

A4 Air Conditioning Control Circuit Troubleshooting

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** This guide is for Manual Air Conditioning (as opposed to Climatronic A/C or Climatic A/C), with two 2-speed fans on Volkswagen A4's built after May 1999. **

This paper is an effort to try to provide some troubleshooting information to TDI owners. It is intended to be used with the Bentley manual or some equivalent. It assumes the user is competent with a multimeter and is capable of ensuring his own safety. Since most of this was checked using only my vehicle the readings are necessarily just what I could read – no definitive band is intended. The whole intent is to provide information to prevent needlessly buying and replacing parts, so stop and think before acting. You might read through this entire paper before doing anything at all. This is a work in progress – I try to change it when I get feedback from users to incorporate lessons learned. You can check for updates on this paper at tdiclub.com, in the photos section, search on postings by DanG144 and key word “air conditioning”.

There are 4 major sources of issues with the Air Conditioning System. The first three are lightly touched; Control Circuit issues are the main (and originally the only) topic of this paper, and are treated in depth.

Fan issues.

If your Radiator/Condenser fans are not operating properly your Air Conditioning will have performance issues. This is very common on the A4's. The low speed radiator fans (both) should run every time you turn on your AC and it is over about 32 degrees F. The radiator fans should shift to high speed when air conditioning pressures are high (which indicates temperatures are high.) The Radiator fans have other start signals from radiator temperature signals and ECU commands for high engine temperature.

- Turn the key on,
- AC on, and
- select a cabin fan speed.
- Verify that both radiator cooling fans run in slow speed. If they do not you need to troubleshoot and repair the fans or their circuits before proceeding to troubleshoot the AC control circuits.
- [A4 fan troubleshooting](#)
- [Fan Repair](#)
- If these links are broken then search the tdiclub.com photo section for posts from DanG144 using these titles as key words.

Refrigerant Charge issues.

It is axiomatic that your AC cannot function without the proper refrigerant charge. Checking the refrigerant pressure is easily done, and this is often the best first step you can do in troubleshooting AC problems. However checking the pressure just ensures there is some charge left; it does not ensure the proper mass of refrigerant is in the system. If your charge is low, then you have a leak in the system.

The only way to guarantee you have the right amount of charge in your system is to remove it, then add the proper charge by weight - a topic for another paper.

Mechanical System Component issues.

Compressor failures

Internal proportioning valve/Variable ratio control valve

<http://www.acsource.com/index.asp?PageAction=VIEWPROD&ProdID=1399>

Reed valve

Compressor case relief valve.

Evaporator Expansion Control valve.

Filter drier.

Leaks.

These are treated in the Repair Manual.

Another parts source on line is www.acparts.com.

No recommendation is intended or implied. I have never done business with either one of these.

System Overview Troubleshooting

This is what I would do initially

1. Do condenser fans run in SLOW when the AC is turned on? (Key on, Engine off)
 - a. Driver's Y/N
 - b. Passenger's Y/N
 - c. If one fan is not running and one is, proceed to fan testing (eventually.)
 - d. If neither fan is running you will need to get at least one running before you do put the system in service. You can do some momentary troubleshooting operation with both fans inoperable.
2. Start the engine while watching the clutch and fans.
 - a. Does the compressor clutch engage with the engine running? Y/N (With no fans running it will only engage for about 20-60 seconds, then trip on high high pressure.)
 - b. If neither fan is running and the clutch is not engaging, then it is possible there is a control signal causing the situation.
 - i. Low system pressure signal from G65.
 - ii. Low ambient temperature signal from F38.
 - iii. ECU lockout of the AC due to high engine load.
 - c. If at least one fan is running, but the clutch is not engaging, then it is possible there is a control signal causing this condition.
 - i. ECU lockout due to high engine temperature.
 - ii. G65 high high pressure signal.
 - d. If the clutch is not engaging at all then check the system pressures.

