

# Airbus: Integration of Autothrust-Flight Director-Autopilot and You

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Having flown the Airbus for several months, I decided to delve deeper into the books and review the complex integration of the autothrust [A THR] and flight director [IFD2]. Assumptions for this article are: [A THR] active, thrust lever in climb detent, Autopilot [AP-OFF], all references to [SPEED] synonymous with [MACH] at the appropriate altitude and the protections or reversions are operative but not activated.

## Autothrust Modes

When active the autothrust is either in a [THR IDLE-THR CLB] (fixed thrust mode) or [SPEED] (variable mode). In the fixed thrust mode an A/P or F/D must be ON, whereas F/Ds can be ON or OFF in the [SPEED] (variable) mode.

### Thrust (fixed)

- A/P or F/D must be ON
- You are either going up [OPN CLB] / [CLB] or down [OPN DES]
- The speed of the aircraft is totally dependent upon pitch attitude.
- If you do not follow the pitch command bar of the F/D the aircraft WILL NOT fly the target speed

### Speed (variable)

- F/Ds can be ON or OFF and N1 will vary to maintain the target [SPEED] (within the performance capability of the engines and aircraft)
- If a F/D is ON the N1 will vary to maintain the Target Speed and the F/D pitch bar will provide guidance to a VERTICAL TRAJECTORY i.e. [VS+-], [FINAL APP], [G/S], [ALT\*] or [ALT CRZ]
- If BOTH F/Ds are OFF N1 will increase or decrease to maintain the target [SPEED]

## 1. There I was:

F/Ds ON - A/P OFF

We were at 6,000 feet, 15 miles out, the first day, first leg of IOE and cleared for the visual approach. High and hot I click off the A/P to maneuver for the runway. The PNF selects a lower altitude, [OP DES] and a speed of 210 knots. My eyes are outside, descending through 3,000 ft. I notice my speed is 192 kts. I confirmed that 210 knots was selected.

THR IDLE	OP DES		1 FD 2 A/THR
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## What's it doing now?

### What it was designed to do.

With the F/Ds ON in an [OP DES] I was in a fixed [THR IDLE] mode. Since my engines were at [THR IDLE], pitch was the only means of speed control (pitch up—go slow, pitch down—go fast). The F/D was providing the pitch commands, but due to outside distractions I inadvertently shallowed the descent not following the F/D pitch commands. Since the engines were at a fixed [THR IDLE] setting the airplane *slowed* below the target speed.

### Lessons learned:

If not following the F/D pitch commands turn them BOTH OFF. Turning off the F/Ds changes the autothrust from a fixed [THR IDLE] to a variable [Speed] mode. Once in the variable [SPEED] mode N1 will increase or decrease to maintain the selected 210 knots.

Note: If even one of the F/Ds is ON with a fixed thrust setting, the aircraft's speed will depend solely on pitch. If you don't fly the commanded pitch you will not fly the target speed since thrust is fixed at [THR IDLE]. This is why it is stressed in training to never fly with one F/D on, it can only confuse you.

**2. There I was:**

F/Ds OFF - A/P OFF

We were at 8,000 feet downwind and cleared for the visual to 36R. Select 210 knots, turn off both F/D's, extend the speedbrake and start down. Speedbrakes were extended descending through 6,500 feet and I noted the engines spooling up as N1 increases.



**What's it doing now?**

**What it was designed to do.**

By turning off the F/Ds the autothrust went into the **SPEED** (variable) mode. In **SPEED**, N1 varies to maintain the 210 knots I selected.

The initial pitch down reduced the power to **THR IDLE**. As I inadvertently shallowed the descent through 6,500 feet, the speed began to decrease and the N1 increased to maintain the selected speed of 210 knots.

**Lessons learned:**

After turning off the F/Ds, to ensure **THR IDLE**, stay at or above your selected speed. In this scenario speed could increase above the target speed because you are in a speed mode, versus the previous scenario where you are in a pitch mode—and pitch controls speed.

**3. There I was:**

F/Ds On - A/P OFF

ATC kept me high and turned me in close intercepting the G/S from above. Selecting **OP DES**, I engaged the speed and as the aircraft slowed to the activated approach speeds I extended flaps and gear. Even though the target speed was 147 knots passing through 4000 feet I noticed my speed slightly below 147.



