torque Converter Clutch								



If there is a clutch problem, the transmission fluid is likely to be burned. Especially if the transmission feels like it is trying to engage. If the transmission feels like it is not trying to engage at all, the problem may be in a solenoid, valve or valve body - not a clutch.

# ROAD TESTING AND DIAGNOSIS

01 L / 5 HP 24								
SOLENOID LOGIC								
POSITION	SOLENOIDS			PRESSURE CONTROL VALVES				
	N88	N89	N90	N215	N216	N217	N218	N233
R = REVERSE	-	X	-	X	X -	X	-	X -
N = NEUTRAL	X	-	X	X	- X	X	-	- X
D, 1ST GEAR	X	-	-	X	X -	X	-	X -
D, 2ND GEAR	X	X	-	X	-	X	- X -	X
D, 3RD GEAR	-	X	-	X	X	X	- X -	-
D, 4TH GEAR	-	X	-	X	-	-	- X -	-
D, 5TH GEAR	-	-	-	X	X	-	- X -	-
2, 2-1 DOWNSHIFT	X	-	-	X	X	X	-	X
D, 5-4 DOWNSHIFT	-	X	-	X	-	X	-	-
Torque Converter Clutch	-	-	-	-	-	-	X	-

01 L / 5 HP 24								
CLUTCH LOGIC								
POSITION	CLUTCH			BRAKE				FREEWHEEL
	A	B	C	D	E	F	-	1st Gear
R = REVERSE			X			X		
N = NEUTRAL						X		
D, 1ST GEAR	X							X
D, 2ND GEAR	X				X			
D, 3RD GEAR	X			X				
D, 4TH GEAR	X	X						
D, 5TH GEAR		X		X				
2, 2-1 DOWNSHIFT	X					X		X
D, 5-4 DOWNSHIFT	(X)	X		(X)				
Torque Converter Clutch								

1. A 5HP24 series transmission is stuck in 1st gear. Technician A says that solenoid N89 could be mechanically inoperative. Technician B says that clutch E could be slipping. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
2. A 5HP24 series transmission slips in 3rd gear. Technician A says solenoid N89 may be mechanically inoperative. Technician B says to see if the transmission also slips in 5th gear. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
3. The torque converter doesn't lock up on a 5HP19 series transmission, Technician A says clutch E may be slipping. Technician B says that solenoid N94 may be mechanically inoperative. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
4. A 5HP19 series transmission slips in 2nd gear. Technician A says clutch A may be slipping. Technician B says solenoid N88 may be mechanically inoperative. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B
5. A 5HP19 series transmission slips in 4th gear. Technician A says see if it also slips in 5th gear. Technician B says solenoid N90 may be mechanically inoperative. Who is right?
  - A. A only
  - B. B only
  - C. Both A and B
  - D. Neither A nor B

## Checking the Fluid

Automatic transmission operate on fluid pressure. Fluid actually drives the vehicle by coupling the engine to the transmission inside of the torque converter. Fluid applies the clutches, cools the transmission and lubricates the geartrain.

So, making sure there's enough fluid in the transmission is an important preliminary check.

Actually, there are three fluid checks that you should perform as part of the preliminary transmission checks: Leaks, level and condition.

### Check 1: Fluid Leaks

Most of the time, leak checking is simply a matter of a visual examination. You look the unit over and check for wet spots on the case.

However, sometimes a leak can be harder to find. Air rushing past the case blows the fluid back, away from the actual source of the leak. That air blowing past the case can even blow-dry the leaking spot, and leave you without a clue as to the source of the leak.

If that happens, there are a couple of ways to identify the source of the leak. One is with talcum powder. Sprinkle a bit of talc on the transmission case, then drive the vehicle. The leak will leave a clear mark on the case as it washes the talc away.

A similar method requires using silver paint. A light layer of silver paint will also leave a clear mark as the leaking fluid washes it away.

If you find any type of leak, fill out the "location of Leakage" section on page two of the Transmission Complaint Form



Transmission fluid dyes, such as those that can be seen with a black light, are not recommended for use in ZF transmissions.

## Check 2: Fluid Level

Checking the fluid level is one of those checks that most people take for granted...which is why most people end up doing it wrong. But it's a very simple check, once you know the correct procedure for it.

There are a few rules for checking the transmission fluid:

- The vehicle must be level
- The transmission must be cold, less than 30 degrees C
- Your scan tool provides the transmission fluid temperature. We'll go over the procedure for receiving transmission data with the scan tool in the next module
- The engine must be running
- You must run the transmission through all of the manual gearshift positions, then put the unit back in park before checking the fluid level
- Raise the car
- Remove the filler plug. A. As the temperature reaches 35 degrees C, a small amount of fluid should begin to drain out of the filler hole. If not, use the VAG 1924 to add fluid
- Since these transmissions don't have dip sticks, there is no way to determine how low the fluid level is. The only thing you can do is let excess fluid drain out, if there is any

These procedures are only for checking the transmission fluid itself - the differentials have their own sumps, and must be checked separately from the transmission. Refer to AESIS for the differential fluid level checking procedure.

Fill out "Test Results" on page two of the Transmission Complaint Form with all of information you gathered.

### Check 3: Fluid Condition

The fluid condition can tell you a lot about the condition of the transmission itself. The color, the odor and the consistency all provide specific indications about the inside of the transmission, and clues to what you'll find when you go inside.

There are four main categories of fluid condition:

- Normal
- Burnt
- Metal or clutch contamination
- Water contamination

We'll look at each of these conditions, and see what you can determine, based on the fluid condition.

#### Normal Fluid Condition

Normal automatic transmission fluid is usually anywhere from a yellow to a very slightly brown color. It should be somewhat transparent, and shouldn't have much of an odor. It should be just a little bit thinner than typical engine oil. As the fluid ages, it tends to take on a brownish color.

### Burnt Transmission Fluid

Burnt fluid is either very dark brown or black and gives off an odor so bad it can clear the shop. You'll smell it from across the room.

Burnt fluid indicates a severe transmission problem: usually burnt clutches or a bad torque converter. A clogged cooler is another possibility for burnt fluid. Don't bother changing burnt transmission fluid.



### Metal or Clutch Contamination

This is exactly what the name suggests: The fluid is contaminated with metal or clutch particles. This contamination is due to wear inside of the transmission. You can identify the type of wear by particles in the fluid.

Clutch facings may appear as tiny particles, or as larger flakes. They indicate excessive wear or damage to the clutches themselves.

Metal contamination may appear as small particles of metal suspended in the oil, or as larger chips or flakes of metal in the bottom of the sump. The type of metal provides a good indication of where to look for a problem.

It's normal to see a small amount of clutch or bushing material in the sump. But, if you find more than a little in the sump, it may indicate severe wear inside of the transmission.

Aluminum - silver particles that won't attract to a magnet. Aluminum is usually from the case or valve body.

Brass or Bronze - gold colored particles that won't attract to a magnet. Brass or bronze particles indicate wear from a bushing or thrust washer.

Iron - gray particles that will attract to a magnet. There's very little iron in an Audi transmission, so you aren't likely to see this type of problem.

Steel - silver colored particles that will attract to a magnet. Steel particles in the fluid indicate wear in the pump, torque converter, clutch housing or gear train.

