Electrical Trouble-Shooting the Porsche 968 Cooling System

Here's a step-by-step diagnostic procedure to help trouble-shoot the electrical part of the cooling system in your 968. This procedure is based on the author's experiences and on information available on 968 Forums and in the 968 and 944 community, notably Garage Shop Manual at clarks-garage.com and Tech Q&A at pca.org.

Looking at the wiring diagram in the Porsche Workshop Manual, one sees that all cooling system electrical activity is controlled through the Fan Relay. This suggests the Fan Relay socket could be used as a point of access for electrical diagnostic measurement and stimulation (a suggestion not original, it seems, as I recently came across mention of it in the Tech area of the PCA website).

Described in this document is a sequence of electrical tests that can be performed right at the relay/fuse box. No claim it's foolproof, but it worked for me (on two occasions). Not only can these diagnostics be performed in street clothes standing next to your car, but they can be done while enjoying your beverage of choice.

There are two fuses, presence of battery voltage, two fans, two fan-speed resistors, two radiator temperature sensing switches (in one housing), a complex fan control relay, and opens/shorts in associated wiring to check.

While the various components can be checked by direct substitution, this may not always be practical. Also, these cars are upwards of fourteen years old and, depending on the car's history, wiring integrity can be a problem. That could mean opens, shorts and/or corroded connections, problems not readily traced with substitution. Some tests in this procedure will be required only in the event of such wiring issues.

The information contained in this document is offered in good faith but the author takes no responsibility for any errors or omissions. He believes this information will help in identifying the cause of most cooling system electrical problems, but cannot guarantee this, and recommends seeking expert advice in the event of any misgivings.

> If you are uncomfortable with performing any of these tests, or with any aspects of this approach, don't use it! A jumper to the wrong pin or an unintentional grounding has the potential to do some really bad things to your car.

You are encouraged to read through the entire procedure before starting the tests.

Preparation

You will need a multi-meter to measure volts and ohms*, seven 16 gauge 0.25" male quick-disconnects (spade connectors, no thicker than the blades on the fan control relay), some insulated stranded hookup wire, some small gauge insulated solid (bell) wire, a few cheap plastic 25A fuses and a few quality ones.

* If all you have is a voltmeter, a bug-light will do for the continuity tests, though resistance measurements will yield more information.

File any rough edges and surfaces on those seven quick-disconnects so when plugged into the relay socket holes they won't scratch the female connector inside. Cut two 4" lengths of stranded wire, strip both ends of each, and crimp or solder a quick-disconnect blade onto each of the 4 ends. These will serve as jumpers fitting some of the wider relay socket holes.

Caution: when using the jumpers, always be sure the two fan fuses identified below are removed first, and limit their use to the relay socket holes indicated in the tests.

The remaining three will serve as probe-blades, which you will touch with the actual probes of your meter. Two will be used in the wide relay socket holes. Cut the third and last blade in half with a diag. cutter, then cut off one of the halves and file the cut edges. This will be for the narrow relay socket holes.
Finally, cut out the fuse wire on one of the cheap fuses; this "defuse" will serve as a probe for the fuse socket.

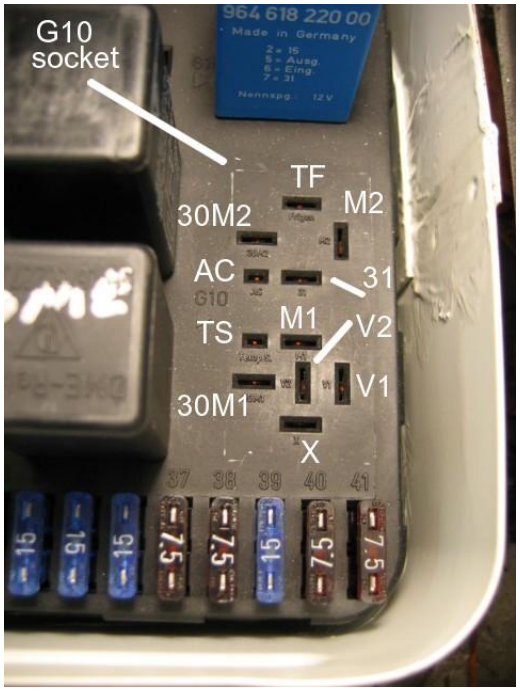
The Procedure

It is important to follow the tests in sequence because many of the tests build on the preceding ones. For example, when testing the switch, we will already know the fans will run, and when testing the relay, we will already know the switches are good.

However, if your problem is that the fans continue to run long after you've turned off the engine (a not uncommon failure) you can go directly to Test 7a and do the TS part of the test.