3. Check the System Pressures:
 - a. Install gauges and check pressures.
 - b. Use Safety Pin, check correlation of high pressure to G65 % duty cycle. If correlation is bad (say 10% error?) then replace the G65 sensor.
 - c. If pressure and duty cycle are high enough to allow running (14.5 psig trip - 68 psig reset/G65, 12.5% trip - 20% reset), and below the High High pressure cutout (450 psig trip – 350 psig reset/G65, 82% trip – 64% reset), but the clutch is not engaging, then go to the AC control circuit troubleshooting instructions below.
 - d. If Pressure is too low, evacuate, repair leaks, and refill with 750 grams of R134a (may be best left to a professional).
 - e. Note that low pressure will preclude clutch engagement and fan operation.
 - f. If the high side pressure is too high (with the compressor running), ensure the fans are working, then bleed some charge and verify pressure drops and the system starts functioning.
4. If the electronic controls are good (clutch engaging), both condenser fans are working, and no system leaks, but the system performance is poor, then check out the mechanical system per the Repair manual troubleshooting guide; this will require removing and replacing the charge to get the proper charge mass in the unit (at least to make definitive determinations).
 - a. There is a replaceable compressor mechanical control valve.
 - b. There are replaceable reed valves in the compressor.
 - c. There is also an expansion valve for the evaporator that can cause trouble.

Air Conditioner Control Circuit Issues.

The main topic of this paper. Please read through the paper and examine the pictures and tables before starting.

The Fan Control Module is the major control unit for the Manual AC system.

The Bentley Manual's schematic for your car would be valuable to many of you. The 38 series of drawings was referenced for this document.

This pinout provided by wulee is also valuable. [pinout of J293](#)

To test the Air Conditioner Control Circuits:

The problem involved an A-4 TDI manual A/C system with no compressor clutch operation. On this vehicle, the cooling fans (in the AC support modes) and A/C compressor operation are controlled by the J293 fan control module, which is bolted under the battery tray. The J293 module has both a 14-pin connector identified as the T14 connector in Volkswagen wiring diagrams and a four-pin connector identified as the

T4a connector. Accessing the T14, T4a, and fan connections is harder on the New Beetle, on vehicles with automatic transmissions, and vehicles with coolant heaters installed. You may have to remove the belly pan, left fender well and left engine compartment side skirt to gain adequate access.

Before you get started with detailed troubleshooting, check:

- Fuse 5 on the cabin fuse panel.
- Fuse 16 on the cabin fuse panel.
- Fuse 25 on the cabin fuse panel.
- Fuses S164 (the center metal fuse#3 above the battery) and S180 (the inboard of three plastic fuses above the battery, called fuse #8). Note well that corrosion under this fuse (causing a loss of power) is a VERY common problem. The fuse holder can often be disassembled and repaired.
- **If possible verify refrigerant pressures are as expected (about 27 to 130 psig without compressor running – see the temperature/pressure chart near the end of this document.)**

To diagnose this system:

- 1) Check that the G65 pressure sensor, mounted on the high pressure line into the evaporator, and usually located near the firewall, has a Duty Cycle signal output greater than 12.5% on its white wire. It should be proportional to pressure as indicated in the table appended to this document.

If you are not able to locate a multimeter capable of measuring duty cycle, then as a rough check verify that you have a DC output voltage on the white wire of greater than 2.0 vdc. You can use safety pins to penetrate the insulation to get these readings, as they must be taken with the G65 plugged in.

See step 11 below for more information on this topic, and to measure the reading when it reaches the T14 plug at the fan control module.

- 2) Check for 12 volts at all times at the four-pin connector, T4a pins
 - a. T4a/1 from fuse S164.
 - b. T4a/3 from fuse S180.
- 3) Check fan circuit resistances
 - a. T4a/2 slow speed fans, 9.6 ohms to ground.
 - b. T4a/4 fast speed fans, 8.9 ohms to ground.
 - c. Plug T4a back in.
- 4) **Start** and **idle** the vehicle.
 - a. Select "A/C on" at maximum cooling and
 - b. Cabin fan at low speed.
- 5) Check for voltage across the two pin connector on the side of the compressor.

