

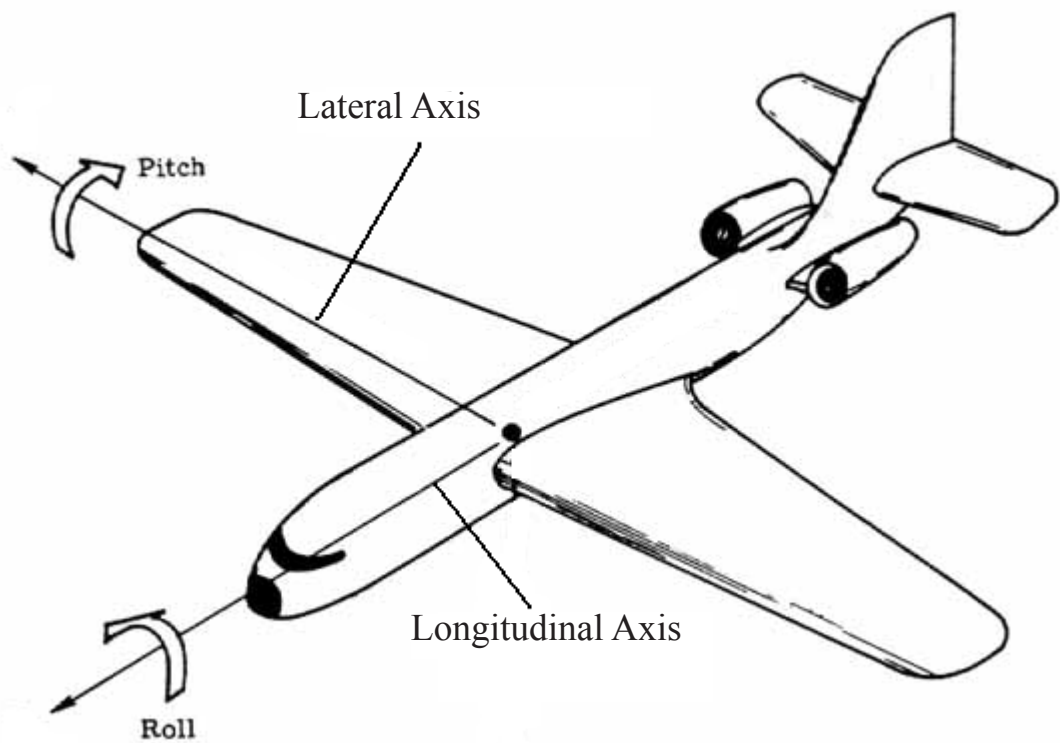
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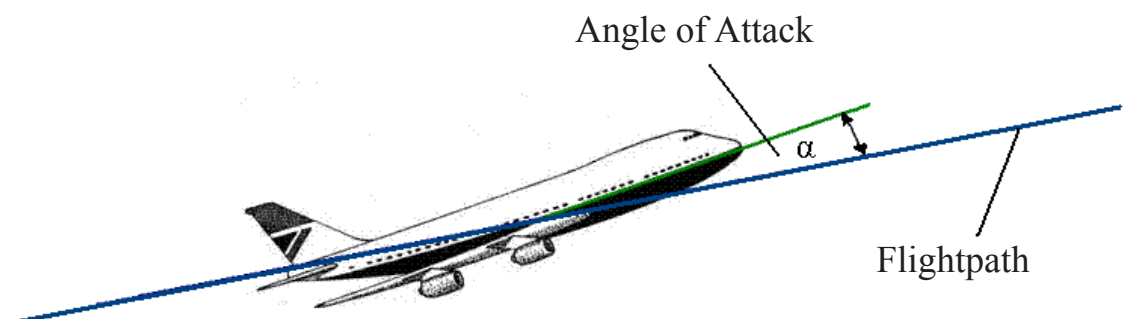
1.0. Start EFIS

To start EFIS press <AUX> and activate the system with the button <EFIS>. The display reacts automatically to the current condition of movement. You just have to carry out a few basic settings.

1.1. Basics



The display of the Pitch in EFIS corresponds to the spatial position of the aircraft. It describes the rotation of the whole plane along the lateral axis. The display of the Roll corresponds to the rotation along the longitudinal axis - i.e. the bank.



