

... 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 subjected 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.

Lamp output connections on the TCU

from MMH

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 Gustav¹⁾ 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 result²⁾ looked like this:

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

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

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

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

The data read out:

- The engine has an operating time of 269:02 h³⁾
- 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.

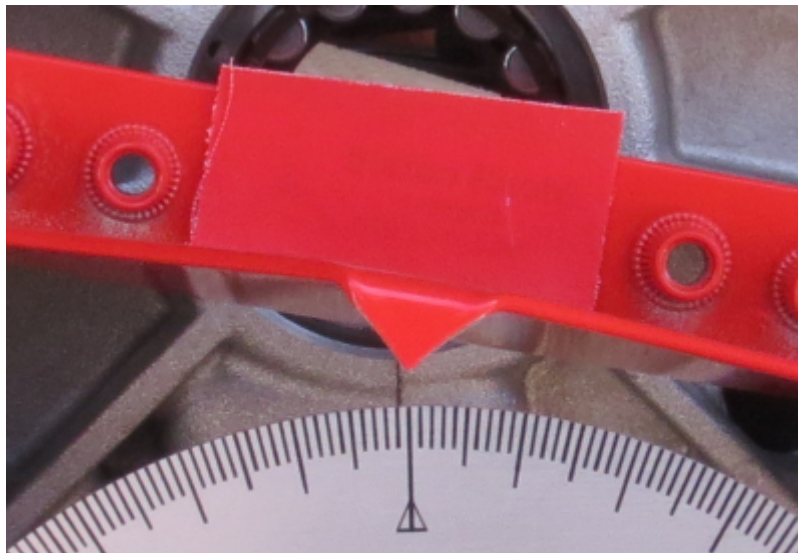
This can then twist or elongate.

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.

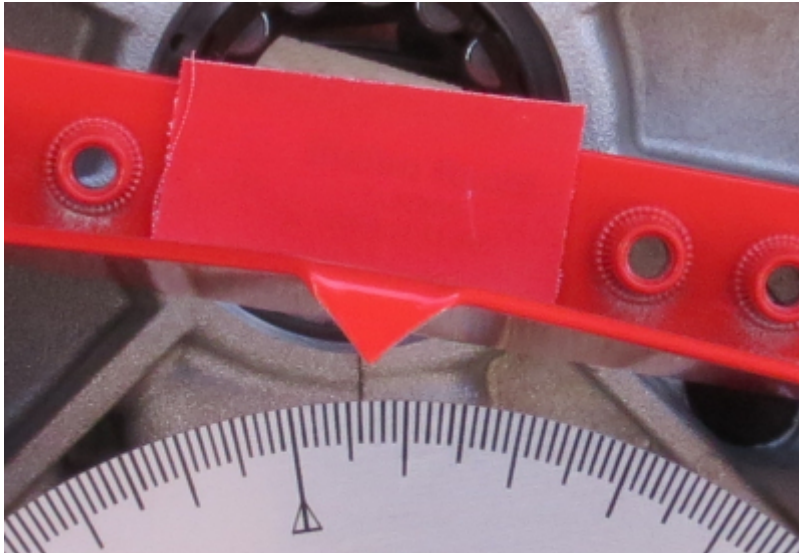
Checking the crankshaft

We now checked the rotation of the crankshaft according to *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

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