Before you do anything else, open the hood, turn the key to ON, (but don't start the engine), and turn on the AC. Both fans should run at slow speed. If they do, you now already know a great deal: the fuses, voltage, fans, fan speed resistors, and the slow speed section of the fan relay (when activated by the AC) are good. You can skip Tests 1, 3, 4a, 4b, 5a, 6a, 6b and 8! In this event, your problem is the switch, some other aspect of the relay, or a wiring fault, the latter being the most problematic.

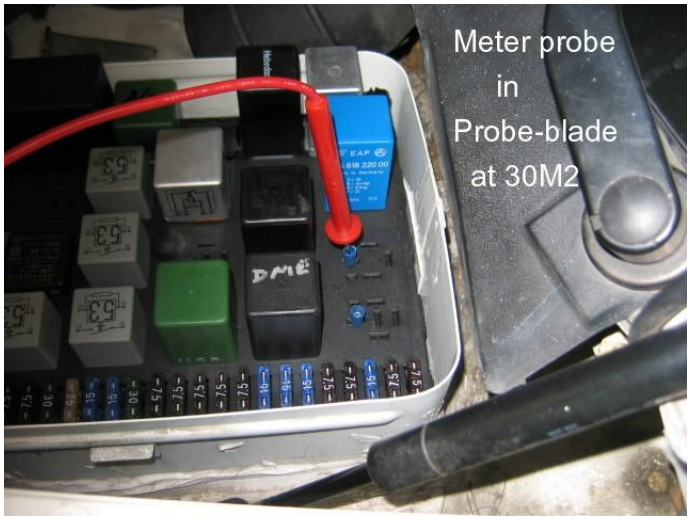
1) **Start with engine cool**, key OFF. Open the relay/fuse box and see if fuse numbers 10 and 15 (both 25A) are good. If not, and a cheap replacement also blows, there's a failed component or short somewhere, and these tests will narrow down where it might be.



2) **Remove the fan relay**, G10 (the big one), and look at its socket on the relay panel. It will look like this picture. Make a drawing of the socket and identify each connection blade hole on this drawing with its connector name as found on the socket, namely TF, M1, etc. These names are also on the bottom of the relay (but in mirror image). Or, simply use one of the tear-offs on the last page of this document.

3) If in Test 1, a replacement fuse also blew, try one of the cheap ones again now that the relay is removed. If one or both of these blow, there's a short to ground inside the fuse box, located somewhere between the inner (i.e., away from the outer edge of the fuse box) connector of Fuse 10 and/or Fuse 15 and the relay socket, that you will have to find before going further. If you are going to open up the fuse box, be sure you have plenty of time and patience on hand.

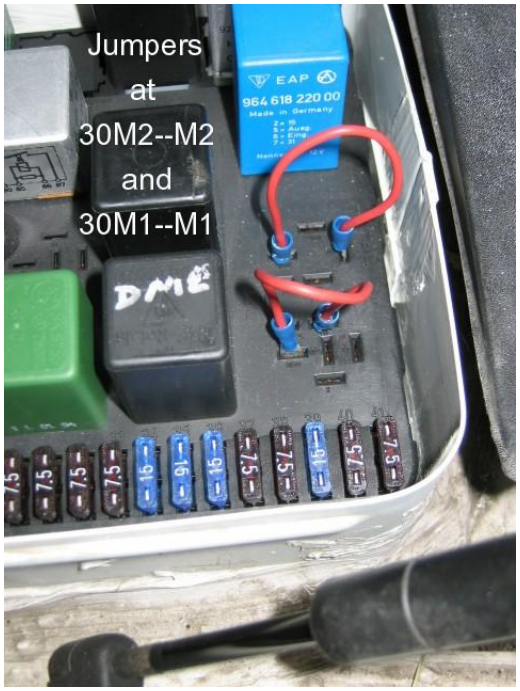
4a) **To check for battery voltage** (assuming neither fuse blew and both are still in place), stick one probe-blade (not a jumper!) in 30M1 and the other in 30M2. Hold the negative meter lead on the engine or a nearby body ground, and touch each probe-blade in turn with your positive meter probe and measure the voltage. Each should read battery voltage, about 12.5 volts. If so, continue to Test 5a. If not, there's an open fault (or corroded connection) somewhere in the wiring path from the battery to the fuse box, or from fuse to relay socket inside the fuse box.



4b) **To determine where these open faults might be**, remove the two fuses. Plug in the "defuse" (no need to press the fuse in all the way, just enough to make contact) and measure the voltage at the outer connector of Fuse 10 to ground. Then repeat for Fuse 15 to ground. If you have voltage, the path from battery to fuse box is good, and there's an open inside the fuse box between fuse and the relay socket. If no voltage, there's an open in the wiring from battery to fuse box. You will have to find the open before going further.