- a. If you have 9-9.5 volts, but the clutch is not operating (when plugged back in), then you will need to check the voltage under load. Use safety pins to pierce the wires and check the voltage near the two pin connector on the compressor with the plug reconnected.
- b. Normal clutch coil resistance is about 4 ohms. Check this at the wires to the clutch with the connector unplugged.
- c. If you do not have 9-9.5 volts loaded, then continue to find out why not.
- 6) Check for 12 volts at the T14 connector pin No. 8 (T14/8)(unplugged).
 - a. This 12-volt signal comes from the A/C switch and requests both cooling fans on at low speed and compressor activation. (Through fuse 25 and the fresh air blower switch.)
- 7) Check for 12 volts at pin T14/9 (unplugged).
 - a. This voltage is a switched ignition source and will have 12 volts when the ignition is in the "on" position. (Through fuse 5.)
- 8) Check for 12 volts at pin T14/4 (unplugged).
 - a. This is a constant battery source and should read 12 volts at all times from fuse S16.
- 9) Check for a good ground at pin T14/6 (unplugged).
 - a. Resistance should be less than .5 ohm.
- 10) Check for continuity between pins T14/14 and T14/5 on harness side to ensure proper operation of the F38 ambient temperature switch.
 - a. Continuity must be present if the ambient air temperature is above 32 degrees Fahrenheit. (unplugged).
 - b. Mine read 1.1 kohms.
- 11) Check pin T14/2 using a duty cycle meter (unplugged, for compressor off, plugged in if you want to monitor pressure during operation).
 - a. If the refrigerant charge in the system is anywhere near normal, then the duty cycle reading that corresponds to the present temperature should be indicated at pin T14/2 (without the compressor engaged).
 - b. The duty cycle signal is supplied by the G65 pressure sensor in response to system pressure changes.
 - c. My G65 pressure sensor is linear with {pressure = (duty cycle times 6.47) minus 64.7 psi}. (See the table below.)
 - d. Readings taken without a duty cycle meter may be difficult to evaluate, and the readings will vary with the meter used. My Fluke 115 showed readings varying between 4.5 and 5.5 VAC at 52 to 53 hz; on DC it showed 2.5 to 3.5 VDC at 70 degrees Fahrenheit ambient temperature (AC off). Another person's Micronta read less than zero VAC, but showed DC voltages as follows: empty system 0.64 vdc, pressurized system (off) 3.4vdc, pressurized system – running, 5.2 vdc.

So very low DC voltages on the G65 may indicate low charge, or a bad G65.

 - e. The duty cycle read 19.5% at about 65 degF.
- 12) Check for a pulsing reference voltage at pin T14/3.

- a. The reference voltage originates in the J293 fan control module and can be grounded by the power control module (PCM/ECU/ECM) under certain circumstances (typically wide open throttle or high vehicle load) to turn the A/C compressor off.
 - b. Unplugged duty cycle readings were 99%, at 12 mvAC, 2 Hz.
 - c. Plugged in duty cycle readings were 45%, at 40 mvAC, 880Hz.
 - d. If zero volts are present, the PCM is commanding "compressor off" or the wiring harness is shorted to ground. Raise vehicle idle speed above 2500 rpm and observe compressor operation and voltage at pin T14/3. If the voltage at pin T14/3 returns to a pulsing DC volts with the engine speed above 2500 rpm and compressor operation resumes, then a throttle basic setting procedure is needed and must be performed with VCDS or equivalent. Note: A loss of throttle basic settings will keep the compressor from activating.
- 13) Check pin T14/13 with a duty cycle meter (unplugged).
- a. Duty cycle was oscillating 33-77%, 4-10Hz, 0-6.5 VDC, 0-6 VAC, looked as if it pulsed to 6.5 volts DC 4 or 5 times per second.
 - b. This signal comes from the ECU as a backup control for engine overheating.
 - c. When the duty cycle drops to zero, the fans are shifted to FAST speed and the compressor clutch is turned OFF.
- 14) If all previous tests have passed, check the T14 connector pin T14/10, for about 4 ohms resistance to ground, this verifies continuity through the clutch.
- 15) Plug the T14 back in.
- 16) Check for voltage at the clutch electrical connector again (with a safety pin through the insulation), if you do not have 9-9.5 volts, and all the other tests were good, then you have a bad fan control module.
- 17) You can test the AC clutch operation by providing battery voltage to the clutch momentarily on pin 1, while grounding pin 2. Do not do this more than a very few seconds.

In order to take readings with the plug still inserted into the jack, you will have to either have a test fitting made up (specific to the connector), or you will have to use a needle (actually I prefer safety pins – they are much easier to handle) through the insulation to make contact with the wires. This latter method is relatively harmless IF you clean the insulation with a non-residue cleaner, then put a dab of liquid rubber or RTV sealant on the hole once you are through with the measurement. Do not leave unsealed holes in any wiring that is subject to moisture.

Fluke instrument company makes a good meter (the model 87-V) that has duty cycle measurements built into the second function of the frequency measurement. Some “engine analyzer” digital multimeters available in chain auto parts stores also claim to measure duty cycle. I have one of these, and it would not function properly.

