Volvo 1800ES

Engine oil and coolant temperature measurements

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Issue about oil temperature measurement

- Oil temp indication on gauge seems unrealistic, as needle deviates lately and does not use gauge full range
- Engine oil temperature sender has been checked and is conform to datasheet
- Oil temp gauge internal resistance in 58 Ω as expected
- Oil temp gauge to sender wiring resistance is 0 Ω
- Voltage regulator is sending 9,9 V to gauges (electronic version)

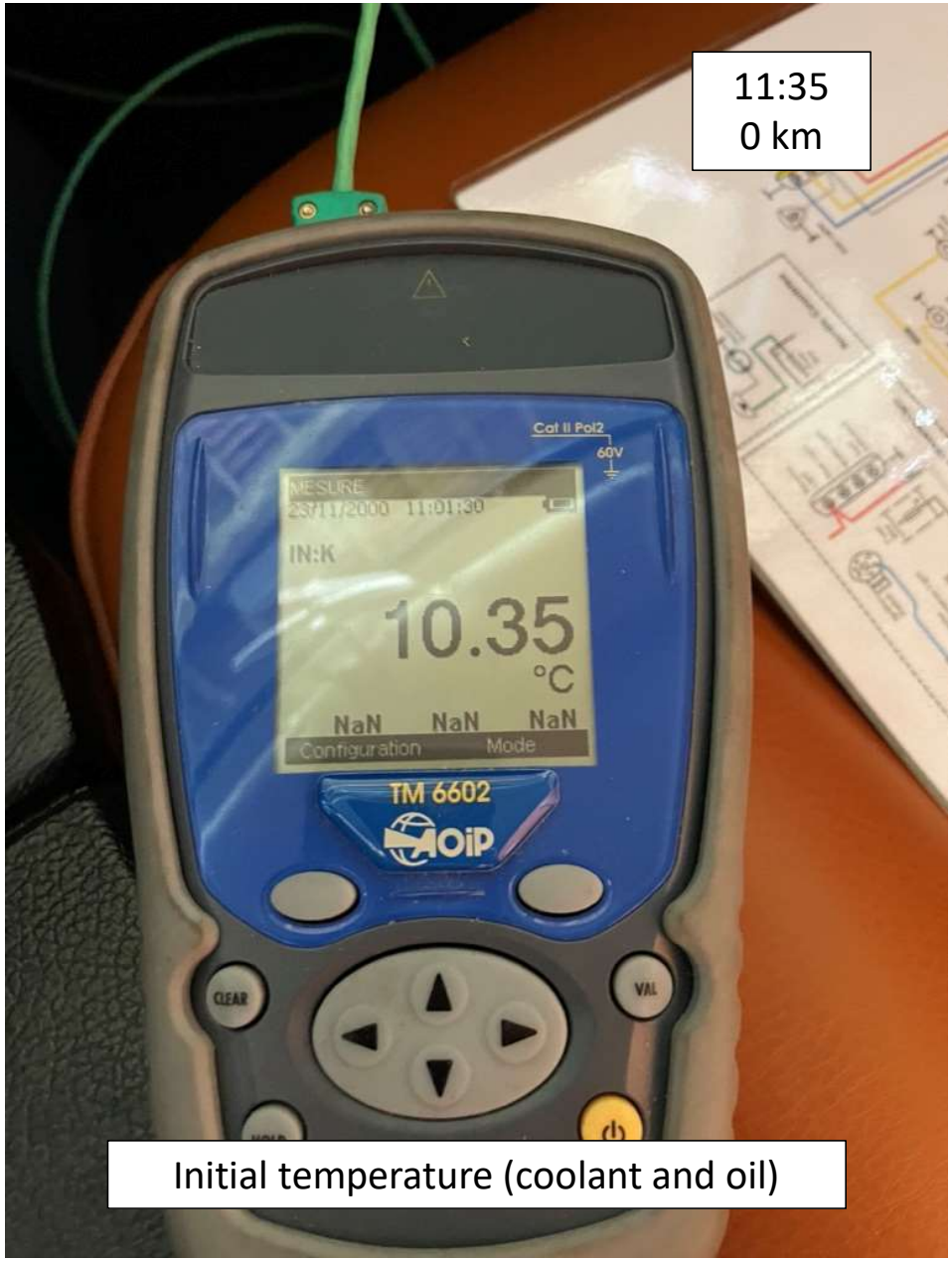
What is the true engine oil temperature as the oil temp gauge needle deviates ?
Only one way to know : measure oil temp in oil pan while driving and link real oil temp to needle position

Remarks :