### Water Contamination

Water in the transmission fluid creates the "milkshake" appearance that most technicians have seen at least once before. The fluid becomes translucent, with a milky look to it.

Often, water in the transmission indicates a failure in the transmission fluid cooler. The cooler allows engine coolant to enter the transmission and mix with the fluid. Water may also indicate that the vehicle has been in a flood. Water can enter through the transmission vents.

The only repair for water contamination for the 5HP19 and 5HP24 automatic transmissions is replacement of the transmission assembly. Keep in mind, this also means replacement of the torque converter, which has the torque converter clutch inside of it.

Draining the contaminated fluid will get the water out of the unit, but it won't save the clutches. Clutch material is hygroscopic. That means that it will displace fluid already in the facings to absorb water. The water gets down to the core the clutch and allows it to begin rusting. Within a short time, the clutch material begins to bubble up and flake off, leaving you right where you started, needing to replace the transmission assembly.

If the problem was in the transmission cooler, which is located inside of the radiator, then the radiator must be replaced. Be sure to thoroughly flush the cooler lines.

Once you've examined the fluid, fill in the appropriate area on your Transmission Complaint Form.

### Stall Testing

The term “stall testing” means checking the stall speed. Stall speed is the highest RPM the engine can develop with the transmission in drive and holding your foot on the brake.

A stall test can help you identify slipping clutches, wrong torque converters, slipping converter sprags or engine performance problems. While a stall test isn't appropriate for every transmission complaint, it can be useful for complaints of a lack of power while accelerating.

Here's how to perform a stall test:

**Caution:** If the engine over-revs during a stall test, release the gas pedal. NEVER perform a stall test for more than about five seconds at a time, and ALWAYS cool the converter immediately afterward by putting the transmission in neutral and running the engine at a fast idle for about 30 seconds.

**Step 1:** Start the engine and bring the engine and transmission to normal operating temperature.

**Step 2:** Block the drive wheels and apply the emergency brake.

**Step 3:** Hold your left foot on the brake and put the transmission selector in drive.

**Step 4:** Press the gas pedal all the way to the floor with your right foot and read the maximum RPM the engine reaches. Remember, no more than five seconds!

The maximum RPM is the converter stall speed for this vehicle. Compare that reading to known good cars at your dealership. Also, the Helpline may give you the specifications for stall tests. These specifications vary by vehicle, engine and torque converter application.

**Stall speed is normal:** The engine is working okay, the transmission is holding okay in first gear, the converter sprag is holding and it's the right converter for the car. However, the sprag in the converter could be seized. A seized sprag will let the car accelerate normally, but it will feel like it's holding back once you reach cruising speed. Check for this condition on your road test.

**Stall speed is low:** Either the converter is the wrong one for the vehicle, there's a problem in the converter or there's a problem keeping the engine from developing full power, such as a fuel or ignition problem or plugged exhaust. If you suspect the converter is wrong, check the converter numbers against the listing in AESIS.

**Stall speed is high:** The converter is the wrong one for the car or the transmission is slipping in first gear. If you suspect the converter is wrong, check the converter numbers against the listing in AESIS.

A transmission problem could mean a slipping clutch or a slipping freewheel clutch. To narrow that down further, try performing the stall test again, but put the transmission in reverse.

After measuring stall speed, fill in the appropriate area on the Transmission Complaint Form.

### Transmission Fluid Checks

Perform all three fluid checks on the demonstration vehicle in your shop. Check for:

- Leaks
- Level
- Condition

As you perform each check, fill in the appropriate area in the Transmission Complaint Form.

If you're not sure how to access the transmission fluid temperature yet, ask your instructor to help with this step. We'll cover that detail in the next module.

Once everyone in your class has performed these checks, go on to the next exercise.

### Transmission Stall Test

Perform a stall test on the shop demonstration vehicle and record your results in the appropriate area on the transmission diagnosis sheet.

Remember, never stall test the unit for more than five seconds at a time. Then, cool the torque converter after each test by running the engine at high idle in park or neutral for about 30 seconds.

## ROAD TESTING AND DIAGNOSIS

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Once you've performed the road test and verified the complaint, you're ready to begin specific adjustment and component testing.

Once the fluid level has been adjusted properly, go for another road test and see if the problem is still there.

If the problem is still there, continue your diagnosis. However, if the problem goes away after adjusting the fluid level, that may have been the entire problem. If the fluid was low, check for signs of a leak.

Show the customer what the problem was, and make sure the customer sees the problem is gone now. Then, fill out the recommendations box on your diagnostic repair sheet and attach it to the repair order.

# 5HP-19 Scan Tool Diagnosis

## 5HP19 SCAN TOOL DIAGNOSIS

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In this module, you will learn:

- How to read and interpret scan tool data
- How to use that scan tool data to diagnose electrical problems in the transmission computer system
- How to read and interpret the binary codes for transmission diagnosis

By the end of this module you will be able to:

- Monitor measuring value blocks
- Use the scan tools to check ECM and TCM coding
- Diagnose input, output and control circuit failures



When driving or riding in airbag equipped vehicles, never hold test equipment in your hands or lap when the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.

Up to this point, your entire focus was on gathering data. You checked the transmission fluid, converter stall speed and trouble codes. You drove the car and verified the complaint. And you recorded all of this data on your transmission diagnosis sheet.

If you haven't found anything to this point, you're probably looking at either a control problem or some sort of internal transmission problem - in the valve body or the transmission itself. There are a few more checks you'll be able to perform to help pinpoint where that problem is.

It's now time to stop gathering general information and start trying to identify the actual cause of the problem. It's time to begin checking actual transmission signals and performing pinpoint electrical system checks, to identify and repair circuit problems.

From these readings, you can identify where to direct your search, to identify and isolate specific circuit failures. Those failures could very easily be the root of the transmission problem.

In the next few pages, we'll look at the scan data that's available, and how to use that data to diagnose transmission control components and transmission operation.

Keep in mind, these readings aren't necessarily the actual readings or component voltages. They are the signals that the computer interprets, based on the signals it is sending and receiving. Even though the scan signal is okay, you may still have a problem in a specific component or sensor.

If any of the readings are outside of specs, take a closer look at that circuit. Never condemn a component just on the basis of the scan tool reading. Check for bad connections, a grounded wire or component or even a wire that's crossed in the connector. Check service bulletins covering the component or circuit you are checking, they can save you time and effort in diagnosis and repair.

Once you find a problem, repair it, clear the codes and recheck the readings.



## Functions

Once you're in the Transmission Electronic address word, the path you take depends on where you want to go.

Function 01 lets you examine the computer serial number and codes. This is a good first check, to make sure the computer is the right one, and up to date.