The spatial position (Pitch) consists of the Flightpath and the Angle Of Attack (AOA).

The Angle of Attack is the angle between the direction of the upstream airflow and the reference line of the profile, respectively aircraft x-axis. The direction of the current is best described as the opposite direction of the flight path.

The Angle of Attack depends on several variable parameters. Some parameters are essential to customize the EFIS individually for each aeroplane..

1.2. Input Values

To enhance the accuracy of the display of EFIS some values have to be determined during a calibration flight. First the Angle of Attack is assessed depending on the speed.

To read the Angle of Attack on the on board gyro horizon, the flightpath has to be horizontal. Then $AOA = \dots$. This is achieved at a horizontal flight without a change in altitude. A total of eight measured values is necessary.

Settings	
Min Speed Clean [kts]	AOA Clean [deg]
85	10
Max Speed Clean [kts]	
160	
Min Speed Flaps [kts]	AOA Min Speed Flaps [deg]
68	10
Max Speed Flaps [kts]	AOA Max Speed Flaps [deg]
130	0
Weight [kg]	
1810	

not MTOW, but weight during the measurement

1.2.1. Values without Flaps

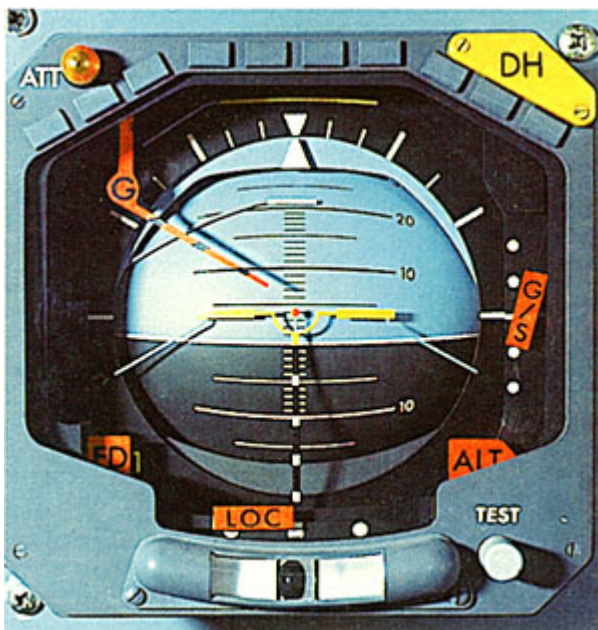
Min Speed Clean:

Enter here the minimal speed in knots (approximately 5 knts before stall).

AOA Clean:

This is for the corresponding value of the Angle of Attack (in degrees) to the minimal airspeed. These readings can be taken directly off the gyro horizon during a horizontal flight.

In the horizon pictured below this would be 4° for this situation. This data is entered in the field "AOA Clean". The corresponding airspeed "Min Speed Clean" is the corresponding IAS, shown on the speedometer at the time.



Max Speed Clean:

This parameter is the IAS, at which during a horizontal flight no Pitch is shown. In this case the symbol coincides with the line of the horizon (zero-line).

1.2.2. Values with Flaps

The measurement is analogous to the description before.

Min Speed Flaps:

Min Speed Flaps is the minimal possible airspeed with set flaps (approx. 5 knts before stall).

AOA Min Speed Flaps:

This field is for the corresponding Angle of Attack (in degrees) at the minimal airspeed with flaps (should be Flaps full or Flaps appr).

Max Speed Flaps:

The maximal possible speed with flaps.