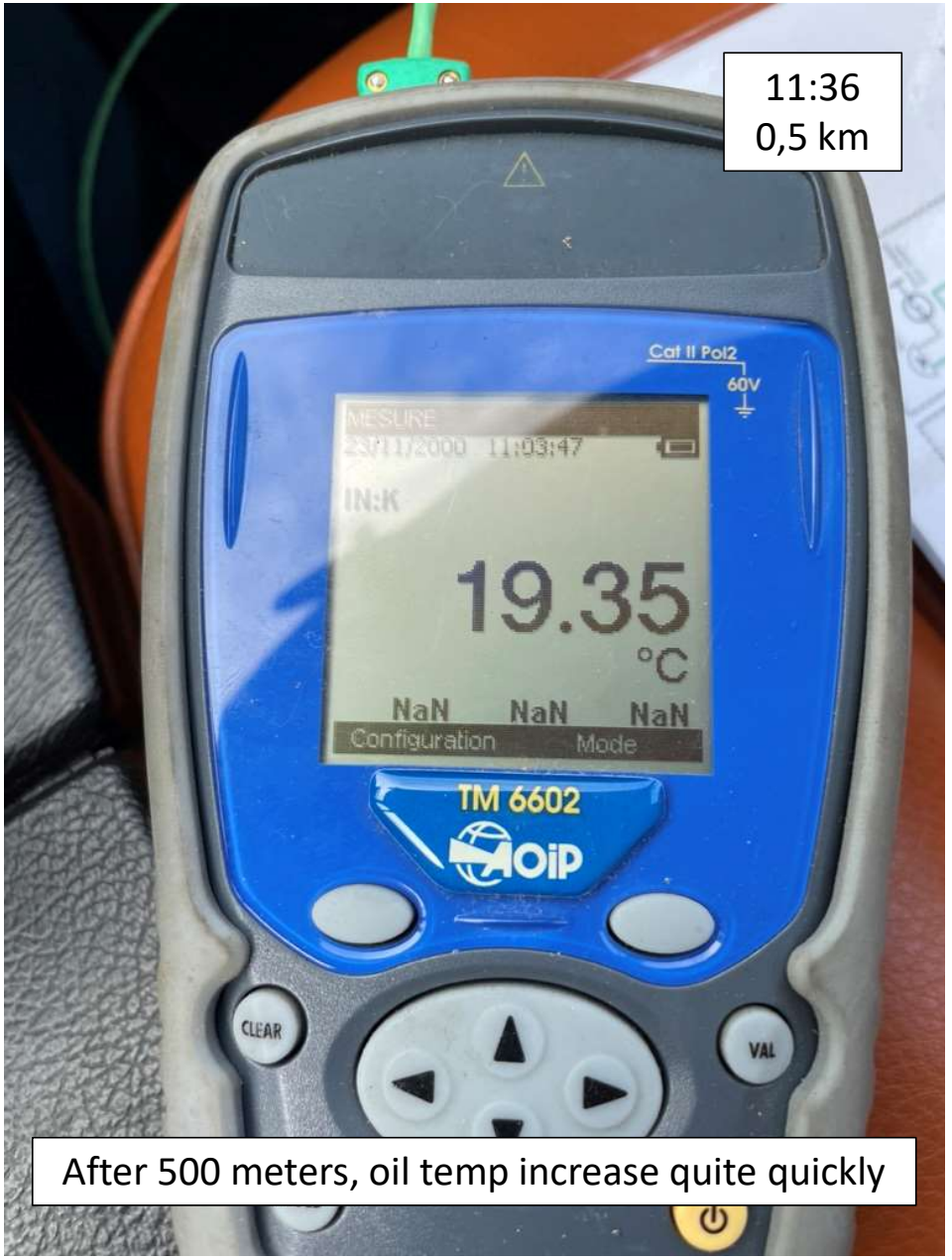
- oil temperature in oil pan is not the oil temperature in the oil gallery because of thermal exchanges between oil pan and exterior air
- This 1800ES has no oil cooler (removed by Volvo France during periodic workshop visits because of coolant leaks in oil)
- oil cooler is an oil heat exchanger (works both ways) : oil heats up during engine warm-up (coolant warms up quicker than oil) and coolant cools down oil after warm-up (coolant temperature is regulated below oil temperature)
- Without oil « cooler » some heat exchanges remain between oil and coolant through metallic engine parts with a lower efficiency

How to measure oil temperature in oil pan

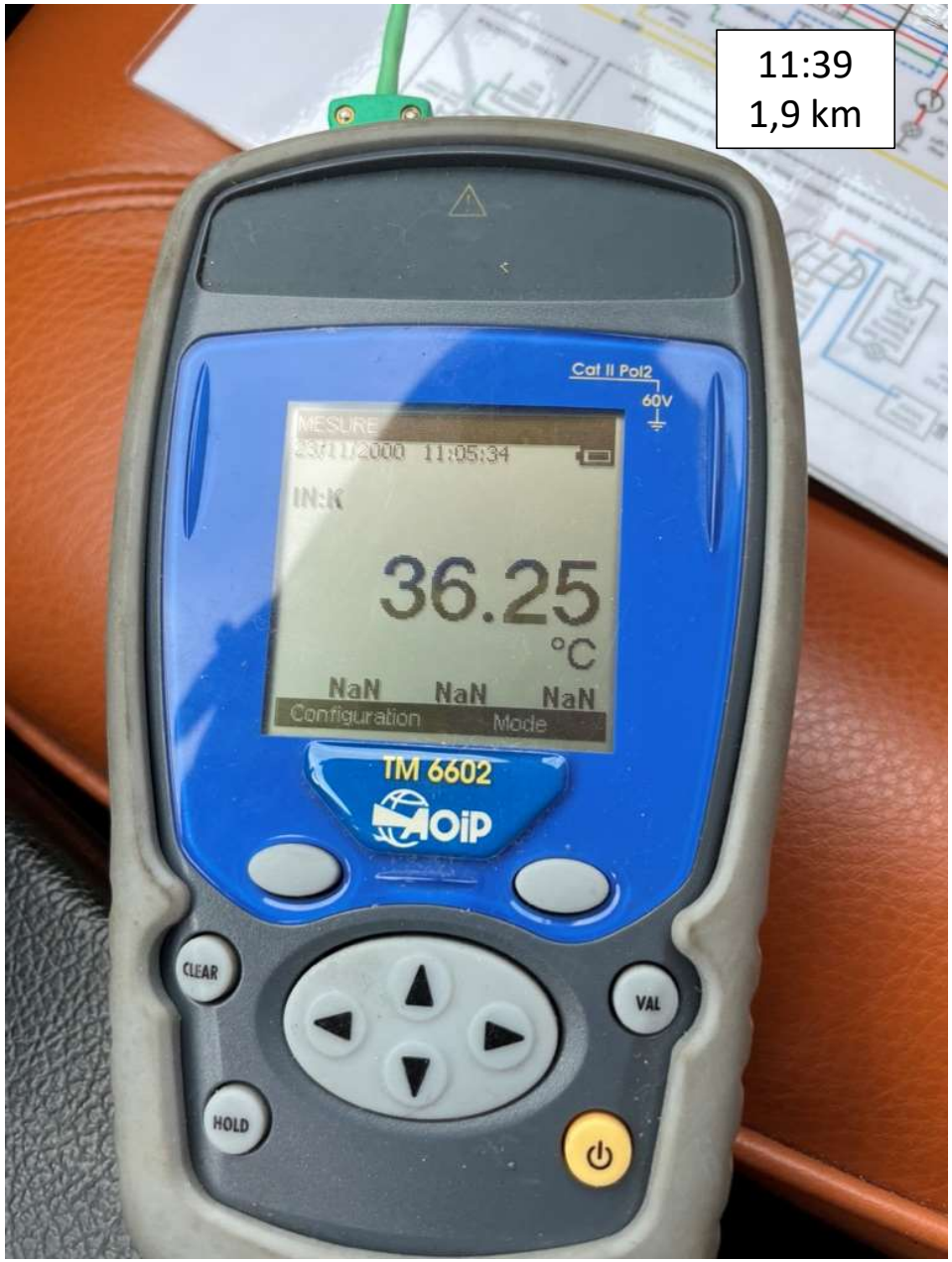
- Thermocouple epoxy-glued on a spare engine oil dipstick ; end of thermocouple positioned below MIN.
- Direct measurement of thermocouple with a specific device
- Oil level is around max to avoid measuring air temp in oil pan (oil level drops noticeably when engine runs)