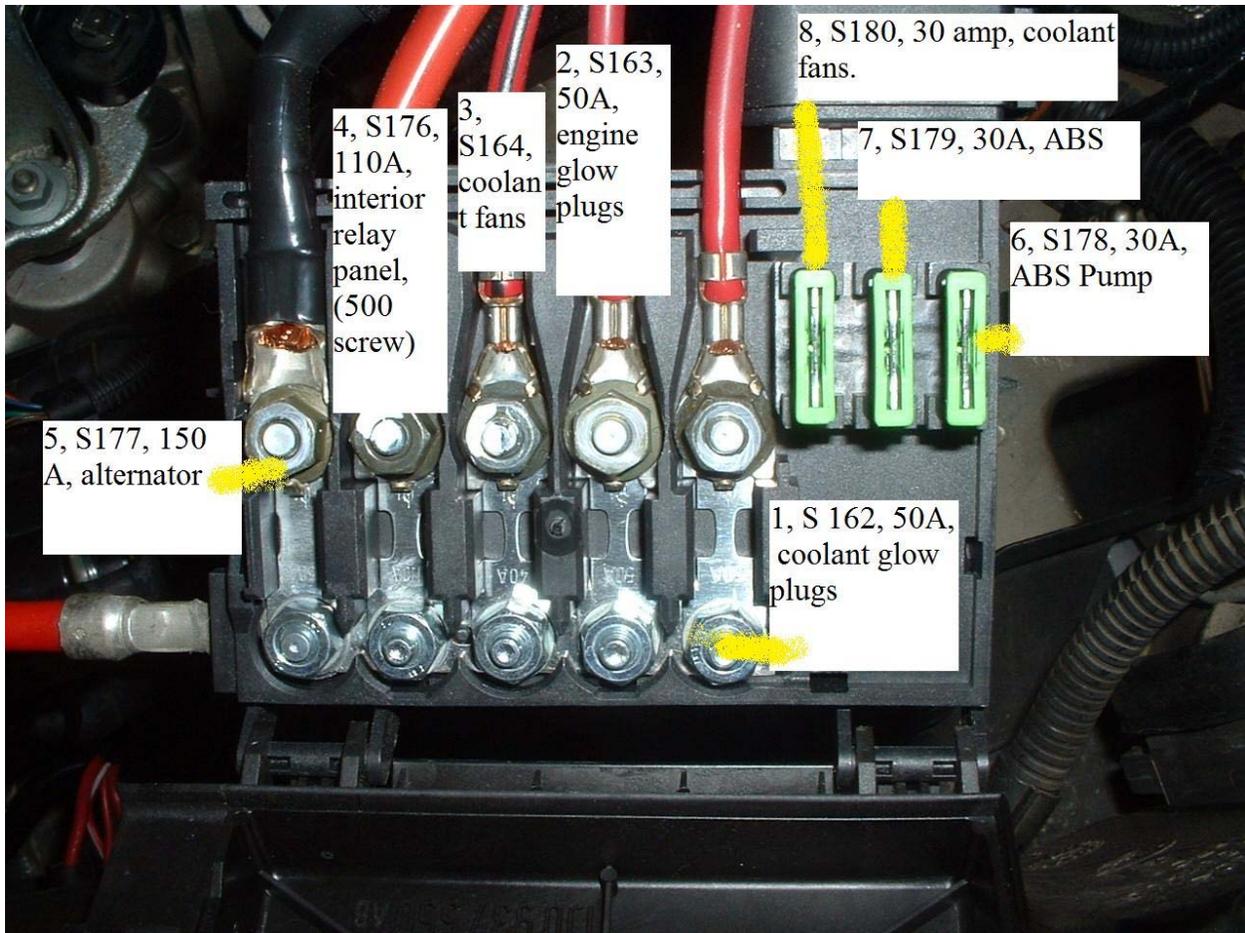
Temp	Temp	Pressure	Pressure	G65 Duty cycle
Deg C	Deg F	Bar	PSIG	%
-30.0	-22.0	0.0	0.0	10.0
-20.0	-4.0	0.3	4.4	10.7
-10.0	14.0	1.0	14.5	12.2
0.0	32.0	1.9	27.5	14.3
10.0	50.0	3.1	45.0	17.0
20.0	68.0	4.7	68.2	20.5
30.0	86.0	6.7	97.2	25.0
40.0	104.0	9.1	132.0	30.4
50.0	122.0	12.2	177.0	37.4
60.0	140.0	15.8	229.0	45.4
70.0	158.0	20.2	293.0	55.3
71.1	160.0	20.7	300.0	56.4
76.1	169.0	24.1	350.0	64.1
82.2	180.0	27.6	400.0	71.8
87.8	190.0	31.0	450.0	79.6
93.3	200.0	34.5	500.0	87.3
		37.9	550.0	95.0
		40.2	582.3	100.0

The above refrigerant table is a rough approximation, based on readings from only one G65. If anyone has definitive data (or even just another transducer's data) please forward it to DanG144 on tdiclub.com.