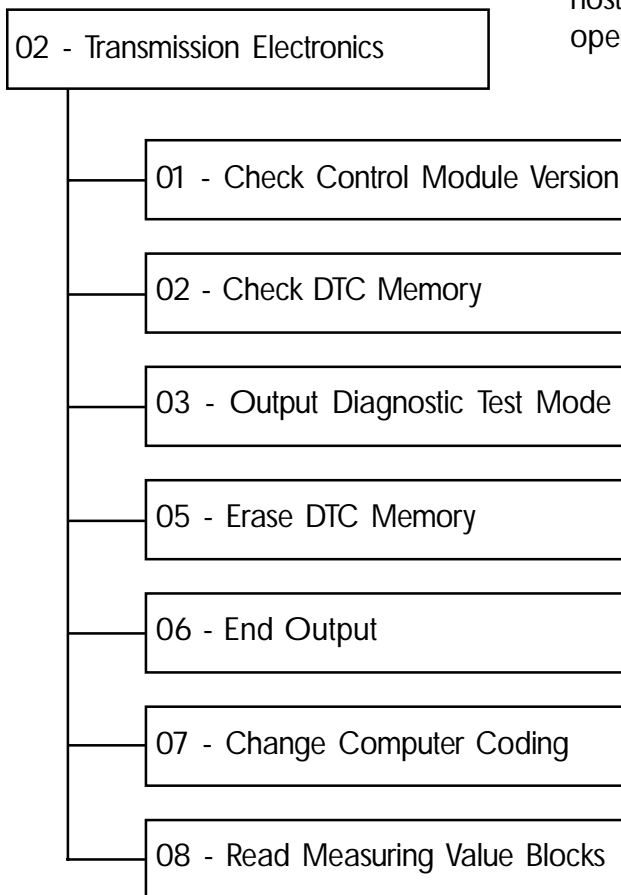
Function 02 lets you examine any diagnostic trouble codes in memory, and 05 lets you erase these codes and clear the memory.

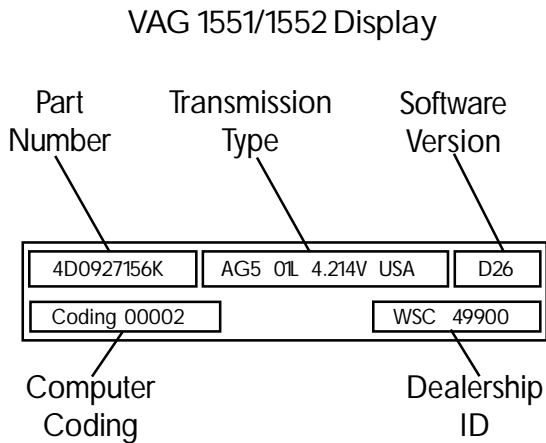
Function 03 is for solenoid testing.

Function 06 is for ending the computer output.

Function 07 is for computer coding.

Function 08 will probably be your most common diagnostic choice. Function 08 provides transmission operating data during actual operating conditions.





*The first ten digits on the first line of the operating display are the part numbers. The center group is the transmission type. The last group of digits provides the software version.*

*The left set of digits on the bottom line is the computer coding number. This number is not in use yet. The final code is the ID number of the dealer who last coded the computer.*

No matter how familiar you become with transmission operation and diagnosis, there may be times when you have to call for help. When that happens, your first call will probably be to the Audi Technical Hotline.

One of the first pieces of information the Audi Hotline technician will ask for is the computer data. That data will include the computer part number, the software level, and where applicable, the computer coding.

The Hotline technician compares the vehicle's computer data to a list of updates, to make sure the computer you are working with is the latest and most up to date. Your scan tool allows you to retrieve all of that information easily. Here's how:

Connect your scan tool (VAG 1551/1552, VAS 5051) to the vehicle.

- Turn the key on, but leave the engine off.
- Enter operating mode 1, "Rapid Data Transfer"
- Enter address word 02, "Transmission Electronics" and press Q to confirm the choice.

The VAG displays the computer information.

- Transmission computer part number
- Transmission type
- Software version
- Transmission coding
- VAG code for the dealership that performed the coding last

Using this information, the Hotline technician can verify that the vehicle you are working on has the latest computer and software version, or compare these numbers to possible recall or update information.

Workshop Exercise

- Use your scan tool to examine the transmission codes and enter them in the appropriate boxes on the transmission diagnostic sheet
- Connect the scan tool to the vehicle
- Turn the key on, but leave the engine off
- Choose 1 - Rapid Data Transfer
- Choose 2 - Transmission Electronics
- Read and record the transmission data in the boxes below

<b>Transmission Data:</b>	<b>Trans. Serial Number:</b>	<b>Trans. Code Letters:</b>	
	.....	.....	
	<b>TCM Part Number:</b>	<b>TCM Coding:</b>	<b>TCM Data Level:</b>
	.....	.....	.....
<b>Vehicle Data:</b>	<b>COMPLETE VIN (17 digits)</b>		<b>Vehicle Mileage:</b>
	-----		.....
	<b>Vehicle Model:</b>	<b>Delivery Date:</b>	
	.....	.....	
	<b>ECM Part Number:</b>	<b>ECM Coding:</b>	<b>ECM Data Level:</b>
	.....	.....	.....

Use your scan tool to read and enter the engine computer part number and coding in the appropriate boxes. If you're unsure of how to retrieve this information, ask your instructor for help.

Computer systems can be very complex, due mainly to the number of functions they replace from earlier, mechanical systems. Because of their complexity, they can be difficult to diagnose when there's a problem in the system.

That's why most computer systems include self-diagnostic capabilities. These self-diagnostics use the computer itself to examine many of the parameters in the system and identify the problems it recognizes.

The Audi transmission computer system has these self-diagnostic capabilities. It can check the electrical system during normal operation and stores these codes in memory to identify any faults it encounters.

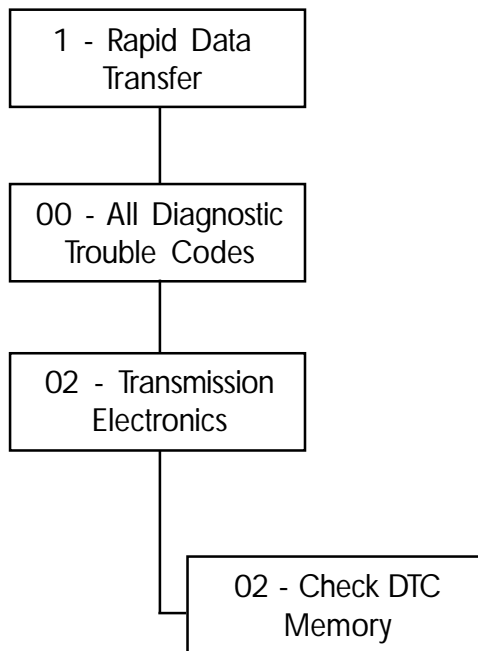
There are two ways to check for codes in memory. Here's how to check for diagnostic trouble codes:

- Connect your scan tool to the vehicle
- Turn the key on, but leave the engine off
- Choose 1 - Rapid Data Transfer
- Choose 02 - Transmission Electronics
- Choose 02 - Check DTC Memory
- Print and record any diagnostic codes in memory

A second method provides you with all codes in memory:

- Connect your scan tool to the vehicle
- Turn the key on, but leave the engine off
- Choose 1 - Rapid Data Transfer
- Choose 00 - All Diagnostic Trouble Codes
- Print and record any diagnostic trouble codes in memory

Since problems in the engine control system can affect transmission operation, you should select "00" at least once during your diagnosis and print them out, so you have a permanent record of all codes in memory.



Reading and Clearing Codes

- Connect your scan tool to the vehicle
- Turn the key on, but leave the engine off
- Choose 01 - Rapid Data Transfer
- Choose 02 - Transmission Electronics
- Choose 02 - Diagnostic Trouble Codes
- Print out any diagnostic trouble codes in memory. Then, record those codes on your automatic transmission diagnostic sheet, or attach the printout to the diagnostic sheet. Indicate whether they are sporadic codes, don't mark off hard codes yet.