AOA Max Speed Flaps:

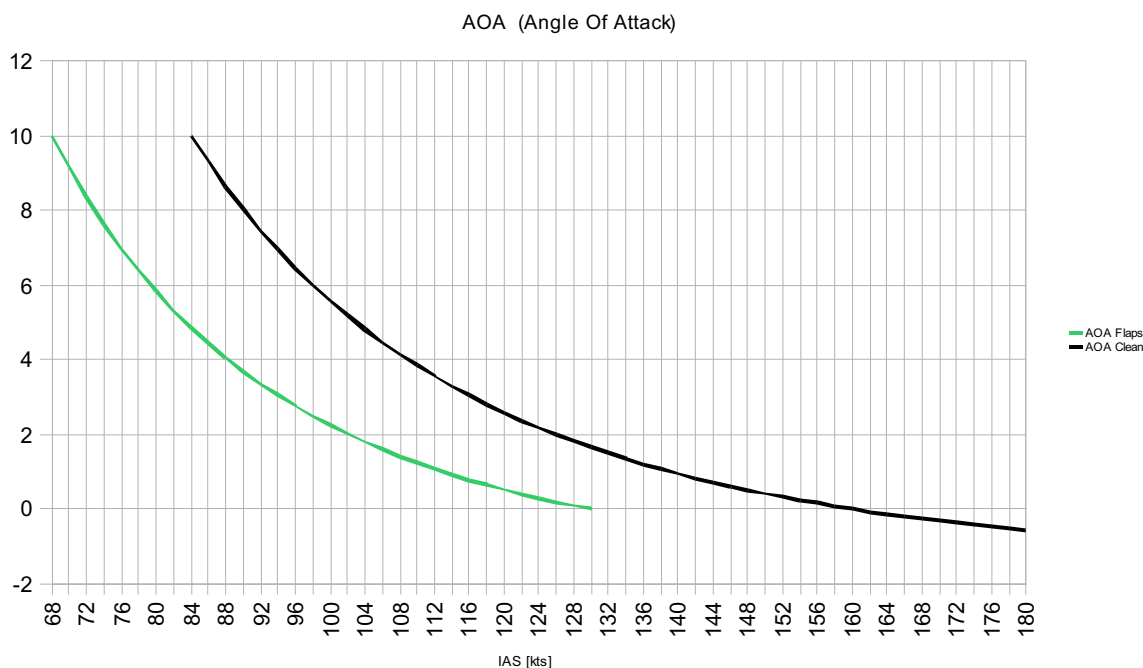
This field is for the corresponding Angle of Attack (in degrees) at the maximal possible airspeed with the above flap setting. Whether you choose the Max Flap Setting or for example a TO&APPR FlapSetting is a decision of the operator. It is described by the white symbol.

Weight:

Insert here the take-off weight of the calibration flight (in kg).

From these statements and the GPS-data the Angle of Attack is calculated continually and entered into the actual Pitch. This results in two symbols in the display. A red one, which stands for the Pitch without flaps and a white one for a flight with flaps.

The following diagram of the Angle of Attack corresponds to the configuration from the example shown above.



1.2.3. Example for a Calibration Flight

The following procedure is an example for a calibration flight:

At a medium airspeed a horizontal flight is set without a change in altitude. Now the speed is reduced as far as possible (e.g. 1.1 x stall speed). Note the measured data for Angle of Attack and IAS in a prepared table.

Now accelerate until you can see the zero-line on the (adjusted) on-board horizon. This value is put into the table as well.

The same manoeuvre is flown with flaps set. There you accelerate until you reach the maximal flyable speed and then take the reading of the pitch.

The altitude of the flight is irrelevant, but it is advantageous to perform the calibration flight in a stable atmosphere.

Take-Off Weight:	[kg]		
Min Speed Clean, IAS =	[kts]	AOA Clean =	[deg]
Max Speed Clean, IAS =	[kts]	AOA = 0	[deg]
Min Speed Flaps, IAS =	[kts]	AOA Min Speed Flaps:	[deg]
Max Speed Flaps, IAS =	[kts]	AOA Max Speed Flaps:	[deg]

After that you can easily enter the data into the MT unit. The predefined default values will be overwritten and the new data will be saved.

With EFIS activated you find the input menu when you press <SET>. To save the data, press <STORE>.

2.0. Settings Before Each Flight

With the button <FLIGHT> you enter the input mask for Wind and Weight. These data should be as up to date as possible as they influence the dynamic calculations. According to feasibility and circumstances this data can be updated during the flight as well. But even with a poor calibration, the display stays "relatively" correct. Only the absolute readout of the Pitch shows a minor discrepancy.