5a) **To check the fans and wiring paths**, stick one probe-blade (not a jumper!) in M1 and the other in M2. Be sure both fuses are removed. Measure the resistance from each probe-blade to ground. Resistances should be quite low (about 0.4 ohm), but not zero. If not low, the fan motor has an open fault and needs to be replaced, or there's an open wire or connection in the path to the fan. If zero, there's a short to ground somewhere, and one of the fuses would be blowing. If you suspect a short, that problem needs to be resolved before going further. You would pull the connectors at the fans and repeat the foregoing test. If resistance is high, a fan is shorted; if low, there's a wiring short.

5b) **To check the fans directly**, we will power them through their fuses to battery voltage on the relay socket. Using the fuses should minimize any potential for arcing/burning the socket connectors. Be sure both fuses are removed. Put one end of one jumper in 30M1 and its other end in M1. Similarly, put one end of the other jumper in 30M2 and its other end in M2. Replace one of the fuses and one fan should run at high speed; remove that fuse. Repeat with the other fuse. If one or both don't run, there's an open wiring fault in the path or a bad fan; if one or both fuses blow, there's a short. In either case, it should have shown up in Test 5a (so I may have missed something there), but this (Test 5b) is the definitive test.



6a) **To check the fan-speed resistors**, stick one probe-blade in V1 and the other M1. Be sure both fuses are removed. Measure the resistance from V1 to M1. Repeat for V2 and M2. These resistances should be low (about 0.6-0.8 ohm), but not zero. If zero, the fans will run at high speed when they should be slow. If too much resistance, or open, the fans won't run at all when they should be running slow (this could also be due to wire corrosion at the resistor connections). In either event, one or both of the resistors will need to be replaced (they are under the cowl cover), or there's an open wire or bad connection somewhere in this path.

6b) **To check the resistors directly**, put one end of a jumper in 30M1, and the other end in V1. Similarly, put one end of the other jumper in 30M2 and its other end in V2. Replace each fuse one at a time and each fan should run slow. If a fuse blows, there’s a short to ground somewhere in the path.

7a) **To check the temperature sensor switches** (both of which are housed in a single unit on the radiator, located beneath the hose at the top, driver's side), stick the narrow probe-blade in TS and a wide probe-blade in TF. In normal operation, with stock sensor, the TS switch closes at 92degC and the TF switch closes at 102degC. Measure the resistances from TS and then from TF to ground. Both should read infinite for a cool engine. If not, you need a new switch, or there's a fault path to ground somewhere.
To differentiate between a bad switch and a wiring short to ground, pull the connector at the radiator switch and measure the resistance from TS then TF to ground again. If now infinite, the switch is bad. If not, there’s a short.

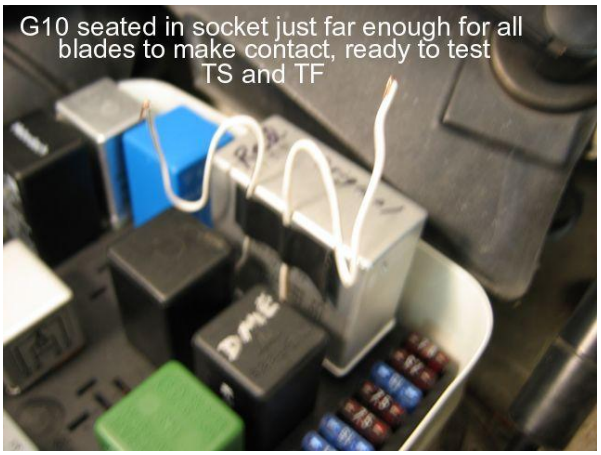
7b) **To continue the check of the sensor switches, the relay, and the fans,** make sure fuses 10 and 15 are still pulled, and there's a probe-blade still in TS and another in TF. Start the engine and let it idle as the temp builds. Important: this test assumes your temp. gauge functions properly. Be attentive as you don't want the engine to seriously overheat. Continuously measure the resistance from TS to ground. It should remain infinite and go to zero (when 92degC is reached). Periodically take a look at the temp gauge. If it goes into the red zone before the switch closes, you should shut off the engine and assume a new sensor switch is needed (this result could also be due to an open in the wiring somewhere, see below). If TS does close, continue at idle and now continuously monitor the resistance at TF. It should go to zero (when 102degC is reached). Again if the temp goes into the red, shut down and assume you need a new sensor switch, or there's an open in the wiring. If all went well though, don't waste any time and get right on to Test 7c.
To differentiate between a bad sensor switch and an open in the wiring, you would pull the connector at the switch and measure the resistance from TS to switch connector, then from TF to switch connector. Orient the connector with the locator tab up, facing the three slots. TS is the center slot, TF is the right slot, and the left slot is ground. If infinite, there's an open. If near zero, the switch is bad.