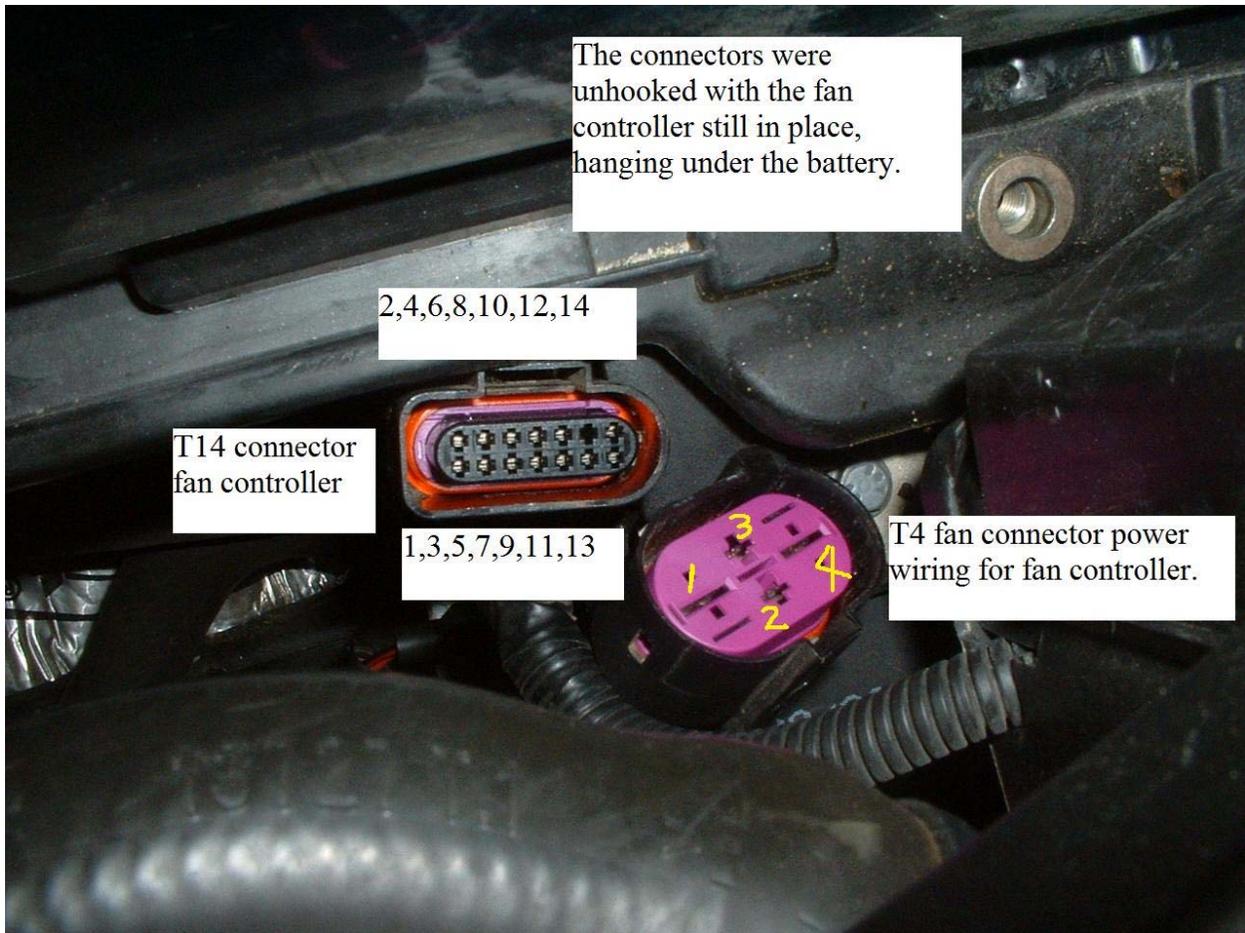
Approximate actuation points.