\_\_\_\_\_

COMPLAINT: \_\_\_\_\_

\_\_\_\_\_

ATF-Level O.K.? yes  no  Condition \_\_\_\_\_

Failure Codes TCM: \_\_\_\_\_ ECM: \_\_\_\_\_

Diagnosis ZF:	Date:	Measures to be taken:	Problem solved:	not solved:
	.....		<input type="checkbox"/>	<input type="checkbox"/>

Use AESIS to translate the codes, and fill in their definition in the spaces provided.

Code	Definition
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Don't clear the codes at this time.

Address word 03 is for the Output Diagnostic Test Mode (DTM). To access word 01, enter 03 and press Q.

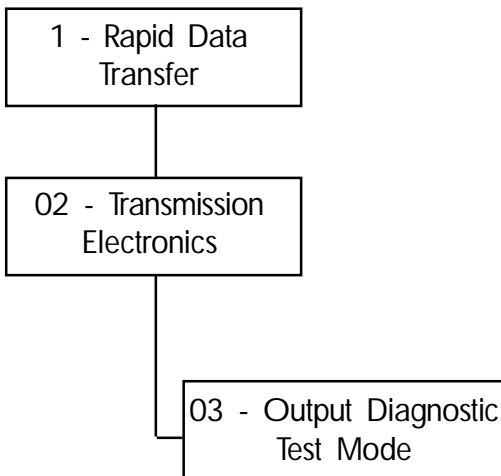
The scan tool displays the solenoid being pulsed. Only one solenoid should be pulsed at a time. Pressing the arrow key advances you to the next solenoid. The TCM pulses the transmission and shift lock solenoids.

Solenoids N88, N89, N90 and the shift lock solenoid are pulsed on and off slowly. The remaining solenoids are pulsed at 1kHz. You can hear solenoids N88, N89, N90 and the shift lock solenoid click on and off if the ambient sound level is low. You cannot hear the remaining solenoids operate.

You can check for a 1kHz signal at the wire of the solenoid being operated, but this does not confirm the operation of that solenoid. It only confirms that the TCM is supplying the signal.

Even though you can't hear the pulse width solenoids operate, cycle through each one. The TCM sets a code if it detects a problem.

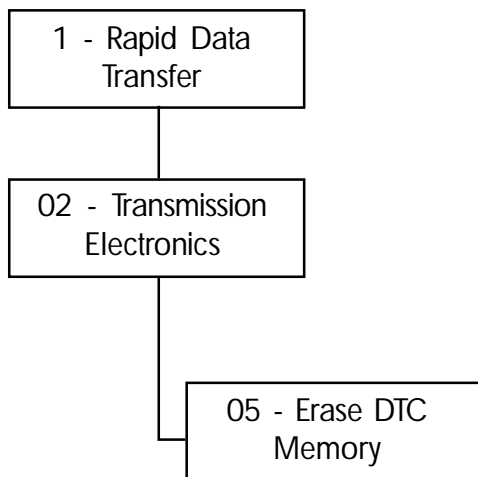
Press the arrow key to exit 03. See the VAG 1598/20 electrical section for further diagnosis.



Once you've recorded any stored codes in memory, your next step is to clear the codes. This does two things: First, it allows you to see whether any of the codes return immediately. Any that reappear are hard codes, and you should deal with these conditions first. Hard codes indicate a problem that's there right now, and will affect system operation.

Second, some codes will prevent the transmission from operating normally. Instead, they'll hold the transmission in fail-safe mode, usually keeping it in fourth gear whenever you put the selector in drive. That will prevent you from diagnosing the rest of the transmission properly.

Before you can clear the codes, you must first read the codes: Your scan tool won't let you clear the codes until you read them. Remember to print out and record any codes you find, to make sure you know where to look for a problem.



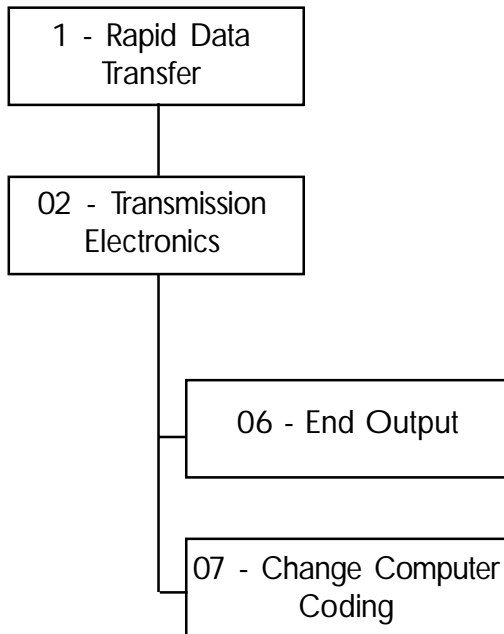
Here's how to clear codes from memory:

- Connect your scan tool to the vehicle
- Turn the key on, leaving the engine off
- Choose 1 - Rapid Data Transfer
- Choose 2 - Transmission Electronics
- Choose 05 - Erase DTC Memory

That's all there is to it. A quick check should show there are no codes left in memory.

Address word 06 is for ending current output. To access address word 06, enter 06 and press Q. This exits you to the prompt that appears after Rapid Data Transfer. You can now select the next desired system or disconnect the scan tool.

Address word 07 is for coding the computer. To access address word 07, enter 07 and press Q. Enter the new code and press Q. The new coding displays. Press the arrow key to exit.

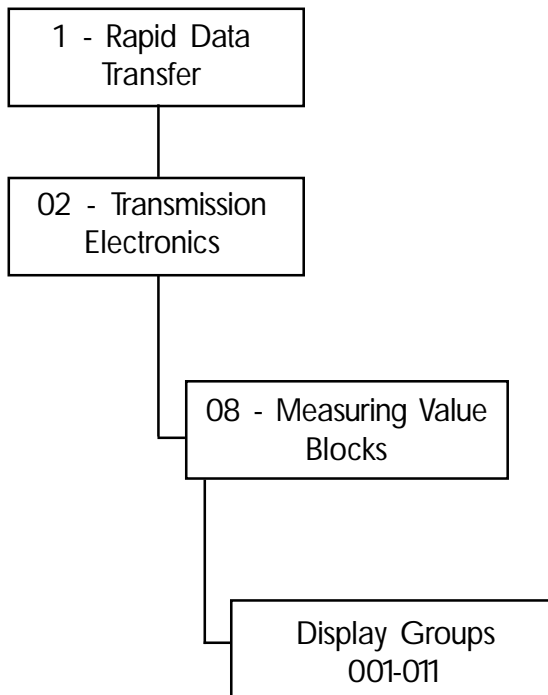




One of the most useful functions is function 08, scan data. This is where your scan tool provides you with actual computer system signals. These are the signals that the computer uses to control the operation of the transmission.

Once you choose function 08, you have one more choice to make before you begin retrieving information through the scan tool: Display Group.

Each display group provides four different fields, containing specific information about the computer system operation.



## Read Measuring Value Block 001

1730/min	1660/min	2240/min	5
----------	----------	----------	---

1            2            3            4

## Display Group 001

Field 1: Engine RPM. This signal comes from the engine control module. It should match the tachometer.