Initial temperature (coolant and oil)



After 500 meters, oil temp increase quite quickly


11:39
1,9 km
Cat II Pol2
60V
MESURE
23/11/2000 11:05:34
IN:K
36.25
°C
NaN NaN NaN
Configuration Mode
TM 6602
CLEAR
VAL
HOLD

OIL TEMP
WATER TEMP
RPM
km/h
AMP
Oil temp gauge stays on C
Coolant temp around 75°C

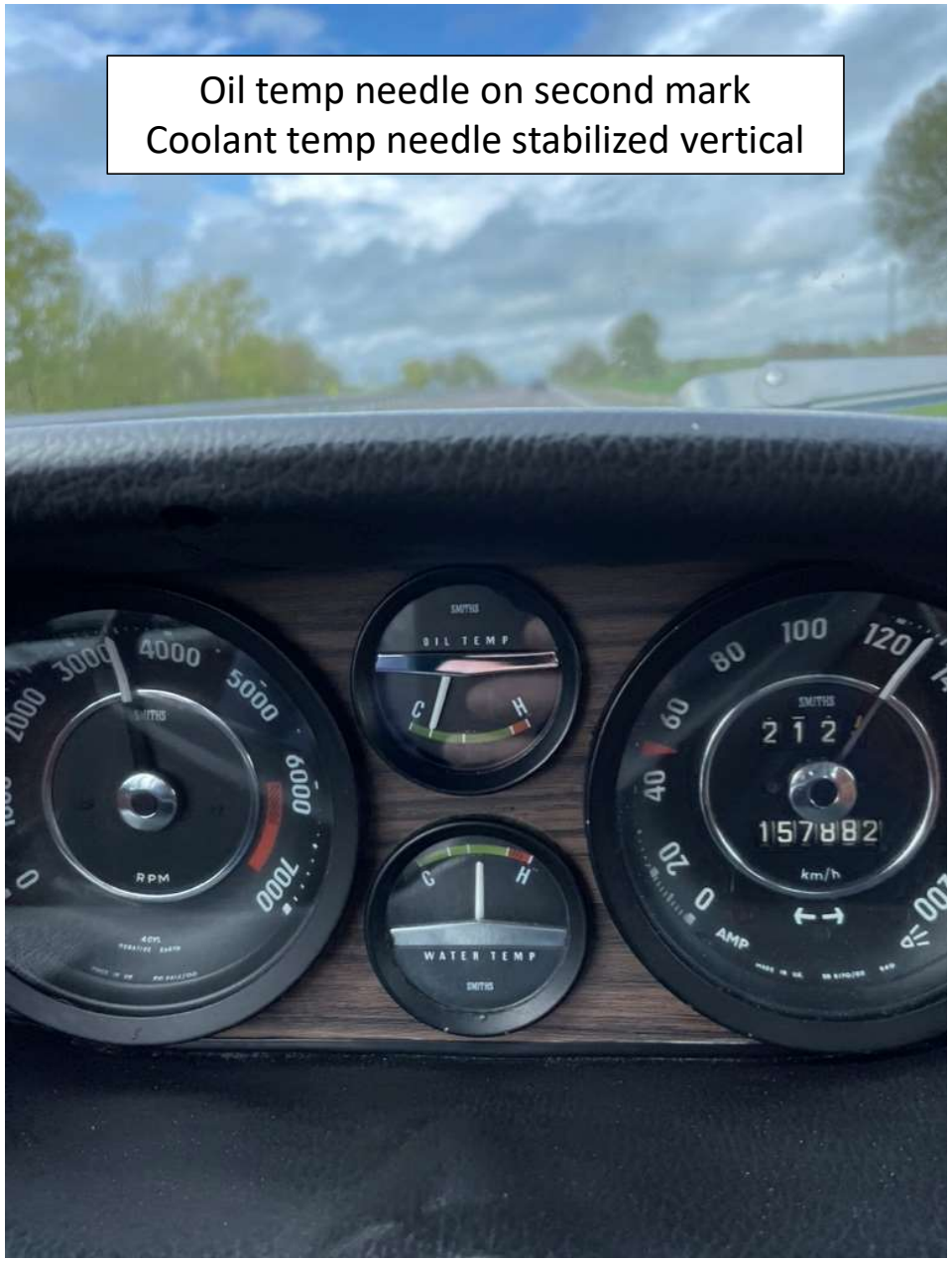
11:41
3,4 km
IN:K
48.65
°C
NaN
NaN
NaN
TM 6602
CLEAR
HOLD
VAL