Temp	Temp	Pressure	Pressure	G65 Duty cycle	Description
Deg C	Deg F	Bar	PSIG	%	Action
-10	14	1	14.5	12.5 decreasing	Low pressure trip Fans and clutch off
20	68	4.7	68.2	20 increasing	Low pressure reset fans and clutch on
50	122	12.2	177	40% decreasing	Fast fan Reset fans drop to low speed
60	140	15.8	230	46% increasing	Fast fan Start fans shift to fast speed
76.1	169	24.1	350	64% decreasing	High High pressure reset clutch on
87.8	190	31	450	82% increasing	High High pressure Trip clutch off
		40	580	100%	Compressor Relief valve opens

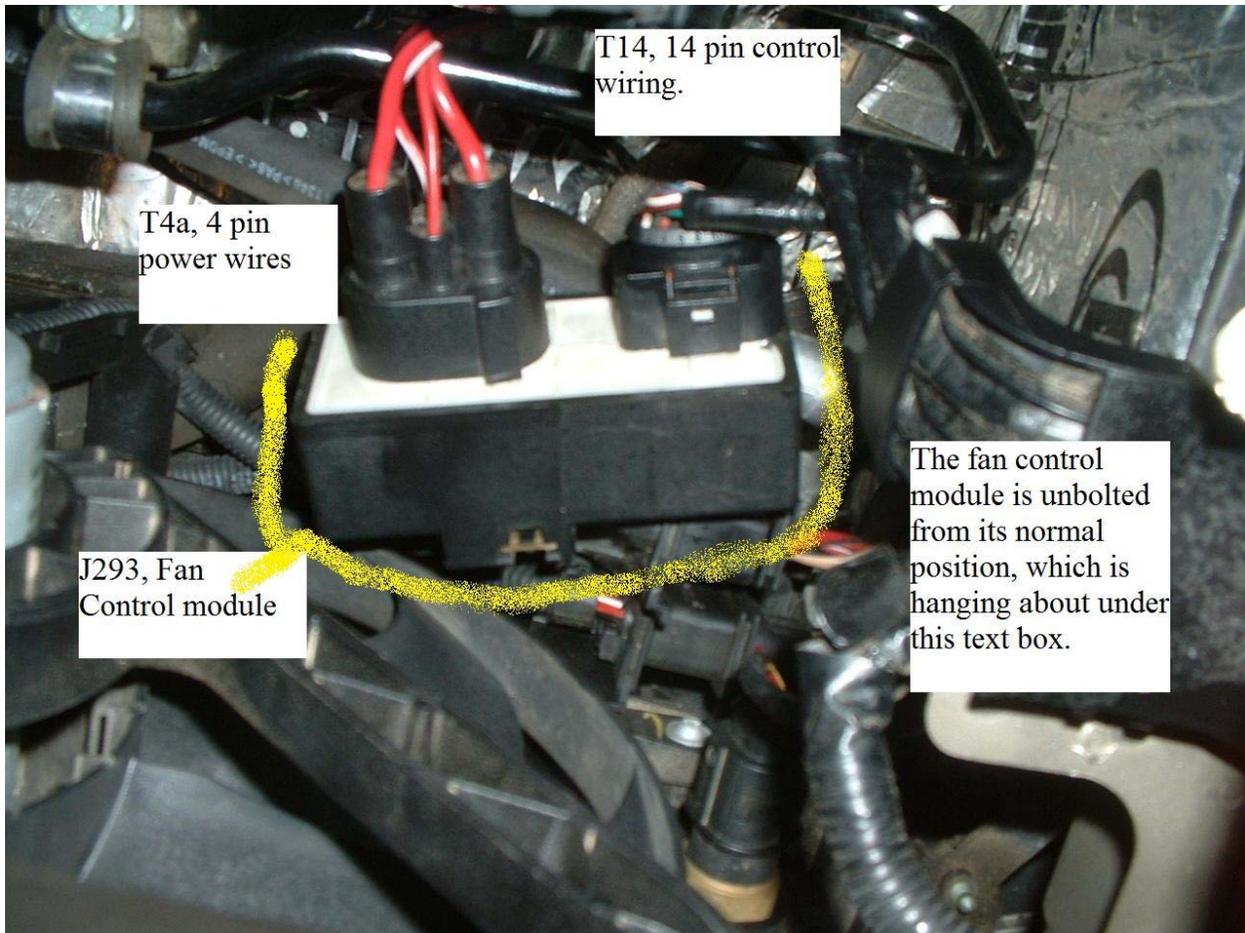
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A labeled view of the fuse box above the battery. The connections **UNDER** the S180 fuse for the coolant fans is often a source of problems. If you do not get power from this fuse to the Fan Control Module then it will not allow the AC clutch to engage. Power also goes directly to the Radiator Thermoswitch from this fuse. This is what allows the thermoswitch to run the slow speed fans on high temperature even with the key off.



