

## Pitch channel operating principle

### SFIM 85T31 Automatic Pilot

#### A. Synchronisation

##### *Figure 1*

Synchronisation takes place when the pitch channel is not engaged:

- the relay "K1" isolates the pitch series actuator "705C3" of the A.P. channel (switch "Q1"),
- switch "Q2" shuts off + 28 Vdc power supply to the same actuator.

The input comparator "C1" connected to the vertical gyro "57F" and "93F" by transformer delivers an error voltage "E1" which is demodulated, filtered then applied to the two lanes:

- the position lane which delivers a voltage "E2" proportional to the attitude deviation,
- the airspeed lane which delivers a voltage "E3" proportional to the attitude variation speed.

These two voltages are added and filtered before being applied to the adaptation circuit of the power amplifier.

The synchroniser taking the position lane supplies a voltage "E4". This voltage is added to voltage "E1" at input of the position lane. As these two voltages have opposing signs, the output voltage of the control lane tends to cancel itself out.

When the pitch channel is not engaged, the altitude and airspeed function cannot be engaged. In synchronisation function, the pitch channel is therefore only influenced by attitude variations from the vertical gyro "57F" and "93F".

#### B. Automatic stabilisation

This function is engaged as soon as the pitch channel is engaged:

- the relay "K1" is in working position and establishes the junction between the A.P. lane and the pitch series actuator "705C3" (switch "Q1"),
- switch "Q2" is closed and powers the pitch actuator with + 28 Vdc.

The pilot does not exert any limited authority pitch ("TRIM REL", "BEEP + stick", etc...) therefore contact "Q1" isolates input of the synchroniser. Consequently the latter is blocked and saves the attitude reference acquired upon channel engagement.

For any deviation of the pitch angle with respect to the reference, the demodulation circuit of the pitch channel connected to the vertical gyro "57F" and "93F" delivers an error voltage which is applied :

- on the position lane then on the actuator power amplifier,
- on the switching and comparison logic of the pitch trim control board.

The pitch actuator “705C3” acts on the control linkage downstream so as to counter the pitch angle deviation.

If the amplitude of the error voltage signal becomes greater than the set threshold, the pitch actuator “705C3 is activated based on the sign control logic.

In both cases, as the action on the flying control is proportional to the control voltage, the helicopter returns to its reference attitude:

- the error voltage at output of the synchroniser tends to be cancelled.

The pitch diverted voltage from the sum of speed lane voltage added to the position lane voltage ensures dynamic stabilisation of the helicopter flight.

## C. Operation in altitude or airspeed modes

When the pitch channel is engaged, the pilot has the possibility to set the helicopter:

- stabilisation of the pressure altitude by engagement of the “ALT” function,
- stabilisation of the airspeed by engagement of the “A/S” function.

Whenever the pilot engages one of the two functions, the amplification module of the position lane, amplifies the error voltage (E5) from the air data module (BARAN) “709C”.

After a delay with respect to the engagement of the function:

- the input of the integrator is isolated and the latter saves the airspeed or altitude reference,
- any variation in altitude or airspeed with respect to the saved reference is transmitted to input “C1” of the position lane. Operation of the pitch channel and the air data channel is therefore identical to that described in the previous paragraph concerning stabilisation.

The movement of the pitch actuator “705C3” is in this case proportional to the voltage resulting from the pitch altitude variation and airspeed or altitude variation.

## D. Control through artificial loads

Control through trim loads is carried out when the pitch channel is engaged and the pilot wants to impose manoeuvres on the helicopter and then return to the initial configuration:

- to this end, the pilot activates the cyclic stick in pitch.

In this flight configuration, the synchroniser is isolated with respect to the position lane. As the “BEEP + stick” and “TRIM REL” controls are not activated, and the synchroniser save the initial pitch reference. The action of the stick adjusts the control linkage and thus helicopter flight.

Helicopter stability during the manoeuvre is ensured by voltage “E3” by pitch deviation (diverted lane) added to voltage “E2” to pitch deviation (direct lane).

When the pilot releases the stick, it is returned to its initial position by the preloaded trim spring and the helicopter returns to its initial flight configuration.

## E. Stick TRIM release function

As the pitch channel is in stabilisation function, the pilot has the “TRIM REL” push button located on the cyclic grip to quickly modify the cyclic stick anchoring point and the attitude reference. Triggering this push button controls release of the trim loads of the trim actuators (“706C2”).

During this action:

- the pitch channel is engaged. The control actuator is controlled and re-centred by the A.P. lane (relay “K1” is in working position),
- slow synchronisation of the memory: the pilot moves the anchoring point of the stick then modifies the attitude reference.

At the same time, the control linkage slaved to the stick movement controls helicopter manoeuvre.

Helicopter stability is ensured by the attitude variation speed voltages (diverted lane).

When the pilot releases the push buttons, the trim actuators are engaged, the trim loads reappear. The pitch channel stabilises the helicopter flight around the reference imposed by the new cyclic stick anchoring point position.

The pilot also has the possibility to disengage the trim loads by the “EFF” push button located on the control panel. The push button in the pressed position allows the artificial loads to be kept disengaged. Operation is the same as activating the intermittent push button of the cyclic stick.

## F. **Manual trim function (BEEP-TRIM)**

As the pitch channel is engaged, the pilot can impose pitch manoeuvres to the helicopter by action on the four-way selector.

Adjusting this selector powers the pitch trim actuator depending on the pressure direction (forward or backward) which slowly modifies the pitch angle reference.