Field 2: Transmission input RPM. This is the speed of the forward planetary carrier. It comes from sensor G182. In 1st gear the forward planetary carrier is held, so no signal should be present. In 4th gear, input RPM should match transmission input RPM with the torque converter locked up fully.

Field 3: Transmission Output RPM. This is the speed of the transmission output shaft. It comes from sensor G38. In 4th gear, the engine RPM, input and output speed should be the same when the torque converter is locked up fully. If the input speed is greater than the output speed while in 4th gear lockup, the TCC may be slipping, or clutch pack A, E, or F may be slipping. If there are no signs of slipping in 5th gear, suspect clutch A. If there are also signs of slipping in 5th gear, suspect clutch pack E or F.

Field 4: Transmission gear engaged. This field displays the actual gear the transmission is in. It is not the position of the gearshift selector.

## Display Group 002

## Read Measuring Value Block 002

40	17%	1310/min	3
----	-----	----------	---

1	2	3	4
---	---	---	---

Field 1: Dynamic shift program index. This field displays the actual program mode in which the TCM is operating. This is determined by the driving habits of the vehicle operator as well as road conditions. This reading can be between zero and 240. A reading of zero indicates a minimum value. This is the most economical mode. A reading over 100 is either a sporty mode or a mountain program. High values raise the shift points. A reading of 241 indicates the cold running program is activated. The cold running mode allows the catalytic converter to warm up quickly. It should only remain in the cold running mode for between 40 seconds and two minutes, or until a specified transmission oil temperature is reached. A reading of 242 indicates the traction control is activated. A reading of 243 indicates the selector lever is in the Tiptronic position.

Field 2: Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 3: Transmission output RPM. This is the speed of the transmission output shaft. It comes from sensor G38. In 1st through 3rd gears, the output speed is less than the input speed. In 4th gear the engine RPM, input and output speeds should be the same when the TCC is locked-up. In 5th gear (overdrive) the output speed should be greater than the input speed. If the input speed is greater than the output speed while in 4th gear lockup, the TCC may be slipping, or clutch pack A, E or F may be slipping. If there's no sign of slipping in 5th gear, suspect clutch A. If there are also signs of slipping in 5th gear, suspect clutch pack E or F. In 5th gear (overdrive) the output speed should be greater than the input speed.

Field 4: Transmission gear engaged. This field shows the actual gear the transmission is in. It is not the position of the gearshift selector.

## Display Group 003

### Read Measuring Value Block 003

Brake	PN intact	23 km/h	13.7V
-------	-----------	---------	-------

1            2            3            4

Field 1: Brake light switch. The scan tool displays "brake" when the brake pedal is depressed.

Field 2: Shift lock solenoid. The scan tool displays "PN active" when the brake is not depressed, and displays "PN inactive" when the brake pedal is depressed.

Field 3: Vehicle speed. This reading is the vehicle speed in kilometers. It comes from sensor G22.

Field 4: Voltage supply. This is the voltage supply to the TCM.

Display Group 004

Read Measuring Value Block 004

68.6 C	D	1011	Eng intervention
--------	---	------	------------------

1            2            3            4

Field 1: ATF temperature. This reading is the temperature of the transmission fluid. This reading is in Celsius.

Field 2: Selector lever position. This reading shows the position of the shift lever.

Field 3: Multifunction switch. This reading displays a four digit binary code that correlates to the selector lever position. The reading are listed below:

• Park	1000
• Z1	1100
• Reverse	0100
• Z1	1100
• Neutral	1110
• Z2	1010
• Drive	1011
• Z3	1111
• Fourth	0111
• Z4	0011
• Third	0001
• Z4	0011
• Second	0010



The Z positions between the gear positions are a reference point for the transmission. As the selector passes through these positions, the transmission knows which direction the shifter is heading, and which gear to start shifting into.

An intermittent Z position in place of drive will not allow Tiptronic to activate.

Multifunction Switch Table (5 speed transmission)						
Selector Position	Digit 1 TCM Pin #36	Digit 2 TCM Pin #8	Digit 3 TCM Pin #37	Digit 4* TCM Pin #9	Pin #B11 J220** MFS #7	Backup Light MFS #8
Park	Power (1)	0	0	0	Ground	
Reverse	0	Power (1)	0	0		Power
Neutral	Power (1)	Power (1)	Power (1)	0	Ground	
Drive	Power (1)	0	Power (1)	Power (1)		
4th	0	Power (1)	Power (1)	Power (1)		
3rd	0	0	0	Power (1)		
2nd	0	0	Power (1)	0		

- Pin #9 is a spliced circuit. Power is also sent to the cruise control switch when the selector is in 3rd, 4th or drive.
- Take the readings with the key on, engine off and your foot on the brake pedal.
- On some vehicles the wire from the multifunction switch #7 goes to the central locking system control module, which uses it to operate the park/neutral position relay. Always consult AESIS for the exact destination.

Digit 1 = Pin #36    Digit 2 = Pin #8  
Digit 3 = Pin #37    Digit 4 = Pin #9

Display Group 004 (continued)

Read Measuring Value Block 004

68.6 C	D	1011	Eng intervention
--------	---	------	------------------

1            2            3            4

Field 4: Engine intervention. This reading indicates when the engine intervention is active. This feature is only active during shifts. Most of the time, field 4 is blank. "Engine Intervention" appears momentarily when the transmission shifts. When it's engaged, it modifies engine settings to help cushion the shifts.

Field 4: (E18/2) On board diagnostic information. A four digit binary code displays. The first digit is for the MIL. A "1" indicates the MIL is on and a "0" indicates the MIL is off.

The second digit is for the drive cycle. A "1" indicates the drive cycle is complete. A "0" indicates the drive cycle is not complete.

The third digit indicates if the transmission is operating in the cold running mode. A reading of "1" indicates the cold running mode is active. A reading of "0" indicates the cold running mode is not active.

The fourth digit indicates if the TCM recognized the engine start. A reading of "1" indicates the engine start was recognized. A reading of "0" indicates the engine start was not recognized. A problem here usually indicates a communication problem between the TCM and the ECM.

## Workshop Exercise

## Diagnosis of the Multifunction Switch

1. Set the parking brake. Turn the ignition to on.
2. Connect the scan tool to the vehicle.
3. Press 1 for rapid data transfer.
4. Enter 02 for transmission diagnostics. Press Q.
5. Enter function 08 and press Q.
6. Enter 004 for display group 4 and press Q. View field 3.
7. Are all of the readings zero?
  - Yes - Check the power supply to the multifunction switch. If the cruise control operates, there's power to the multifunction switch. If power is present, replace the multifunction switch.
  - No - Continue.
8. Are all of the readings wrong when the shifter is in the proper detents for each gear, or do the readings change as the shift lever is wiggled?
  - Yes - Check shift cable adjustment.
  - No - Continue.
9. Move the selector to each position. What gear has the wrong reading? Probe the appropriate TCM pin. If the chart shows a one, there should be battery voltage present. If the chart shows a zero, close to zero volts should be present. If not, the multifunction switch is faulty. If the proper voltage is present and the scan tool displays the wrong reading, the TCM may be at fault. The VAG 1598/20 can be used for this step.