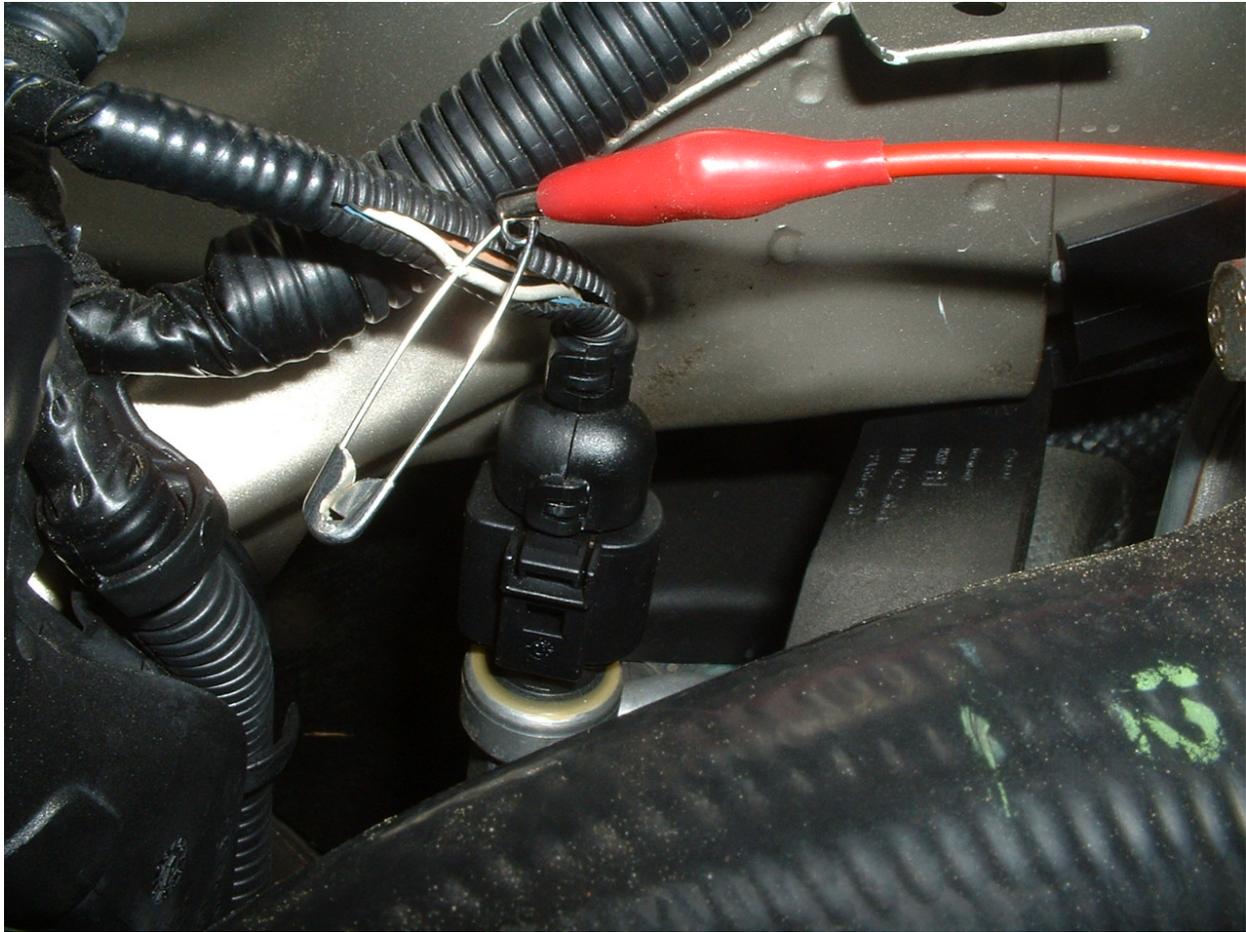
On my A4 Jetta Manual transmission there was room to unhook the connectors and snake them out and up in front of the battery. I am told this may be problematic on New Beetles and cars with automatic transmissions due to a simple lack of room. You may have to remove the belly pan and even the side skirt and wheel well liner to get access on some cars.