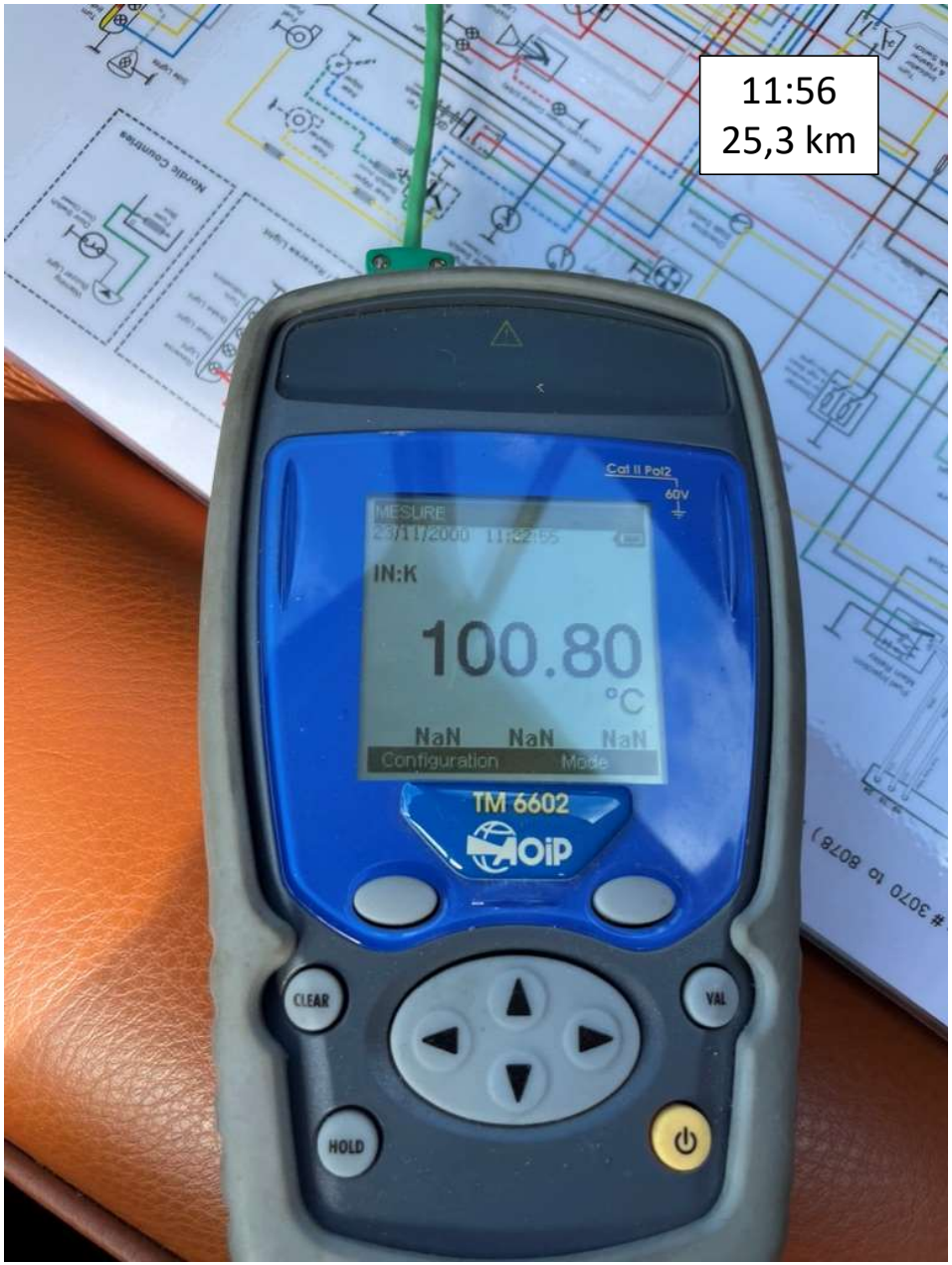
OIL TEMP
WATER TEMP
RPM
AMP
km/h
157863
Oil temp gauge stays on C
Just before coolant thermostat opening
(max deviation of coolant temp needle)