## Display Group 005

Read Measuring Value Block 005

1	1	0	1
---	---	---	---

1      2      3      4

Field 1: Solenoid valve N88. The scan tool displays a "1" when the solenoid is active and a "0" when the solenoid is inactive.

Field 2: Solenoid valve N89. The scan tool displays a "1" when the solenoid is active and a "0" when the solenoid is inactive.

Field 3: Solenoid valve N90. The scan tool displays a "1" when the solenoid is active and a "0" when the solenoid is inactive.

Field 4: Transmission gear engaged. This field displays the actual gear the transmission is in. It is not the position of the gearshift selector.



Read Measuring Value Block 006

0.492 A	0.150 A	0.150 A	4
---------	---------	---------	---

1            2            3            4

Display Group 006

Field 1: Specified current of solenoid valve 4 (N91/215). The scan tool displays the current flow to solenoid N91/215. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 2: Specified current of solenoid valve 5 (N92/216). The scan tool displays the current flow to solenoid N92/216. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 3: Specified current of solenoid valve 6 (N93/217). The scan tool displays the current flow to solenoid N93/217. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 4: Transmission gear engaged. This field displays the actual gear the transmission is in. It is not the position of the gearshift selector.

Read Measuring Value Block 007

75.6 C	0.150 A	TC open	340/min
--------	---------	---------	---------

1            2            3            4

Display Group 007

Field 1: ATF temperature. This reading is the temperature of the transmission fluid in Celsius.

Field 2: Specified current of solenoid valve 7 (N94/218). The scan tool displays the current flow to solenoid N94/218. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 3: Torque converter clutch. This display shows the TCC status. A reading of "TC Open" means the clutch is disengaged. A reading of "control" means the clutch is partially applied. A reading of "TC closed" means the TCC is locked-up fully.

Field 4: Torque converter slip speed. This reading indicates the amount of converter slippage. When field 3 (above) indicates "control" this reading should be between 20 and 120 RPM. When field 3 (above) indicates "closed" this reading should be between zero and 20 RPM.



These specifications depend on individual shift programming.

Display Group 008

Read Measuring Value Block 008

0%	0%	Decel	
----	----	-------	--

1      2      3      4

Field 1: Kick-down switch. The scan tool displays “kickdown” when the throttle is wide open. Otherwise, field 1 is left blank.

Field 2: Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 3: Throttle valve duty cycle. At idle the reading should be less than 30%. At wide open throttle it should be greater than 70%. The percentage reading increases constantly when the accelerator is pressed.

Field 3: (E18/2) Engine torque. This field displays engine torque in Newton meters (Nm).

Field 4: Deceleration mode. This field displays “deceleration” when the vehicle is in that mode. The display is blank the rest of the time.

Display Group 009

Read Measuring Value Block 009

144 Nm	408 Nm	2180/min	15%
--------	--------	----------	-----

1      2      3      4

Field 1: Engine torque. This field displays engine torque in Newton meters (Nm).

Field 2: Maximum torque.

Field 2: (E18/2) Engine RPM. This signal comes from the ECM. It should match the tachometer.

Field 3: Engine RPM. This signal comes from the ECM. It should match the tachometer reading.

Field 3: (E18/2) Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 4: Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 4: (E18/2) Transmission input torque. This is a calculated figure that represents how much torque the engine is applying to the transmission.

## Read Measuring Value Block 010

1.17	1980/min	3	
------	----------	---	--

1            2            3            4

## Display Group 010

Field 1: Torque increase in converter. This field shows the torque increase through the converter. The value is calculated by the TCM based on the torque converter stall speed. A reading of zero indicates a minimal torque increase. The higher the reading, the higher the torque increase is.

Field 2: Engine RPM. This signal comes from the ECM. It should match the tachometer.

Field 3: Transmission gear engaged. This field displays the actual gear the transmission is on. It is not the position of the gearshift selector.

Field 4: Traction control activation. This display shows "traction control active" when the traction control is active. The display is blank when it is inactive.

## Display Group 011

## Read Measuring Value Block 011

R	M-Switch	UP button	Compr. ON
---	----------	-----------	-----------

1            2            3            4

Field 1: Selector lever position. This reading shows the position of the shift lever.

Field 2: Tiptronic switch F189. This display indicates whether the Tiptronic switch is on or off. M - Switch is displayed when the switch is on. When the switch is off, the display is blank.

Field 3: Tiptronic switch F189 change up/down. The display reads "UP button" with the selector in the up position. The display reads "DOWN button" when the selector is in the down position.

Field 4: Air conditioning kickdown. When kickdown is active, the reading will display "Compr. OFF" When the kickdown is not active, the reading will display "Compr. ON."

## Display Group 012

### Read Measuring Value Block 012

E	101	43	7
---	-----	----	---

1            2            3            4

Field 1: Type of driving. This field shows whether the vehicle is driving with or without load. With load would be displayed as a B. This would indicate some sort of uphill driving. Without load would be displayed as an E. This would indicate that the vehicle is being driven on a relatively flat surface. is.

Field 2: Dynamic code number. This signal is calculated from the resistance index and from driver evaluation.

Field 3: Drive resistance index. This field is necessary for the calculation of the dynamic code number.

Field 4: Driver evaluation. This field is necessary for the calculation of the dynamic code number.

## Display Group 013

### Read Measuring Value Block 013

25 Nm	1	1	1
-------	---	---	---

1            2            3            4

Field 1: CAN-Bus norming value.

Field 2: CAN-Bus engine index number.

Field 3: CAN-Bus transmission index number.

Field 4: CAN-Bus software status index number.

Display Group 125

Read Measuring Value Block 125

1	0		
---	---	--	--

1      2      3      4

Field 1: Reception of engine messages via CAN-Bus.

Field 2: Reception of ABS messages via CAN-Bus.

Field 3: Not used.

Field 4: Not used.



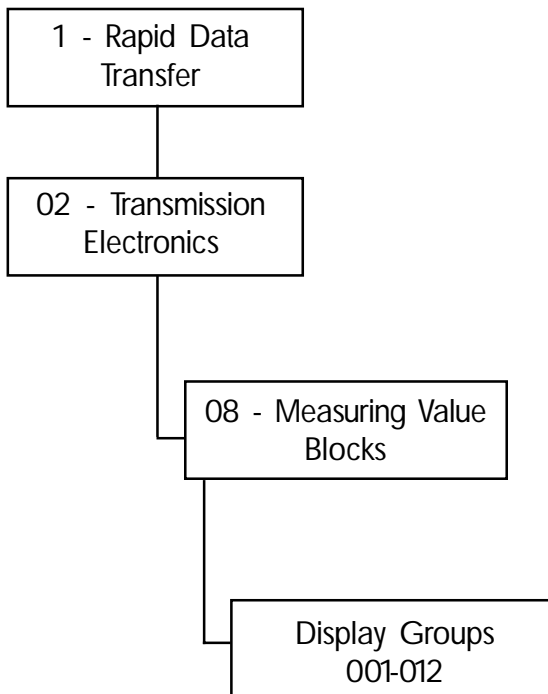
# 5HP24 Scan Tool Diagnosis

Your scan tool provides a number of different functions. You can read and clear diagnostic trouble codes, read the transmission computer information and initiate basic settings.

One of the most useful functions is function 08, scan data. This is where your scan tool provides you with actual computer system signals. These are the signals that the computer uses to control the operation of the transmission.