7c) **To continue the check of the relay,** assuming TS and TF have both closed, quickly shut off the engine, but return the key to RUN position, and plug in relay G10. Quickly replace one of the fuses, which should result in one fan going at high speed. Leave the fuse in place and quickly replace the other fuse which should start the other fan. Wait a bit and both fans should drop to slow speed. Quickly turn the key to OFF and the fans should continue to run at slow speed. Wait a bit more and both should stop. If this sequence is not obtained, you need a new relay.

8) **To test the fans for AC control,** turn the key to RUN and turn AC ON. Both fans should run slow (they will run fast only after the compressor kicks in).

9) The following test isn't necessary, but offers a quick way to check if the relay is responding properly to TS and TF. Cut two 4 inch lengths of that bell wire, strip each about 1/2 inch on one end and 1/8 inch on the other. Bend the shorter ends over onto the wire's insulation. Tightly wrap the longer ends onto the relay's TS and TF blades. Fold the wires up along the side of the relay can,

making sure no bare wire comes in contact with the metal can or another blade, and tape the wires onto the can. With the key OFF, engine cool, and fuses removed, plug the relay into its socket (no need to push it in all the way, just enough to insure contact) with the ends of the wires standing free, and replace the fuses. Ground the TS wire and the fans should run slow. Turn the key to RUN, and they should run fast when you ground the TF wire. If not, you need a new relay.



That's it!

If you got here because of a problem, and these diagnostics all checked out, you can begin to suspect the mechanical parts of the cooling system (thermostat, water pump, radiator or hose blockage, fill tank cap, air pocket). Also, you might be amazed at how much stuff can accumulate in the front radiator, and in the gap between the two radiators (and in the oil cooler too for that matter). An air gun extension shaped like an L, such that the short leg fits between the two radiators and the long leg reaches to the top, works well in blowing the stuff out (from back to front). And as many have found, whenever you install a new thermostat, it's a good idea to test it first.

Relay pin functions:

-- 30M1, 30M2 - fused battery power (aka Terminal 30)
-- M1, M2 - relay-switched power to fans 1 and 2
-- V1, V2 - relay-switched power to fans through low-speed resistors
-- TS, TF - slow and fast signal from radiator temp. switch to relay
-- X - battery/alt. power when Key-On (aka Term. X)
-- 31 - body ground (aka Term. 31)
-- AC - AC On signal to relay

Katalog #'s:

-- G10 Fan Relay	- 944-615-104-03	(same p/n as '87 and newer 944)
-- Radiator Switch	- 951-606-481-00	
-- Fan Speed Resistors	- 944-616-522-00	
-- Thermostat	- 944-106-019-00	(same as 944S2)

Miscellaneous information:

-- Stock radiator temp. switch closures are 92dC low-speed and 102dC high-speed, and the stock thermostat opens at 83dC and is fully open at 90dC.
   If you were to install a lower temp. thermostat, you'd want to install a correspondingly lower temp. radiator switch too.
-- The radiator switch(s) turn on both fans via the relay.
-- The AC turns both fans on low via the relay.
-- The AC turns both fans on high via the AC Pressure switch.
-- I know of no circumstance when only one of the two fans is supposed to run.
-- The thermostat's sensor faces the radiator (rather than the block), meaning the temperature of the coolant at the bottom of the radiator is what causes the thermostat to open.

Constructive feedback, comments, or questions are welcome.
John Hiltebeitel: john on 968 forums, jhiltebeitel@gmavt.net

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Porsche 968 Cooling System",
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A note on printing: the photos seem good when printed in color on an Inkjet or in b&w on a Laser, but appear a bit grainy in b&w on an Inkjet so use the highest print quality available.

968 G10 Relay socket representations

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Notes: 1) --, -, and | represent the blade holes in the socket
       2) the figure is oriented with M2 and V1 toward the firewall
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```
          TF
          --

30M2 --            | M2

   AC -   --
          31

          M1
   TS -   --

30M1 --     | V2   | V1

          --
           X
```

```
          TF
          --

30M2 --            | M2

   AC -   --
          31

          M1
   TS -   --

30M1 --     | V2   | V1

          --
           X
```

```
          TF
          --

30M2 --            | M2

   AC -   --
          31

          M1
   TS -   --

30M1 --     | V2   | V1

          --
           X
```

```
          TF
          --

30M2 --            | M2

   AC -   --
          31

          M1
   TS -   --

30M1 --     | V2   | V1

          --
           X
```