11:47
9,9 km
80.85
°C
NaN NaN NaN
Configuration
Mode
TM 6602
CLEAR
VAL
HOLD

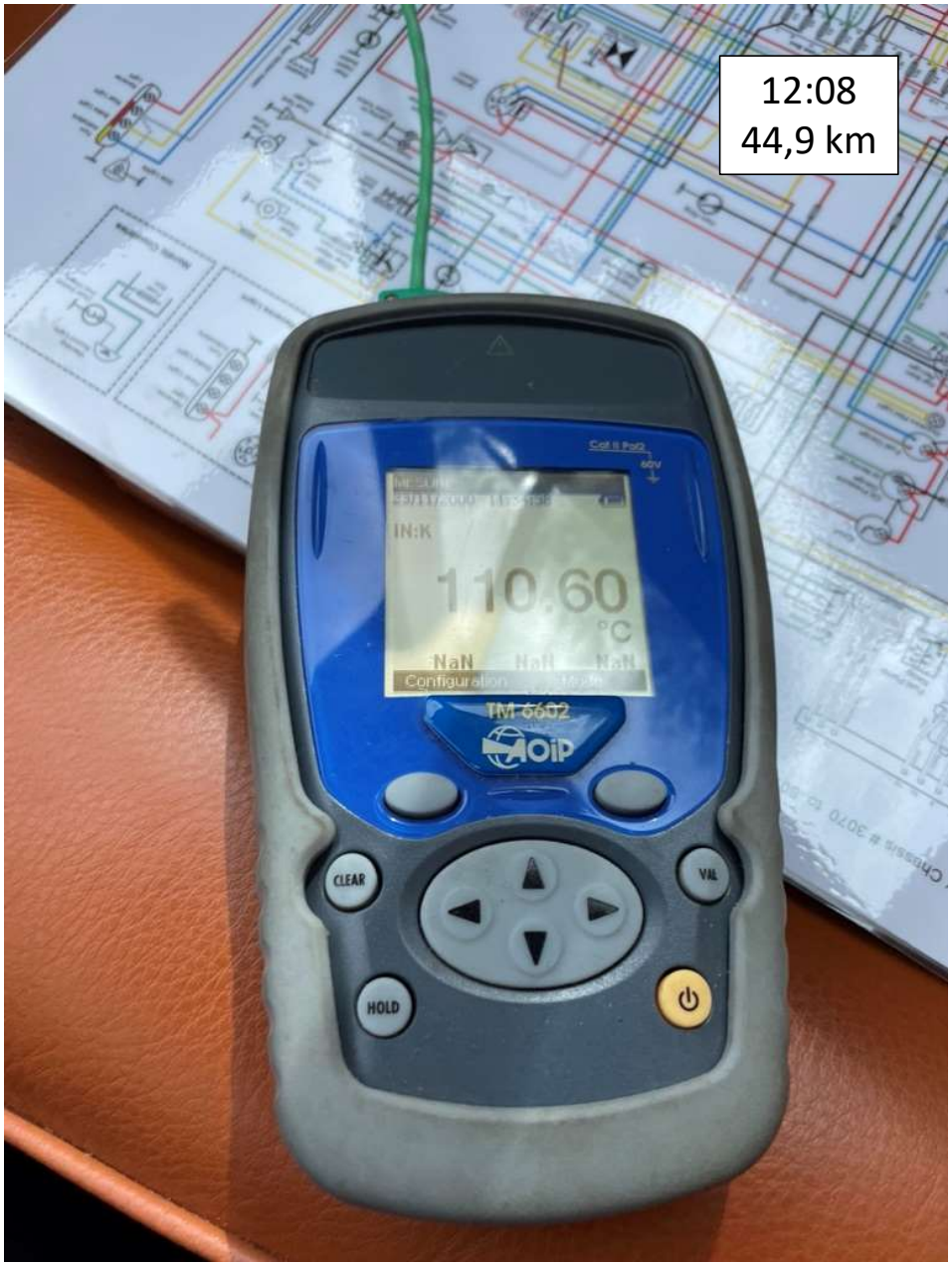
Oil temp gauge begins to deviate
Coolant temp needle goes back (coolant temperature regulation)
SMITHS
OIL TEMP
H

11:55
23,0 km
97.60
°C
NaN NaN NaN
Configuration
Mode
TM 6602
AOiP
CLEAR
VAL
HOLD


Oil temp needle on second mark
Coolant temp needle stabilized vertical
OIL TEMP
WATER TEMP
RPM
AMP
km/h
157882



High speed to increase oil temp as much as possible
Coolant temp is correctly regulated



110 °C on oil is the max value obtained

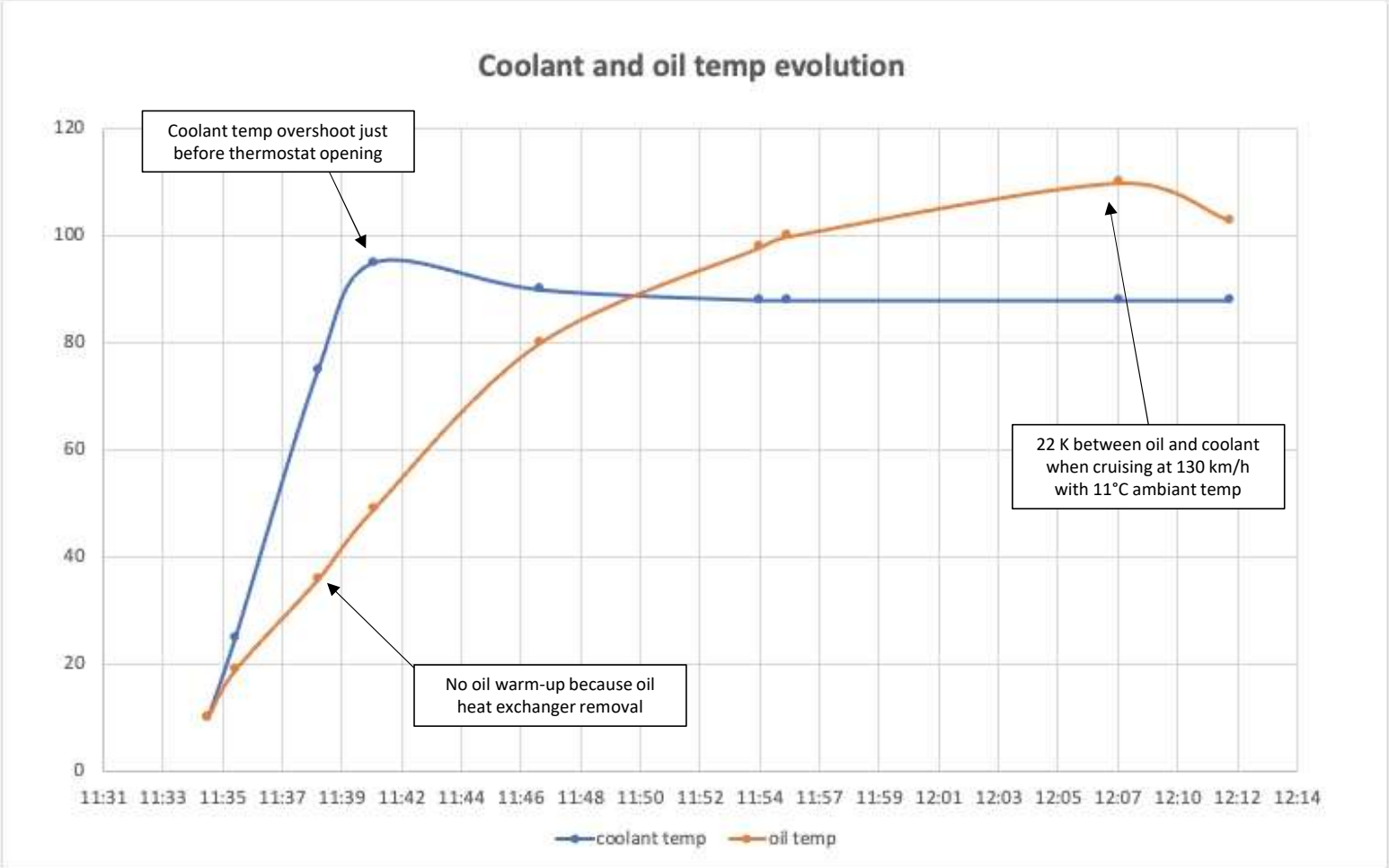
12:12
49,9 km
103.15
°C
NaN
TM 6602
CLEAR
HOLD

