ThermoStasis Troubleshooting Rotax 912 Low Oil Temperatures

Troubleshooting low oil temperatures on the Rotax 912 family of engines should be approached in two phases: (1) troubleshooting the temperature instrumentation and (2) troubleshooting the engine installation. It is important that potential instrumentation issues are thoroughly addressed before beginning any engine work.

Troubleshooting Temperature Instrumentation

This troubleshooting process consists of identifying the components of your temperature instrumentation and verifying that they are compatible and correctly installed.

Identify the oil temperature sender: The oil pump temperature sender should be either Rotax P/N 965 530 or P/N 965 531. (Identical senders / different manufacturers). Both senders have a temperature range of 120-300°F (50-150°C) and can be identified by the number 150°C stamped on the hex portion of the sender body .

If the sender is used with an analog gauge – often a VDO gauge – the temperature range of the sender must match the temperature range of the gauge for the correct oil temperature to be indicated. This means that a 300°F/150°C sender (e.g. Rotax P/N 965 530) must be used with a gauge where the highest temperature marked on the gauge dial is 300°F/150°C.

If your oil temperature sender is NOT Rotax P/N 965 530 or P/N 965 531, it is important to determine whether your sender is a 300°F/150°C sender or a 250°F/120°C sender. Other possible installed senders include:
VDO P/N 323 057, a 300°F/150°C sender , identified by this number stamped on the body – 801/9/1
VDO P/N 323 095, a 250°F/120°C sender , identified by this number stamped on the body – 801/5/1

Confirm that the oil temperature sender and gauge are compatible: The table below shows the effect on indicated temperature when the sender and gauge are either correctly matched or mismatched.

Sender Part Number	Identifying Stamp	Sender Temperature Range	Gauge Temperature Range	Gauge Part Number (For Example)	Gauge Temperature Indication
Rotax 965 531	150°C	300°F/150°C	300°F/150°C	VDO 310 012	Correct
Rotax 965 531	150°C	300°F/150°C	250°F/120°C	VDO 310 039	**29°F/16°C LOW**
VDO 323 057	801/9/1	300°F/150°C	300°F/150°C	VDO 310 012	Correct
VDO 323 057	801/9/1	300°F/150°C	250°F/120°C	VDO 310 039	**29°F/16°C LOW**
VDO 323 095	801/5/1	250°F/120°C	300°F/150°C	VDO 310 012	**29°F/16°C HIGH**
VDO 323 095	801/5/1	250°F/120°C	250°F/120°C	VDO 310 039	Correct

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Confirm that the EIS is correctly programmed for your oil temperature sender: If your engine installation uses an EIS to display oil temperature, refer to the EIS operator's manual to confirm that the operating parameters are correctly set for your temperature sender.

Check your oil temperature instrumentation for installation problems: The Rotax oil temperature sender is a thermistor, a device whose resistance varies with temperature. Your oil temperature gauge or EIS is actually measuring resistance to aircraft ground through the oil temperature sender. The resistance of the oil temperature sender INCREASES as its temperature FALLS. This is an important point – any problems with your oil temperature instrumentation that increase resistance to aircraft ground through the sender will be read by your gauge or EIS as a lower oil temperature. Hence, the goal of troubleshooting your oil temperature instrumentation installation is to be sure there are no additional resistances introduced into the wiring from the gauge through the sender to aircraft ground.

Sender grounding: The oil temperature sender is grounded through the threads on the sender body to the oil pump. Rotax specifies that the oil temperature sender should be installed with Loctite 243 Blue Threadlocker at an installation torque of 7 Nm (62 in-lbs). Teflon tape, thread sealer or excessive quantities of threadlocker should NOT be used. If the continuity of the sender ground is in doubt, remove and reinstall the sender.

Sender connector: The wiring connection to the oil temperature sender is through a ¼" Faston-type connector. Any corrosion at the sender pin or on the Faston connector may allow a contact resistance to develop. It is good practice to safety wire the Faston connector to the pin on the oil temperature sender to ensure a solid contact between the sender and the connector.

Wire gauge: The linear resistance of copper wires varies with wire gauge. An 18 gauge stranded copper wire has a resistance of approximately .007 Ohm per foot while a 22 gauge stranded copper wire has a resistance of approximately .019 Ohm per foot – so 22 gauge wire has almost three times the resistance of 18 gauge wire. However, 10 feet of 22 gauge stranded copper wire has a total resistance of only 0.19 Ohm, insufficient to have any noticeable effect on indicated temperature.

Fatigue damage: It is possible for stranded copper wire to suffer internal breakage of the copper strands due to vibration-induced fatigue with no visible external damage to the wire insulation. If in any doubt, measure the resistance of your temperature sender wiring from the sender connector to the gauge connector. The resistance of this wire, connector to connector, should be less than 1 Ohm.

Oil temperature gauge connections: The wire connectors and connector crimps at the oil temperature gauge should be checked for mechanical and electrical integrity. When troubleshooting problematic oil temperature indications, if the oil temperature gauge has a ground connection that is shared with other instruments or devices, replace the shared ground with a separate connection to aircraft ground.