Once you choose function 08, you have one more choice to make before you begin retrieving information through the scan tool: Display Group.

Each display group provides four different fields, containing specific information about the computer system operation.





## Display Group 001

## Read Measuring Value Block 001

770/min	700/min	0/min	1m
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1            2            3            4

Field 1: Engine RPM. This signal comes from the engine control module. It should match the tachometer.

Field 2: Transmission input RPM. This is the speed of the transmission input shaft. It comes from sensor G182. In 1st through 3rd gears the input speed is less than engine RPM, assuming the TCC is not engaged. In 4th gear, input RPM should match transmission input RPM with the torque converter locked up fully.

Field 3: Transmission Output RPM. This is the speed of the transmission output shaft. It comes from sensor G38. In 1st through 3rd gears, the output speed is less than the input speed. In 4th gear, the engine RPM, input and output speed should be the same when the torque converter is locked up fully. If the input speed is greater than the output speed while in 4th gear lockup, the TCC may be slipping, or clutch pack A or B may be slipping. If there are no signs of slipping in 5th gear, suspect clutch A. If there are also signs of slipping in 5th gear, suspect clutch pack B.

Field 4: Transmission gear engaged. This field displays the actual gear the transmission is in. It is not the position of the gearshift selector.

## Display Group 002

### Read Measuring Value Block 002

DS	13.3%	1310/min	4
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1            2            3            4

Field 1: Actual program. This field displays the actual program mode in which the TCM is operating. "DS" indicates the dynamic shift program is active. "WL" means the cold running mode is active. "AS" means the Anti-Slip Reduction (ASR) is active. "POS2" means the shift lever is in the 2nd position. "GR" means the cruise control is active.

Field 2: Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 3: Transmission output RPM. This is the speed of the transmission output shaft. It comes from sensor G38. In 1st through 3rd gears, the output speed is less than the input speed. In 4th gear the engine RPM, input and output speeds should be the same when the TCC is locked-up. In 5th gear (overdrive) the output speed should be greater than the input speed. If the input speed is greater than the output speed while in 4th gear lockup, the TCC may be slipping, or clutch pack A or B may be slipping. If there's no sign of slipping in 5th gear, suspect clutch A. If there are also signs of slipping in 5th gear, suspect clutch pack B. In 5th gear (overdrive) the output speed should be greater than the input speed.

Field 4: Transmission gear engaged. This field shows the actual gear the transmission is in. It is not the position of the gearshift selector.

## Display Group 003

## Read Measuring Value Block 003

	PN intact	66 km/h	13.9V
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1            2            3            4

Field 1: Brake light switch. The scan tool displays "brake" when the brake pedal is depressed.

Field 2: Shift lock solenoid. The scan tool displays "PN active" when the brake is not depressed, and displays "PN inactive" when the brake pedal is depressed.

Field 3: Vehicle speed. This reading is the vehicle speed in kilometers. It comes from sensor G22.

Field 4: Voltage supply. This is the voltage supply to the TCM.

## Display Group 004

### Read Measuring Value Block 004

38 C	D	1011	
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1            2            3            4

Field 1: ATF temperature. This reading is the temperature of the transmission fluid. This reading is in Celsius.

Field 2: Selector lever position. This reading shows the position of the shift lever. A faulty reading here could indicate a faulty multifunction switch.

Field 3: Multifunction switch. This reading displays a four digit binary code that correlates to the selector lever position. The reading are listed below:

• Park	1000
• Z1	1100
• Reverse	0100
• Z1	1100
• Neutral	1110
• Z2	1010
• Drive	1011
• Z3	1111
• Fourth	0111
• Z4	0011
• Third	0001
• Z4	0011
• Second	0010



The Z positions between the gear positions are a reference point for the transmission. As the selector passes through these positions, the transmission knows which direction the shifter is heading, and which gear to start shifting into.

An intermittent Z position in place of drive will not allow Tiptronic to activate.

Multifunction Switch Table (5 speed transmission)						
Selector Position	Digit 1 TCM Pin #36	Digit 2 TCM Pin #8	Digit 3 TCM Pin #37	Digit 4* TCM Pin #9	Pin #B11 J220** MFS #7	Backup Light MFS #8
Park	Power (1)	0	0	0	Ground	
Reverse	0	Power (1)	0	0		Power
Neutral	Power (1)	Power (1)	Power (1)	0	Ground	
Drive	Power (1)	0	Power (1)	Power (1)		
4th	0	Power (1)	Power (1)	Power (1)		
3rd	0	0	0	Power (1)		
2nd	0	0	Power (1)	0		

- Pin #9 is a spliced circuit. Power is also sent to the cruise control switch when the selector is in 3rd, 4th or drive.

- Take the readings with the key on, engine off and your foot on the brake pedal.

- On some vehicles the wire from the multifunction switch #7 goes to the central locking system control module, which uses it to operate the park/neutral position relay. Always consult AESIS for the exact destination.

Digit 1 = Pin #36    Digit 2 = Pin #8  
Digit 3 = Pin #37    Digit 4 = Pin #9

Display Group 004 (continued)

Read Measuring Value Block 004

38 C	D	1011	
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1            2            3            4

Field 4: Engine intervention. This reading indicates when the engine intervention is active. This feature is only active during shifts. Most of the time, field 4 is blank. "Engine Intervention" appears momentarily when the transmission shifts. When its engaged, it modifies engine settings to help cushion the shifts.

Field 4: (E-gas) On board diagnostic information. A four digit binary code displays. The first digit is for the MIL. A "1" indicates the MIL is on and a "0" indicates the MIL is off.

The second digit is for the drive cycle. A "1" indicates the drive cycle is complete. A "0" indicates the drive cycle is not complete.

The third digit indicates if the transmission is operating in the cold running mode. A reading of "1" indicates the cold running mode is active. A reading of "0" indicates the cold running mode is not active.

The fourth digit indicates if the TCM recognized the engine start. A reading of "1" indicates the engine start was recognized. A reading of "0" indicates the engine start was not recognized. A problem here usually indicates a communication problem between the TCM and the ECM.

Display Group 005

Read Measuring Value Block 005

0	X	0	4
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1            2            3            4

Field 1: Solenoid valve N88. The scan tool displays an "X" when the solenoid is active and a "0" when the solenoid is inactive.

Field 2: Solenoid valve N89. The scan tool displays an "X" when the solenoid is active and a "0" when the solenoid is inactive.

Field 3: Solenoid valve N90. The scan tool displays an "X" when the solenoid is active and a "0" when the solenoid is inactive.

Field 4: Transmission gear engaged. This field displays the actual gear the transmission is in. It is not the position of the gearshift selector.

### Workshop Exercise

#### Diagnosis of the Multifunction Switch

1. Set the parking brake. Turn the ignition to on.
2. Connect the scan tool to the vehicle.
3. Press 1 for rapid data transfer.
4. Enter 02 for transmission diagnostics. Press Q.
5. Enter function 08 and press Q.
6. Enter 004 for display group 4 and press Q. View field 3.
7. Are all of the readings zero?

Yes - Check the power supply to the multifunction switch. If the cruise control operates, there's power to the multifunction switch. If power is present, replace the multifunction switch.

No - Continue.

8. Are all of the readings wrong when the shifter is in the proper detents for each gear, or do the readings change as the shift lever is wiggled?

