... what can happen with a defective wastegate flap servo

... the TCU warning lights indicate a possible defect in the wastegate flap servo and what the consequences can be.

Let's start at the beginning

what the manuals say about the TCU indicator lights :

When switching on the voltage supply, the two lamps are automatically subject to a function test. Both lamps illuminate for 1 - 2 seconds, then they extinguish. If they do not, a check as per Maintenance Manual is necessary.

from MMH

Lamp output connections on the TCU

The TCU is furnished with output connections for an external „**red**“ boost lamp and an „**orange**“ caution lamp.

When the TCU is switched on, the two lamps are automatically subjected to a function test. Both lamps light up for 1 to 2 seconds and then go out.

Orange caution lamp:

All sensor inputs are monitored by the TCU via this caution lamp.

When the lamp goes out, this indicates that the TCU is ready for operation. A lamp which flashes continuously indicates a malfunction of the TCU or its periphery.

In the event of a malfunction, for instance if a circuit is interrupted, the TCU switches over to pre-programmed default values to ensure engine operation.

■ CAUTION : While the default values are effective, monitoring of the respective channel e.g. overspeeding, is not possible. The monitoring function is **inactive.**

Red boost lamp:

- Exceeding the admissible boost pressure will activate the red boost lamp, and it will light up continuously until boost pressure falls below the threshold.

  Threshold..... 1550 hPa (actual boost pressure)

- The TCU registers the time of full engine operation with boost pressure. Full throttle operation for longer than 5 minutes will cause the red warning lamp to flash.

■ CAUTION : The red boost lamp helps the pilot to avoid full power operation with too high boost pressure for longer than 5 minutes as otherwise the engine would be thermally overstressed.

◆ NOTE: The time observation starts at actual boost pressure of 1250 hPa. After 5 minutes the warning is issued via the boost lamp.

The warning is deactivated again as soon as the boost pressure falls below 1250 hPa. If the pressure limit is exceeded again, for example after 30 seconds, the boost lamp lights up again.

what does this have to do with the servo ?

The input says: **When the power supply is switched on, an automatic function check of the two lamps is carried out.**
What most pilots should also have noticed is that the servo performs a „check run“ from stop to stop. This is clearly audible when the ignition is switched on.

If there is a problem with the potentiometer in the servo, the orange light will flash.
If it is also determined that the current required by the servomotor to keep the wastegate closed is too high, the orange light will also flash.\

Now for a concrete example

I was asked by Gustav[1)] to have a look at his wastegate flap servo because he thought it was not working properly.

He described that the orange indicator light was flashing on his second-hand aircraft, which he had not yet flown after taking delivery, and that he did not want to operate the engine in this way, as stated in the user manual.

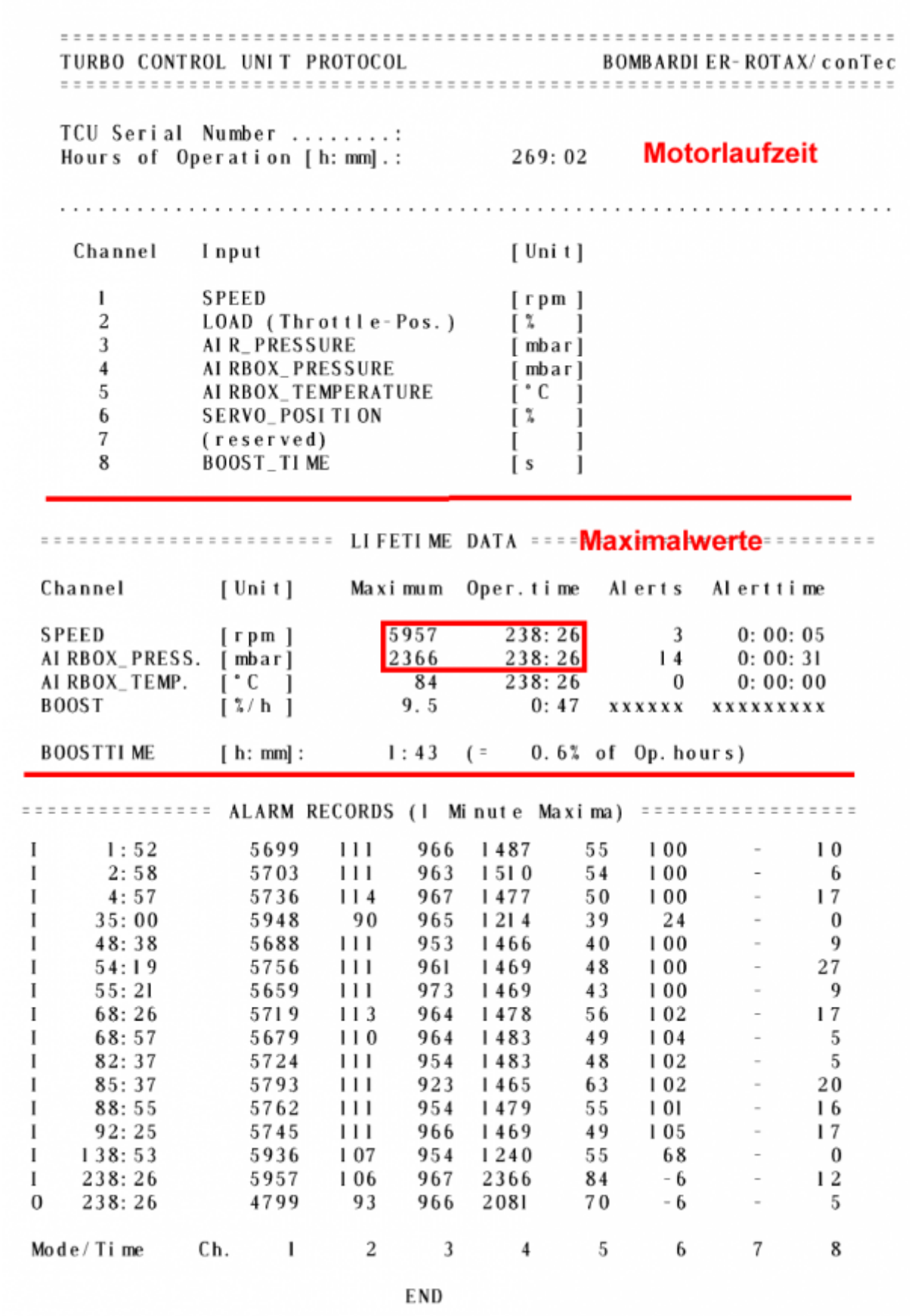
According to his information and the statement of the previous owner, he once had an aborted start because the engine „ran away“.
The previous owner then discovered a fault with the servo, dismantled it and „repaired“ it.