Lower speed -> oil temp lowers slightly
OIL TEMP
RPM
WATER TEMP
AMP
km/h
157909

Temperatures evolution

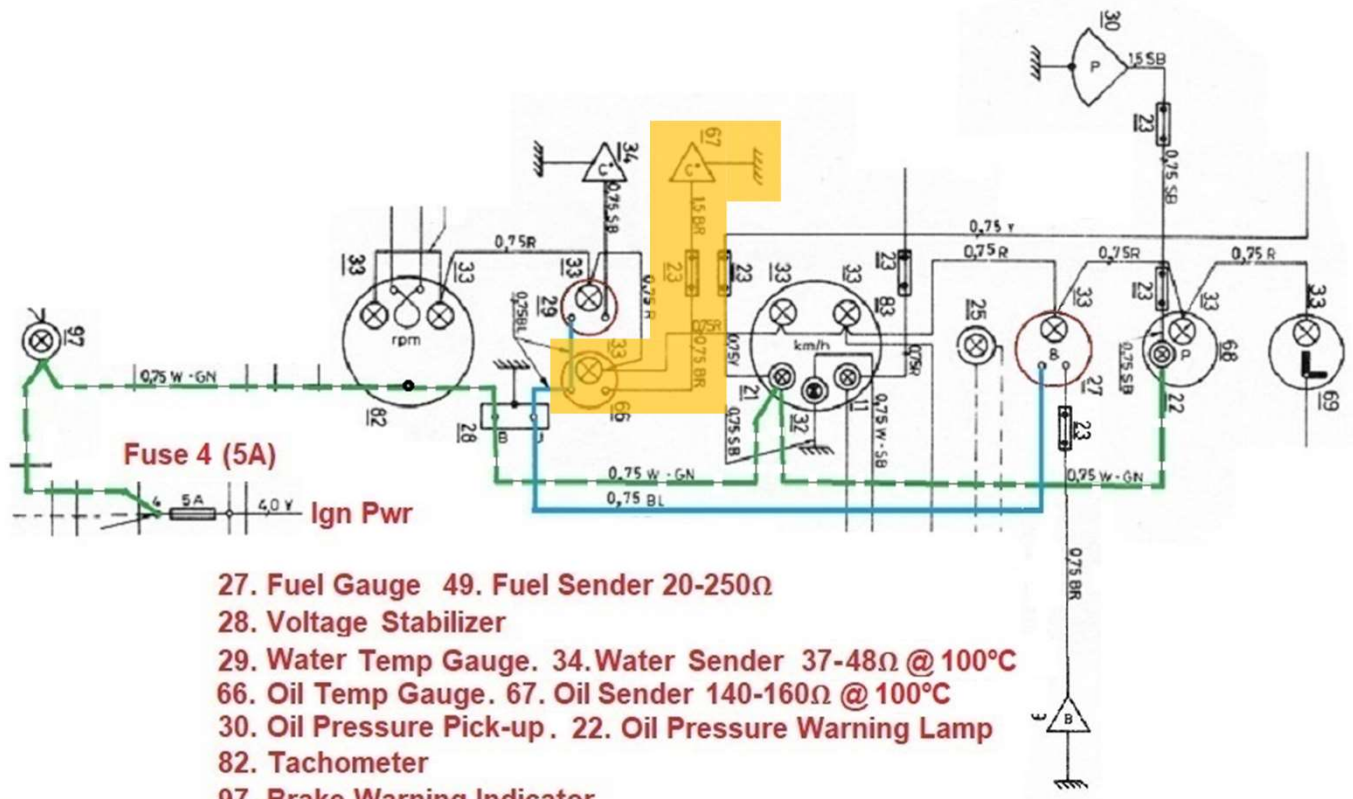
time	km	coolant temp	oil temp
11:35	0	10	10
11:36	0,5	25	19
11:39	1,9	75	36
11:41	3,4	95	49
11:47	9,9	90	80
11:55	23	88	98
11:56	25,3	88	100
12:08	44,9	88	110
12:12	49,9	88	103