**What's it doing now?**

**What it was designed to do.**

Since I was in an **OP DES** I was in a fixed thrust mode. The airplanes speed is totally pitch dependent in the fixed thrust mode. Unintentionally shallowing the descent from F/D com-

manded pitch slowed the speed below the targeted speed of 147.

**Lessons Learned:**

If **OP DES** is selected, you MUST fly the pitch commands of the F/D. Since your thrust is fixed at **THR IDLE**, if you do not fly the pitch commanded you will be either faster or slower (imagine yourself as a glider pilot) than the target speed.

Selecting **VS-** would set you in a **SPEED** mode and the N1 would increase or decrease as necessary to maintain the target speed.

**4. There I was:**

F/Ds ON A/P OFF

We were 10 miles from the airport, level at 6,000 feet and IMC. ATC advises me to “turn left to 330 degrees, descend to 3,600 feet, cleared for the ILS approach.” Intercepting the G/S from above I request **OP DES**. As I descend I realize that I'll intercept the G/S between 3200-3000 feet. Approaching 3,600 feet the N1 increases. Instead of intercepting the G/S my immediate concern is preventing a flap overspeed.



**What's it doing now?**

**Guess what? What it was designed to do.**

By selecting **OP DES** the autothrust was in a fixed thrust mode **THR IDLE**, remember glider pilot. I thought I would stay in **OP DES** until intercepting the G/S but I intercepted another vertical trajectory, **ALT\*** (3,600 feet that ATC last cleared me to and set in the FCU), before the **G/S** intercept. The autothrust system reacted as I requested and changed from **OP DES** to **SPEED** as it thought I wanted to level off at 3,600 and fly the target speed.

**Lessons learned:**

Know what you are asking the airplane to do. I asked the aircraft to level at 3,600 feet and intercept the **G/S**. If and when I realized I was not going to capture the **G/S** by the 3,600-foot altitude I should have:

- Set the FAF altitude on the FCU and selected **VS-** or **OP DES**
- Select speed of 170-195 knots depending on flap setting

- Follow flight director commands
- Deploy speed brakes, landing gear, and flaps as required
- When the glide slope is captured, select the missed approach altitude on the FCU and engage speed
- If not stabilized by FAF, GO AROUND.

NOTE: Selecting **V/S** versus **OP DES** has the advantage of keeping you in the **SPEED** mode. If the F/D orders are not followed when using **OP DES** and the pilot decides to apply nose up control, the aircraft will lose airspeed because the thrust remains at idle. The aircraft may decelerate below VLS until Alpha floor is activated. If the F/D guidance commands are not compatible with the desired glide path, select V/S or switch both F/Ds off. This ensures that the A/THR is in the speed mode.

### Conclusion

When the F/Ds (both) are OFF you will always be in the **SPEED** or **MACH** mode.

With F/Ds ON N1 can be fixed or variable.

If the F/Ds are ON and **SPEED** or **MACH** is on the FMA, the N1 will vary to the engine limits available to maintain the Target Speed. The Pitch Bar of the F/D will ADVISE you of the pitch necessary to maintain the vertical trajectory.

<b>SPEED</b> or <b>MACH</b>	<b>ALT*</b> <b>VS</b> <b>GS</b>		<b>1 FD 2</b> <b>A/THR</b>
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If F/Ds ON and **OP DES**, **OP CLB** or **CLB** is on the FMA the power is FIXED (glider pilot). If you do not follow the Pitch Bar you will not fly the Target Speed.

Think of the Pitch Bar as commanding the pitch to maintain the Target Speed in the FIXED thrust mode.

<b>THR IDL</b> or <b>THR CLB</b>	<b>OP DES</b> or <b>OP CLB</b> or <b>CLB</b>		<b>1 FD 2</b> <b>A/THR</b>
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If you believe in the old pilots' adage of speed is life then:

Target Speed in FIXED THRUST **THR IDLE** or **THR CLB** is attained by following F/D PITCH COMMANDS.

Target Speed in **SPEED** or **MACH** is achieved by N1 increase or decrease with the F/D *advising of the pitch* necessary to maintain the vertical trajectory.

- From the moment you make a selection on the FCU, know what you are asking the airplane to do, present and future.
- Be aware: mode changes WILL occur with nothing more than a visual message on the FMA.