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Connector crimps: A poorly crimped connector can allow a contact resistance to develop at the crimped connection. All wire crimp connections should be made with aircraft-quality connectors and crimping tools.

Sender resistance tolerance: Rotax specifies the manufacturing tolerance on the resistance of the Rotax oil temperature sender as ±10% (Rotax 912 Installation Manual, Section 21.2, page 128). This means, for example, that at an oil temperature of 194°F/90°C, where the nominal resistance of the sender is about 84 Ohm, the sender may have a resistance between 76 Ohm and 92 Ohm (84 Ohm ±10%). This resistance range translates into an indicated temperature range of ±5°F/3°C. So at an actual oil temperature of 194°F/90°C the indicated oil temperature may be anywhere between 189°F/87°C and 199°F/93°C due to sender resistance error. Also, sender resistance error increases with temperature so that the possible indicated temperature range at an actual oil temperature of 240°F/116°C increases to ±7°F/4°C.

Troubleshooting The Engine Installation

The Rotax 912 uses a combination of liquid cooling (cylinder heads) , air cooling (cylinders) and engine oil cooling and has a well-deserved reputation as a cool-running engine. If indicated oil temperatures are not reaching the desired range after the oil temperature instrumentation troubleshooting process has been completed, the engine installation itself may be modified to achieve higher oil temperatures.

Engine oil thermostat: An appropriate engine oil thermostat such as ThermoStasis P/N P6-H-190 will reduce engine warm-up time and will raise the engine oil temperature in most phases of engine operation when installed in accordance with Rotax Service Letter SL-912-011. However, an engine oil thermostat may not by itself completely solve the problem of low engine oil temperatures if the specific engine installation is overcooled as a result of the installation of an oversize oil cooler, oversize coolant radiator, or both. The oil thermostat raises engine oil temperature by providing an alternate oil flow path through the oil thermostat center bypass when the oil is cold but the engine oil cooler is never completely isolated from the oil circuit. This means that the oil thermostat must be matched with an oil cooler and coolant radiator that are both sized appropriately for the specific engine installation, taking into account whether the engine is cowled and whether the oil cooler or coolant radiator are located inside or outside the cowling.

Engine oil cooler: Rotax offers two oil coolers for 912-series engines: (1) part number 886 033 (superseded 886 027), which is recommended for the 912 UL and has 142 sq. cm. (22 sq. in.) of cooling area and; (2) part number 886 034 (superseded 886 029), which is recommended for the 912 ULS and has 234 sq. cm. (36.3 sq. in.) of cooling area. Rotax's oil cooler recommendations for the 912 UL and 912 ULS ensure that adequate oil cooling capacity is available to each engine under worst-case operating conditions. In practice this means that some engine installations may be overcooled in normal operation. In particular, uncowled engines may benefit from the installation of an oil cooler that is smaller than the Rotax recommendation for that engine.

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Engine oil cooler (continued): The table below offers some observations on the effect of oil cooler sizing for different engine installations. Note that oil cooler performance for cowled engine installations will vary depending on the location of the oil cooler, airflow through the cowling and other factors.

	Engine Installation					
	Uncowled Engine e.g. Pusher OR Cooler Outside Cowling			Cowled Engine Cooler Inside Cowling		
	Oil Cooler / Cooling Area			Oil Cooler / Cooling Area		
	20708ERL*	886 033	886 034	20708ERL*	886 033	886 034
	9 sq. in.	22 sq. in.	36.3 sq. in.	9 sq. in.	22 sq. in.	36.3 sq. in.
Rotax 912 UL	Appropriate	Overcooled	Highly Overcooled	Undercooled	Appropriate	Overcooled
Rotax 912 ULS	Undercooled	Appropriate	Overcooled	Undercooled	Undercooled	Appropriate

* Earl's TEMP-A-CURE oil cooler part number 20708ERL

Engine coolant radiator: Rotax P/N 995-697 is the standard coolant radiator for Rotax 912-series engines. However, many Rotax 912 engine installations utilize alternative non-Rotax coolant radiators. It is important to recognize that heat rejection via the coolant circuit is several times greater than heat rejection via the oil circuit and that coolant temperature influences oil temperature. Low coolant temperature can be addressed by the installation of a coolant thermostat (not present on the standard 912 installation) or by installation of an appropriately sized coolant radiator.

Engine coolant: Evans NPG+ is a Propylene Glycol-based waterless coolant. Rotax recommends the installation of Evans NPG+ in Rotax 912-series engines – see Rotax SB-912-043 and SI-912-016. The primary reason for Rotax's recommendation is that Evans NPG+ has a higher boiling temperature than conventional 50/50 Ethylene Glycol/Water coolant and so prevents localized boiling of the coolant at cylinder head hot spots. The installation of Evans NPG+ offers an additional advantage for cool-running 912s as it typically raises the operating (cylinder head) temperature by as much as 18°F/10°C. [Evans NPG+ has a lower specific heat capacity than conventional 50/50 Ethylene Glycol/Water coolant (0.60 Btu/lb°F vs. 0.78 Btu/lb°F) and so a given volume of Evans NPG+ transfers less heat than conventional coolant on each pass through the cylinder head.] This increase in cylinder head temperature will raise the engine oil temperature by a small amount.

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