Ambiant temperature 11°C

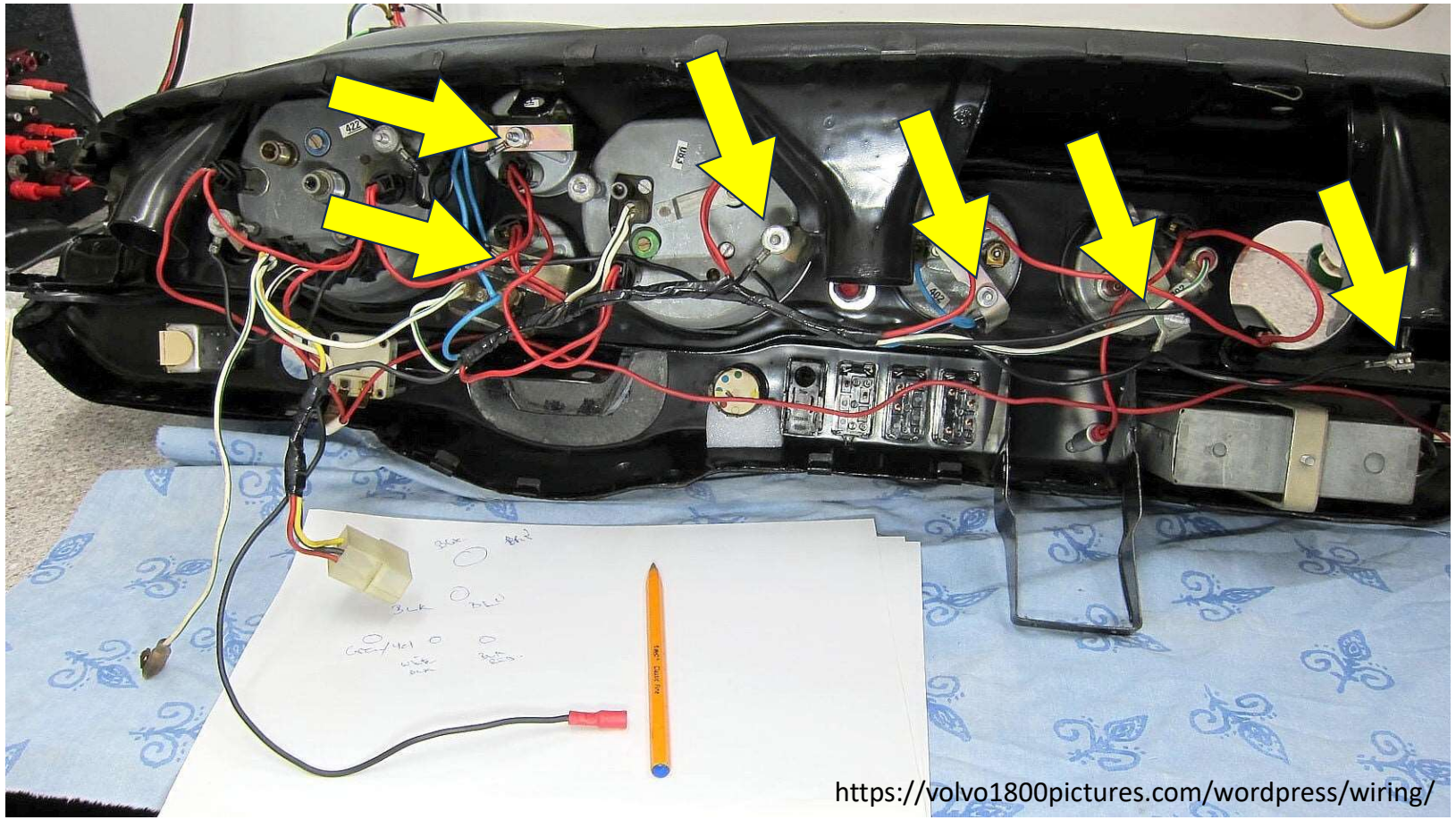


Electrical circuitry

- Oil temperature gauge, as coolant temp and fuel tank gauges, is feeded with 10 V regulated tension to ensure that needle deviation is not due to voltage variation but only by sensors values.
- Gauges grouding is very important for reliable indication. Volvo has mounted a black ground wire between all gauges. This daisy chain ground is not mentioned in the electric wiring scheme but is present on cars (see next slide).
- As voltage regulation and proper grounding are OK, only sensor value influences needle position