Yes - Check shift cable adjustment.

No - Continue.

9. Move the selector to each position. What gear has the wrong reading? Probe the appropriate TCM pin. If the chart shows a one, there should be battery voltage present. If the chart shows a zero, close to zero volts should be present. If not, the multifunction switch is faulty. If the proper voltage is present and the scan tool displays the wrong reading, the TCM may be at fault. The VAG 1598/20 can be used for this step.

## Display Group 006

## Read Measuring Value Block 006

0.632 A	0.800 A	0.096 A	0.096 A
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1            2            3            4

Field 1: Specified current of solenoid valve 1 (N215). The scan tool displays the current flow to solenoid N215. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 2: Specified current of solenoid valve 2 (N216). The scan tool displays the current flow to solenoid N216. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 3: Specified current of solenoid valve 3 (N217). The scan tool displays the current flow to solenoid N217. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

Field 4: Specified current of solenoid valve 5 (N233). The scan tool displays the current flow to solenoid N233. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases.

## Display Group 007

### Read Measuring Value Block 007

44.0 C	0.416 A	TC CTRL	130/min
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1            2            3            4

Field 1: ATF temperature. This reading is the temperature of the transmission fluid in Celsius.

Field 2: Specified current of solenoid valve 4 (N218). The scan tool displays the current flow to solenoid N218. This reading changes as the duty cycle sent from the TCM changes. As the duty cycle increases, flow also increases. Solenoid N218 is responsible for controlling TCC lockup. A reading around 0.145 amps correlates to about a 17% duty cycle meaning the solenoid is effectively off (TCC open). A reading of about 0.400 amps correlates to about a 35% duty cycle and indicates the solenoid is partially operating (Control). A reading around 0.710 amps correlates to about a 55% duty cycle and indicates the solenoid is working effectively (TCC Closed).

Field 3: Torque converter clutch. This display shows the TCC status. A reading of "TC Open" means the clutch is disengaged. A reading of "control" means the clutch is partially applied. A reading of " TC closed means the TCC is locked-up fully.

Field 4: Torque converter slip speed. This reading indicates the amount of converter slippage. When field 3 (above) indicates "control" this reading should be between 20 and 120 RPM. When field 3 (above ) indicates "closed" this reading should be between zero and 20 RPM.



Display Group 008

Read Measuring Value Block 008

1	2	3	4
	18.8%	-----	

1      2      3      4

Field 1: Kick-down switch. The scan tool displays “kickdown” when the throttle is wide open. Otherwise, field 1 is left blank.

Field 2: Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 3: Deceleration mode. This field displays “deceleration” when the vehicle is in that mode. The display is blank the rest of the time.

Display Group 009

Read Measuring Value Block 009

1	2	3	4
152 Nm	1700/min	7.8%	244 Nm

1      2      3      4

Field 1: Engine torque. This field displays calculated engine torque in Newton meters (Nm).

Field 2: Engine RPM. This signal comes from the ECM. It should match the tachometer.

Field 3: Throttle position value. This field displays the percentage of throttle position. Closed throttle equals zero percent. Wide open throttle equals 100%.

Field 4: Output torque. This field displays a calculated output torque figure based on the converter torque multiplication (Display Group 010, Field 1).

## Read Measuring Value Block 010

.90	1760/min	5	
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1            2            3            4

## Display Group 010

Field 1: Torque increase in converter. This field shows the torque increase through the converter. The value is calculated by the TCM based on the torque converter stall speed. A reading of zero indicates a minimal torque increase. The higher the reading, the higher the torque increase is.

Field 2: Engine RPM. This signal comes from the ECM. It should match the tachometer.

Field 3: Transmission gear engaged. This field displays the actual gear the transmission is on. It is not the position of the gearshift selector.

Field 4: Vehicle actual acceleration. This is a calculated acceleration force figure.

## Read Measuring Value Block 011

D	M-Switch	Up	
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1            2            3            4

## Display Group 011

Field 1: Selector lever position. This reading shows the position of the shift lever.

Field 2: Tiptronic recognition. This field displays "M-Switch" when the selector lever is in the Tiptronic position.

Field 3: This field displays "up" or "down" when the selector lever is in the Tiptronic position and the upshift or downshift button is pressed.

## Display Group 012

## Read Measuring Value Block 012

E	48	0	48
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1            2            3            4

Field 1: Type of road load. The scan tool displays "E" when the vehicle is driven without much load - like a flat road. The scan tool displays "B" when the vehicle is driven under load - like driving uphill.

Field 2: Dynamic identification. This reading is calculated from the road resistance number in field 3 and the driver evaluation number in field 4. The higher the reading is, the more load the vehicle is under.

Field 3: Road resistance. This reading indicates the amount of road resistance. The higher the reading is, the more resistance there is. This reading is used to calculate the dynamic identification.

Field 4: Driver evaluation. This reading indicates the driving style of the driver. The higher the reading is, the harder the driver is on the vehicle. This reading is used to calculate the dynamic identification.

## Display Group 013

## Read Measuring Value Block 013

25 Nm	1	1	1
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1            2            3            4

Field 1: CAN-Bus norming value.

Field 2: CAN-Bus engine index number.

Field 3: CAN-Bus transmission index number.

Field 4: CAN-Bus software status index number.

## Display Group 125

Read Measuring Value Block 125

1	0		
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1            2            3            4

Field 1: Reception of engine messages via CAN-Bus.

Field 2: Reception of ABS messages via CAN-Bus.

Field 3: Not used.

Field 4: Not used.

You will need at least two people to perform this exercise: One to drive and one to operate the scan tool.

Connect your scan tool to the vehicle.

Start the engine

Choose 1 - Rapid Data Transfer

Choose 02 - Transmission Electronics

Choose 08 - Measured Value Blocks

Choose 005 - This display group displays the solenoid commands from the computer, the gear range.

Put the manual selector in drive and print the display.

Go for a drive, and print the display each time the computer commands the transmission to shift gears.

Enter your results below.

Solenoid Commands			Gear Range



# VAG 1598/20 Diagnosis

In this module, you'll learn:

- How to install and use the VAG 1598-20
- How to perform electrical tests on the ZF transmission electrical system

By the end of this module, you should be able to:

- Demonstrate connecting the VAG 1598-20
- Demonstrate ZF electrical testing



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## Electrical Testing

This module tests the electrical inputs to the TCM and allows resistance checks to be made on the outputs. You need to refer to the service manual for the specific transmission you are working on. Electrical testing can be found in group one. Testing is done using the VAG 1598-20. There are 26 or 27 test steps. Each step tests a particular circuit or component. A diagnostic trouble code chart may send you to a particular test step. Also, there's an index that allows you to look up a circuit or component and gives you the test steps. A shop exercise worksheet is provided to keep track of which test steps passed or failed.



### Circuit Diagnosis:

- Turn the key off
- Disconnect the computer connector and connect your VAG 1598-20 breakout box to the harness connector
- For each test step, check off the pass/fail on the Shop Exercise chart
- Use your Fluke 83 multimeter to check these circuits, and refer back to the appropriate shop manual for the proper meter settings



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<b>Test Step</b>	<b>Result</b>	
	<i>Specification</i>	<i>Actual Reading</i>
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		
26		
27		

*\* See the following pages for the optional test steps.*