I was presented with the following picture:

- the wastegate flap cable was set correctly
- the orange light was flashing
- the servo did not perform a correct check drive

I had a servo with me for testing. We plugged it in and it worked perfectly.

Now I first read out the operating parameters from the TCU with the old DOS program and saved them as a PDF.
The result[2)] looked like this:



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================================================================================
TURBO CONTROL UNIT PROTOCOL                          BOMBARDIER-ROTAX/conTec
================================================================================

TCU Serial Number .........:
Hours of Operation [h:mm].:                269:02        Motorlaufzeit

................................................................................

 Channel    Input                          [Unit]

    1       SPEED                          [rpm ]
    2       LOAD (Throttle-Pos.)           [%   ]
    3       AIR_PRESSURE                   [mbar]
    4       AIRBOX_PRESSURE                [mbar]
    5       AIRBOX_TEMPERATURE             [°C  ]
    6       SERVO_POSITION                 [%   ]
    7       (reserved)                     [    ]
    8       BOOST_TIME                     [s   ]

========================= LIFETIME DATA ====Maximalwerte==========

Channel          [Unit]     Maximum  Oper.time  Alerts  Alerttime

SPEED            [rpm ]        5957     238:26       3    0:00:05
AIRBOX_PRESS.    [mbar]        2366     238:26      14    0:00:31
AIRBOX_TEMP.     [°C  ]          84     238:26       0    0:00:00
BOOST            [%/h ]         9.5       0:47  xxxxxx  xxxxxxxxx

BOOSTTIME        [h:mm]:       1:43   (=    0.6% of Op.hours)

================ ALARM RECORDS (1 Minute Maxima) ================

I      1:52        5699   111    966   1487    55   100    -    10
I      2:58        5703   111    963   1510    54   100    -     6
I      4:57        5736   114    967   1477    50   100    -    17
I     35:00        5948    90    965   1214    39    24    -     0
I     48:38        5688   111    953   1466    40   100    -     9
I     54:19        5756   111    961   1469    48   100    -    27
I     55:21        5659   111    973   1469    43   100    -     9
I     68:26        5719   113    964   1478    56   102    -    17
I     68:57        5679   110    964   1483    49   104    -     5
I     82:37        5724   111    954   1483    48   102    -     5
I     85:37        5793   111    923   1465    63   102    -    20
I     88:55        5762   111    954   1479    55   101    -    16
I     92:25        5745   111    966   1469    49   105    -    17
I    138:53        5936   107    954   1240    55    68    -     0
I    238:26        5957   106    967   2366    84    -6    -    12
0    238:26        4799    93    966   2081    70    -6    -     5

Mode/Time     Ch.    1      2      3      4      5      6      7      8

                                  END
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The data read out:

- The engine has an operating time of 269:02 h[3)]
- At 238:26 h we have an overspeed of 5957 rpm

- At 238:26 h we have an **overboost of 2366 mbar**

From this we can conclude the following:
The event occurred before 30:76 h\\. The wastegate flap was not open wide enough according to the specified parameters, so we had an overboost of 2366 mbar.
At the same time, either the slipping clutch slipped or the engine revved up to 5957 rpm due to the high power output.
The latter does not yet require any action - this speed does not bother the engine.