Electrical circuitry – ground wiring

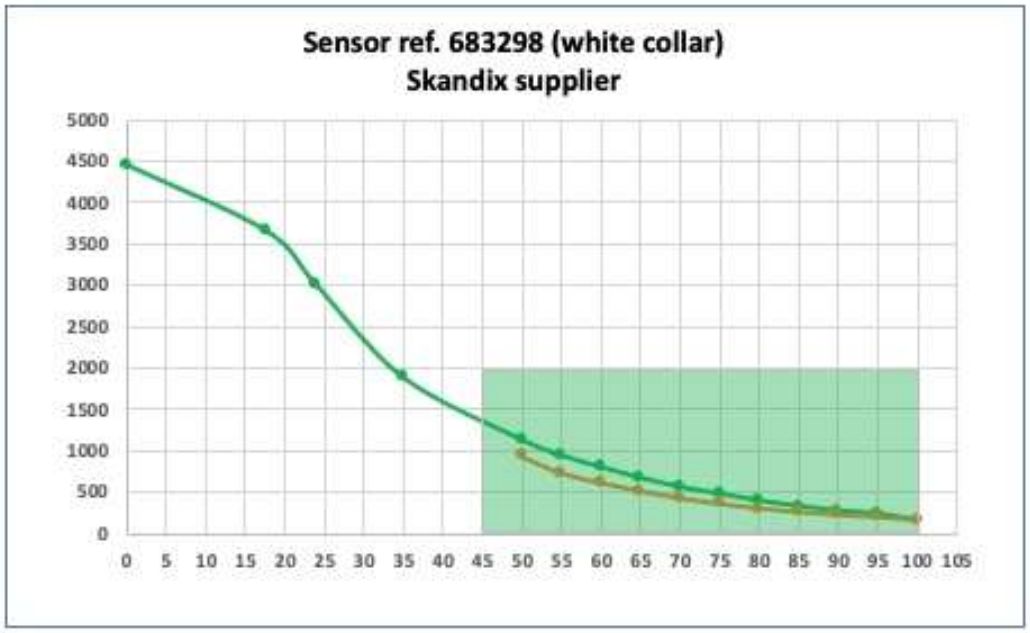


Oil temp sensor characteristic

Oil temp sensor measurement B970 34/17

(measurement done in water)

Oil temp [°C]	new sensor (2023) R [Ohm]	installed sensor (recent) R [Ohm]
0	4450	
17,7	3650	
24	3000	
35	1880	
50	1130	938
55	940	737
60	800	615
65	670	517
70	560	427
75	480	361
80	395	302
85	330	261
90	275	226
95	240	197
100	160	162

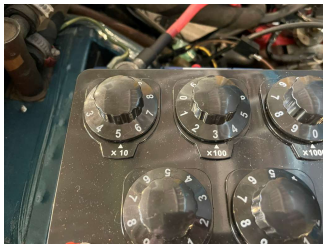


- Sensor characterization in boiling water, so limited to 100°C
- Volvo specs : 140 – 160 Ω @ 100°C

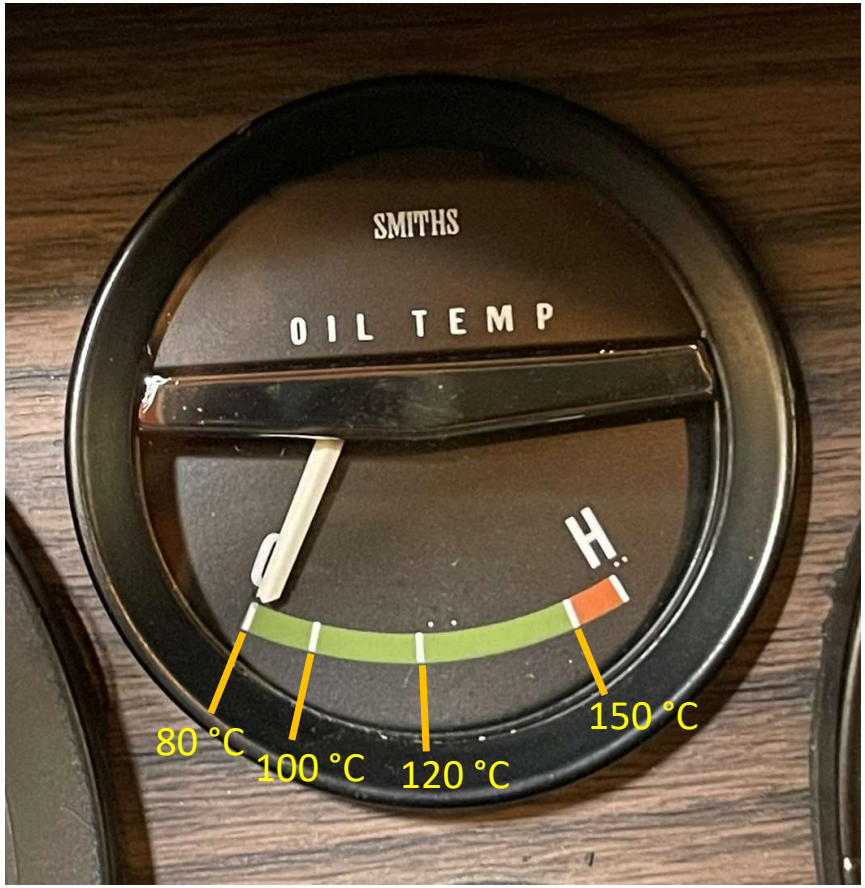
Needle position versus sensor resistance

- The oil temperature sensor is unplugged (connector near the firewall)
- A resistance box is plugged instead of sensor, in order to apply any resistance value on the car system
- Resistance values are applied to the car to match relevant needle positions for the driver information
- For each resistance value, needle position is pictured and according oil temperature is noted, either by measurement on car if reached, or from extrapolation of the sensor characteristic for above 100 deg temperatures

Needle position versus sensor resistance



Needle begins to deviate at 350 Ω	Needle reaches second white mark at 180 Ω	Needle reaches third white mark at 80 Ω	Needle near red zone at 40 Ω	Needle reaches red zone at 30 Ω
80 deg measured on car	100 deg measured on car	(not reached)	(not reached)	(not reached)
Corresponds to 84 deg on sensor characteristic	Corresponds to 98 deg on characteristic	120 deg on extrapolated characteristic	140 deg on extrapolated characteristic	148 deg on extrapolated characteristic

Conclusions

- Oil temp gauge deviates only when oil reaches 80°C
- Needle vertical position corresponds to 120°C oil temp
- Red zone is reached for around 150 deg oil temperature, which is a very high value, even for modern engine oils
- OEM validate engine and oil for 135°C, 140°C (long duration test), sometimes 145°C during short test ; my opinion is that level of engine oil temperature presents a high risk of failure on old engines like B20E
- Safe and reasonable area is on the left side of the gauge !
- Do not forget to check voltage stabilizer output (10V) at first !