During this action:

- the contact “Q3” is placed in rest position by the TRIM logic (synchronisation of the pitch channel),
- synchronisation of the pitch channel inhibits the automatic pitch trim function,
- inhibition of the TRIM alarm by the combining logic controlled by the TRIM logic,
- the control actuator A.P. is not cut-off from the A.P. channel the relay “K1” is in work position,
- the control linkage slaved to movement of the trim actuator controls stick movement and helicopter manoeuvre.

When the pilot releases the four-way selector, the pitch channel is stabilised (Contact “Q3” opens) and stabilises helicopter flight on the new imposed references.

## G. **BEEP-TRIM plus stick function**

As the pitch channel is in stabilisation function, the pilot may impose pitch manoeuvres to the helicopter. A simultaneous action of the trim loads on the cyclic stick and the four-way selector is required.

During this action:

- the contact "Q3" is placed in rest position by the TRIM logic (synchronisation of the pitch channel),
- synchronisation of the pitch channel inhibits the automatic pitch trim function.

The TRIM alarm is inhibited by the combined logic controlled by the TRIM logic and the micro-switch of trim actuator opens.

The control actuator "705C3" is not cut off by the A.P. channel (relay "K1" is in work position).

The action exerted by the pilot on the stick results in movement of its anchoring point, therefore in modification of the pitch attitude reference.

The control linkage slaved to lever movement, controls helicopter manoeuvre.

Adjusting the four-way selector controls movement of the trim actuator depending on the pressure direction which brings the actuator neutral towards the new anchoring point.

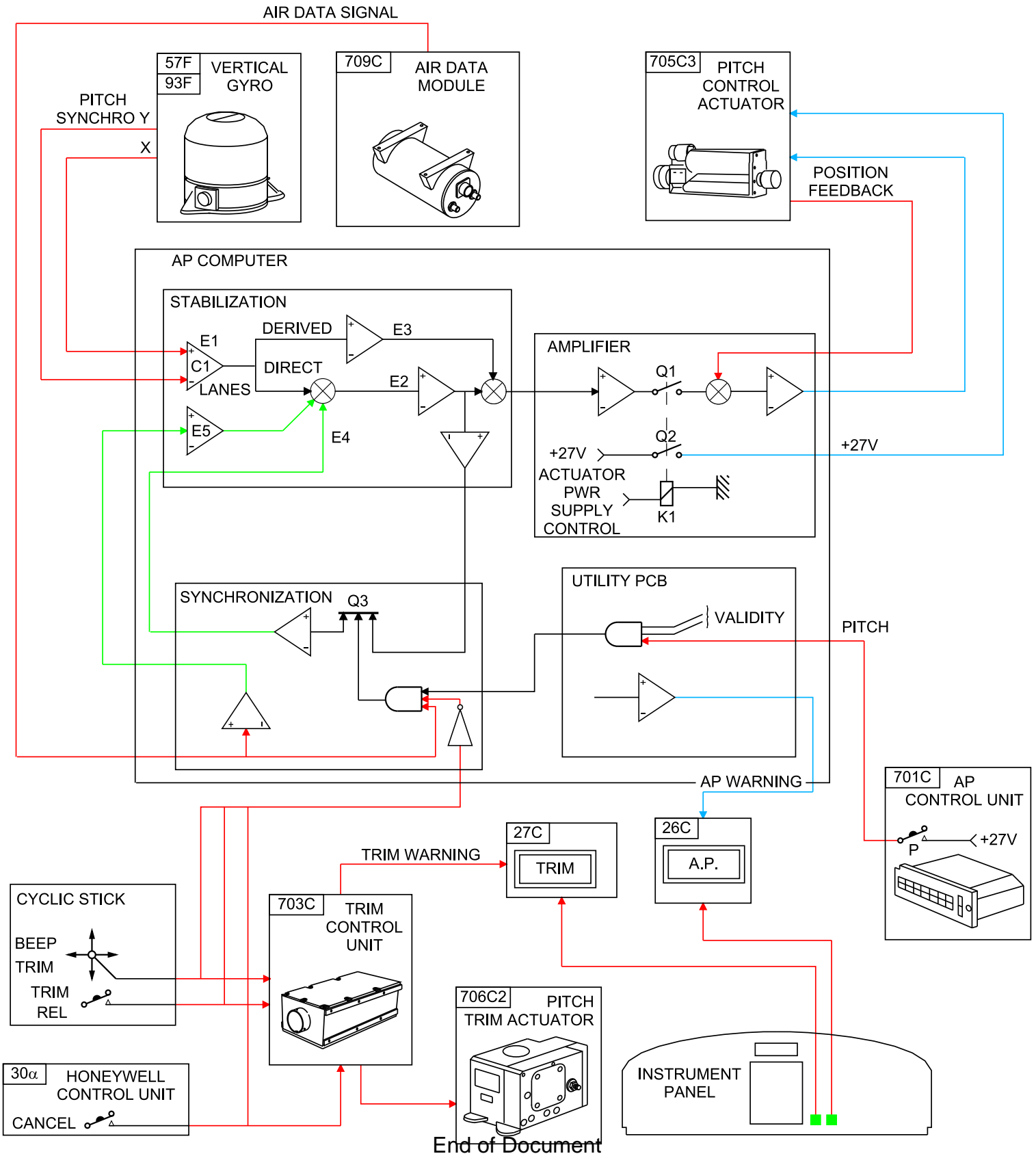
During manoeuvre, helicopter stability is ensured by voltage "E3" delivered by the direct lane.

When the pilot releases his load on the stick, and the "BEEP - TRIM" button, the pitch channel is stabilised, the helicopter flight is stabilised, pitch reference is imposed by the new position of the stick anchoring point.

## H. **A.P. re-centring function (TAC)**

Activating the "TAC" push button on the control panel recentres the pitch trim actuator.

**Figure 1: SFIM 85T31 Automatic Pilot - Pitch channel operating principle**



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