Overboost, on the other hand, is a cause for concern.
Experience has shown that a boost pressure of over 1800 mbar is dangerous for the interference fit of the crankshaft.

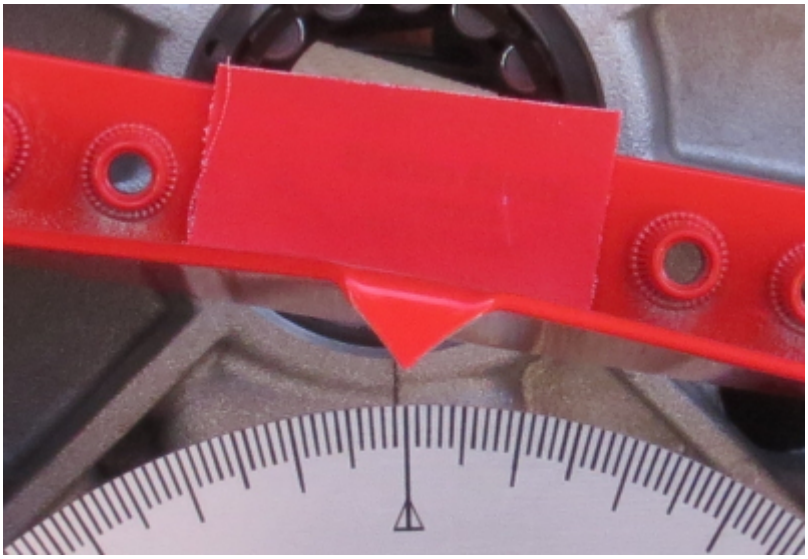
This can then twist or elongate.

If the crankshaft elongates, the crank webs in the area of the main bearings grind against the walls of the crankcase, causing the crankshaft to jam or become stiff.

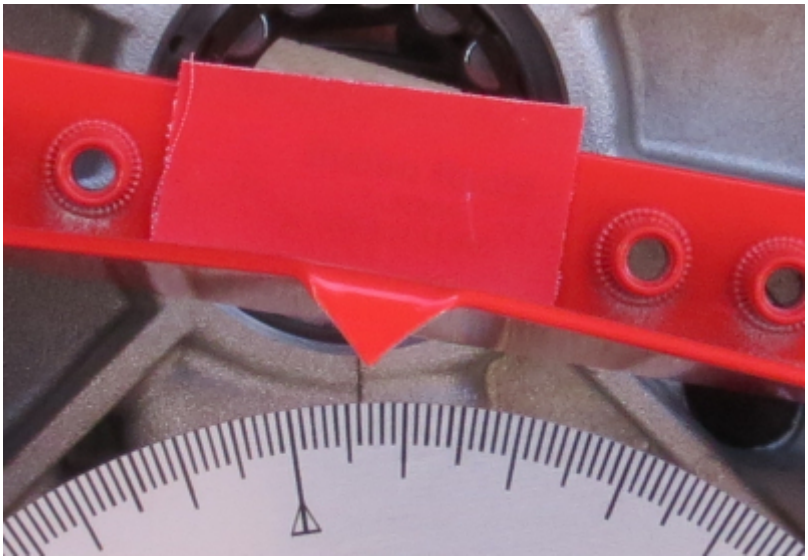
Checking the crankshaft

We now checked the rotation of the crankshaft n*accordingto Chapter 72-00-00 CRANKSHAFT DISTORTION INSPECTION of the Rotax Maintenance Manual Heavy 912/914 Edition 2 Revision 0, dated 28.10.2022,* and found the following:

Piston turned to the piston stopper at cylinder 1 and the degree disk set to 0°.



Turn the piston to the piston stopper at cylinder 2 and read the position on the degree disk.



Here you can clearly see that the crankshaft is rotated by approx. 6° between the two measured cylinders, in this case between cylinders 1 and 2. The measured value for cylinders 3 and 4 was also 6°.

This means that the crankshaft is only twisted between cylinders 1 and 2.
For cylinder 1, the piston is therefore advancing by 6°.

As you can imagine, there was a hard lump in Gustav's face - **the crankshaft needs to be replaced**.

... I may tell you later how the story continues

1)
name changed
2)
shortened and motor number removed
3)
hora = hours