Actual Settings

<p>Wind Speed [kts]</p> <div style="background-color: #90EE90; width: 40px; height: 20px; margin-bottom: 5px;"></div> <p>_____</p>	<p>Wind (from) Direction [deg]</p> <div style="background-color: #FFFFFF; width: 40px; height: 20px; margin-bottom: 5px;"></div> <p>_____</p>
<p>Weight [kg]</p> <div style="background-color: #FFFFFF; width: 60px; height: 20px; margin-bottom: 5px; display: flex; align-items: center;"> 1810 </div>	

Enter the current data of windspeed, direction of wind and the weight. As a default value the weight from the calibration flight is entered. If no data is entered, the system calculates with wind=0 and the default standard weight. The settings can be updated during the flight.

Save the values by pressing <STORE>.

3.0. QNH-Display

By use of the exact height measurement of the GPS and the barometric altimeter of the aircraft the current QNH can be calculated very accurately. For this you set the atmospheric pressure of your altimeter to 1013 hPa. Open the input mask with the button <QNH>.

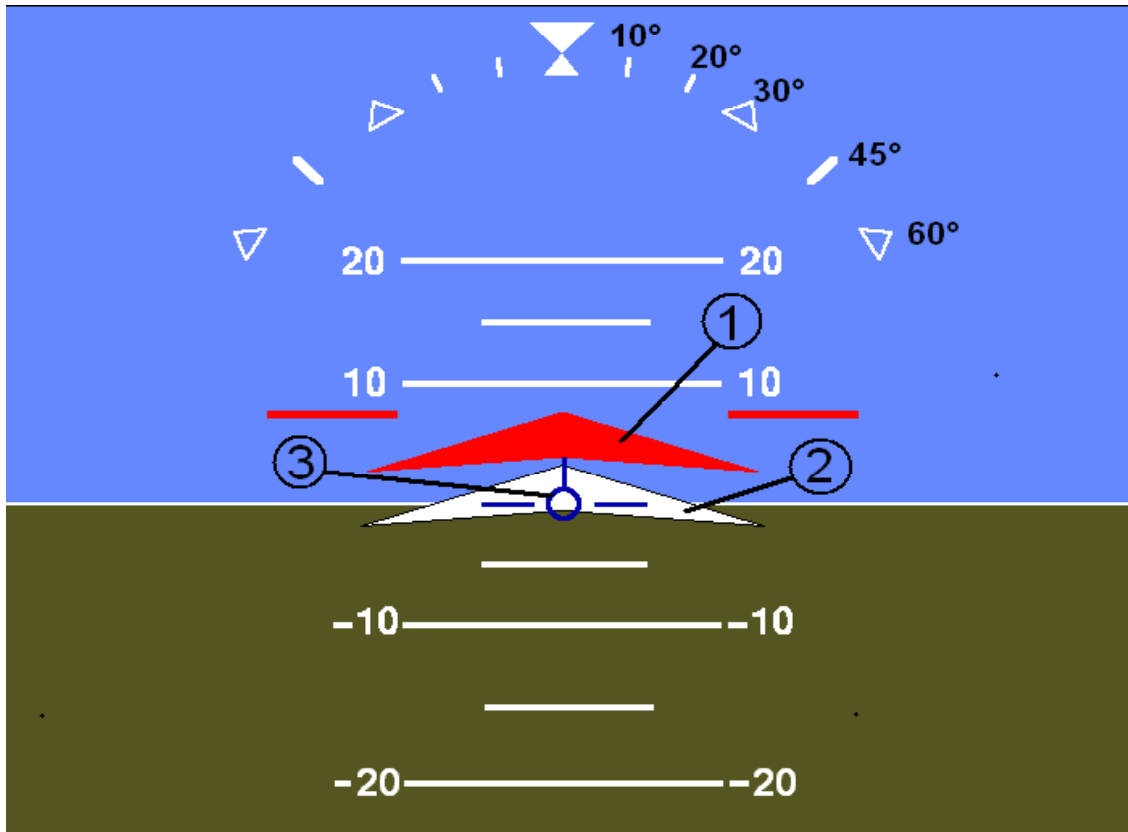
QNH

Altitude (1013 hPa) [ft]

Now you enter the reading of your altimeter in feet (Flight Level Display). After pressing <STORE> the current reference-QNH is calculated for the area you fly through.