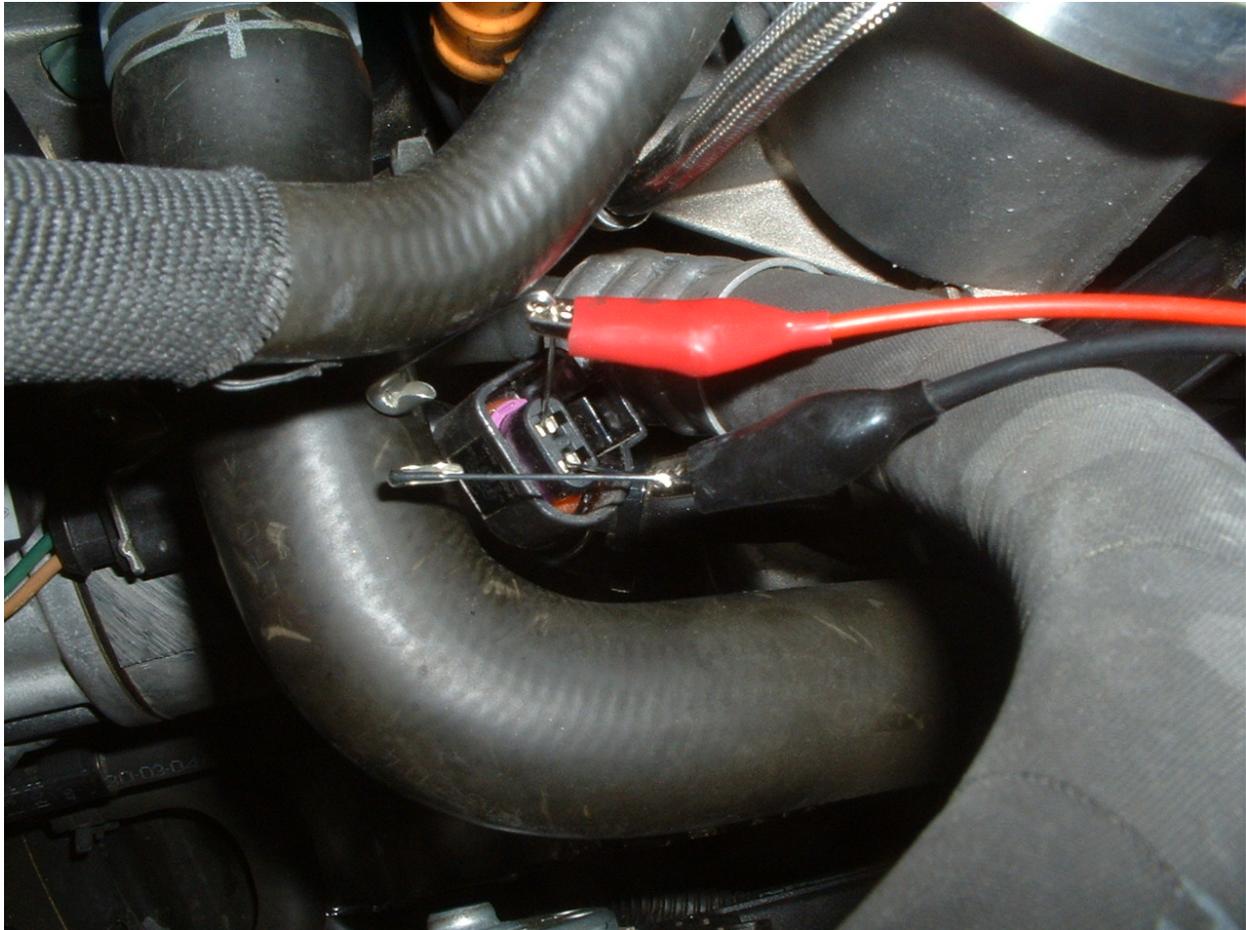
The fan control module normally hangs under the battery. This one has been unbolted and moved inboard. On my Jetta I could do this with the skid plate and side skirts still in place.



These are the only two bolts that hold the Fan Control Module in place. They are just forward of the battery box. The battery box is removed in this photo (which was taken while cleaning grounds.)



The G65 refrigerant pressure transducer is shown above, with as safety pin inserted in the output signal wire for measuring duty cycle.



The Air conditioning compressor clutch connector can be seen in the dark corner below and left of where the two hoses cross. It is bolted to the compressor. The plug has been removed, and two safety pins inserted to measure the supplied voltage. 9 to 9.5 volts is normal. If you connect to the jack (and it was a pain!) instead of the plug you can measure resistance, mine read 3.6 ohms. This resistance can also be read from pin T14/10 to ground, which checks the whole circuit, if you are unplugging T14 from the Fan Control Module for other readings.

The only definitive way to check the voltage to the clutch is with the circuit loaded (connector plugged in), and use a safety pin to penetrate the insulation. Some properly operating Fan Control modules (but with some control signal holding out the clutch –such as Less than 12.5% duty cycle from the G65) will show 9.5 volts when unloaded, but the voltage will go very low when loaded, and the clutch will not engage.