4.0. Read Out of the EFIS-Information:

To show several flight conditions at the same time there are several reference markings. In the horizon there are three different symbols:



1.) The red aircraft symbol is the reference for Pitch under normal conditions (without flaps). It is visible from the minimal clean speed onwards.

2.) The white symbol shows the pitch attitude with the position of the flaps for which the EFIS was calibrated. It is visible from the minimal speed with flaps set to the maximal speed with flaps set. The values 1.) and 2.) also depend on the take-off weight.

3.) The blue symbol visualises the angle of the flight path. It stays always in the center of the pitch-scale where the Flight Path Angle (Slope) can be read.

At a very low speed only the white symbol is shown. When the red marking is added, the display references itself to the pitch without flaps. This is the reason for a skip in the display.

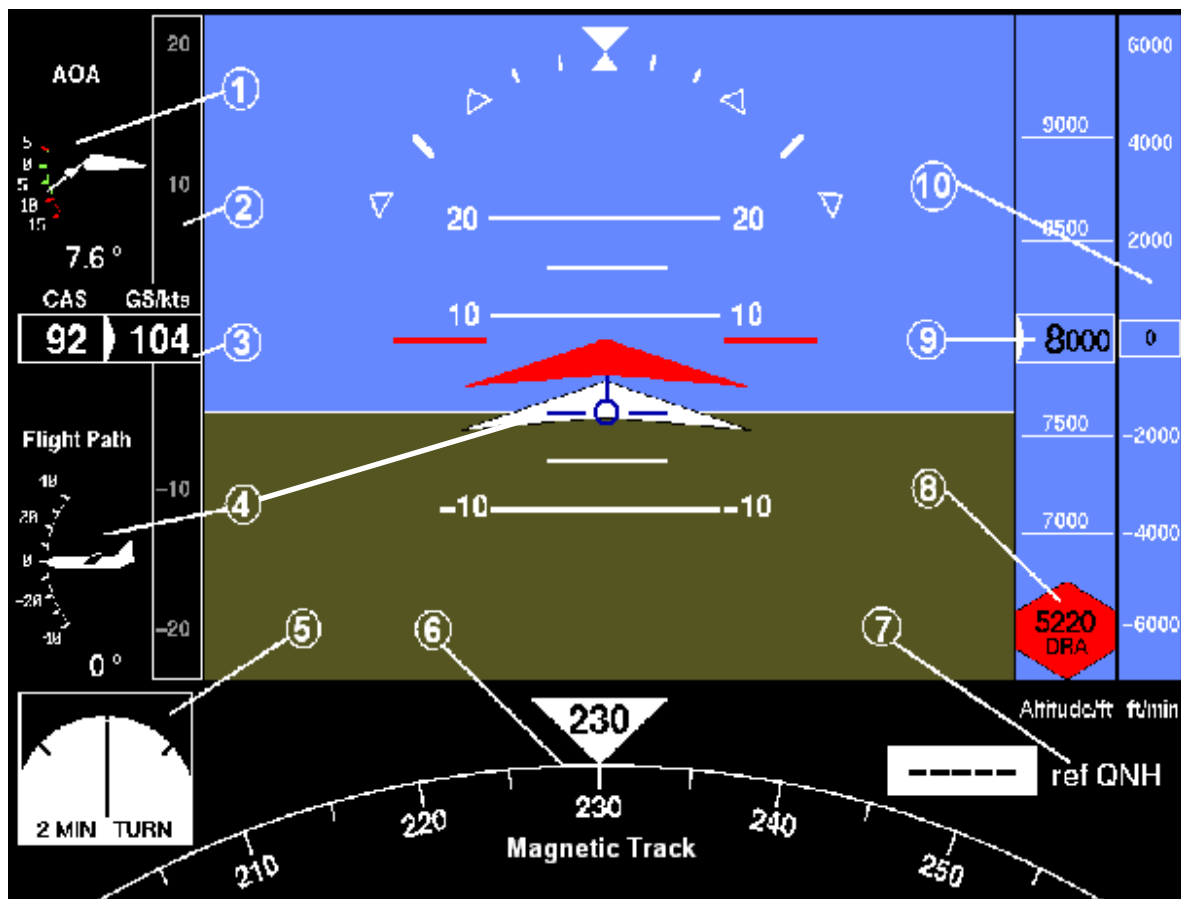
In turning flight:

The roll-position is shown on the white scale at the top of the display. The gradation has the following increment (from the inside to the outside):

- Roll Angle = 10 degrees (first narrow bar)
- Roll Angle = 20 degrees (second narrow bar)
- Roll Angle = 30 degrees (first triangle)
- Roll Angle = 45 degrees (broad bar)
- Roll Angle = 60 degrees (second triangle)

5.0. Elements in the Display

In this chapter you find the description of all the flight information shown.



- 1.) The value in the display corresponds (with correct calibration) to the Angle of Attack.
- 2.) This display visualises the speed trend. That implies the expected acceleration in 10 secs (+- kts).
- 3.) This is the display for the ground speed (knts) and the CAS (knts). The CAS is the air speed calculated by EFIS, which depends on the ground speed, change of height, air density and wind.

- 4.) The Flight-Path-Angle corresponds to the flight path, i.e. the Slope of the aircraft. The point of the aircraft-symbol shows the current value. In the example the aircraft is in a horizontal position, so the slope (FPA) is zero.
- 5.) The indicator of the Two-Minute-Turn shows the mark where the turning rate of a 360° turn is exactly two minutes.
- 6.) Below the display of the horizon is the display of the Mag Track. This shows the current track over ground.
- 7.) After the input of the current pressure (see chapter 4) this window shows the reference value of the current QNH.
- 8.) DRA stands for Digital Radar Altitude. The value shown here is the distance between the aircraft and the ground (in ft). In order to achieve a high sensitivity when flying close to the ground, up to a height of 490 ft above ground the altitude data is visualised by a linear function. Above 490 ft the display switches to logarithmic. This display is only active in combination with an activated TAWS (terrain data available).
- 9.) This shows the true altitude over MSL.
- 10.) On the right hand part of the screen there is a variometer that shows the rate of ascent respectively the rate of descent in ft/min.

6.0. Error Messages

- | | |
|-------------------|--|
| - NO DATA: | No Data received by EFIS |
| - LOADING DATA: | Data is loading (about 2 sec after being switched on) |
| - LOW SPEED: | Insufficient speed for a useful display (min. 40 kts) |
| - ALTITUDE ERROR: | Wrong or no data regarding the altitude available |
| - SIGNAL ERROR: | Error in the data transmission respectively wrong GPS-data |

7.0. Limitations

EFIS does not work properly in aircrafts with a low (e.g. gliders) and not in aircrafts which can be subject to uncoordinated conditions of flight (e.g. Helicopters).

Unaccuracy in the display can occur...

- ... because of strong, time relevant changes in of the wind conditions coinciding with a low airspeed
- ... yawning flight (e.g. engine failiure in a Twin-Aircraft)
- ... in the post-stall area
- ... with some acrobatic flight manoeuvres

8.0. WAAS/ EGNOS

With systems like EGNOS and the fully compatible system WAAS, correction signals are transmitted on the frequency L1 of the geostationary satellites like Inmarsat or Artemis

This correction data is acquired from a multitude of stationary ground stations which collect the ionosphericly induced run time errors within their reception area and calculate the correction factors for different geographical areas. From this the EGNOS/WAAS-suitable GPS-receivers can determine the additional runtime effects of the signals in the ionosphere and the resulting divergence of the positioning is less than 1 m. Without this correction data the standard accuracy of civil GPS lies between 5 m and 15 m.

EGNOS is a joint project of [ESA](#), the [EU](#) and the european air traffic control [Eurocontrol](#), which initialize this project together as European Tripartite Group (ETP). The European Satellite Service Provider (ESSP) will put EGNOS on the market and run it as a business.

At the moment the system is in transition from testmode to sroutine mode.

List of satellites with an EGNOS-transponder:

- ARTEMIS (PRN 124; ID 37)
- Inmarsat AOR-E (PRN 120; ID 33)
- Inmarsat IOR-W (PRN 126; ID 39)