

Learjet 45 DDJD Revision 3 Documentation

Jon Dyer 28 February 2021

Updated 3 March 2021

This document describes the many changes made to David Durst's Learjet 45 panel, and shows new hotspots.

Revision 2 changes and additions are shown in red.

Revision 3 additions are shown in green.



Hidden hotspot for GA Mode.

Autopilot

The Autopilot has been further improved in revision 2. This complex autopilot has "true" VS Mode; see below.

All knobs use left/right clicks to decrease/increase values
 Toggle XFR arrow.
 Toggle IAS Hold or MACH Hold. Right-click to Sync IAS.
 Click FLC for Altitude Select (ASEL). ALT now Altitude Hold.
 Green LED indicators.
 Middle click to Sync Course.
 Middle click to Sync Heading.
 Change IAS, or VS when VS indicator lit. Middle click to toggle IAS/Mach Mode.
 Click for "True" VS Mode
 Middle click to Sync Altitude.

If VOR tuned, syncs to VOR, CDI centred.
 If ILS tuned, syncs to RWY heading/ILS course.
 If neither tuned, syncs to current heading.

Display Controller

Now correctly has a NAV button.

Click HSI to toggle compass modes. (See below.)

FMS and NAV together form the "NAV/GPS" switch.

NAV1 or NAV2 radios can now drive the HSI and autopilot.

Click on NAV to toggle between NAV1 and NAV2.



Knobs use left/right mouse clicks to operate switches.

Bearing Pointer for NAV1 radio, ADF1 radio, or FMS.

Bearing Pointer for NAV2 radio, ADF2 radio, or FMS.

HSI Compass Modes

Default Rose Compass

Arc Compass

Arc Compass with Map



PFD

AP and YD flash amber for 5 secs when disengaged

Minimums Indicator.

Radar Altitude. (in feet)

Heading readout.

Red caution bands On ASI tape.

Now has drift bug (track bug)



Minimums Set. Display RA or BARO

STD Baro. Set.

Updated autopilot annunciator.

BARO minimums bug.

Hash box below 10,000 ft

RA or BARO readout.

VS Set.

VS readout.

EICAS

Throttle Detent Indication.

Crew Alerting System (CAS) display updated with many authentic warnings.

Shows ITT not EGT



Fuel Tank analogue

Right-click FUEL to toggle lbs/kg fuel.

Flaps Configuration Warning

Minimums.

quantity indicators.

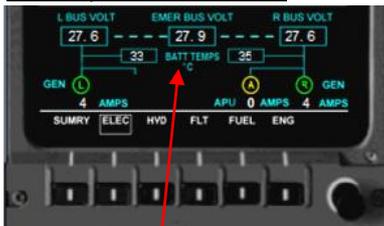
All knobs use left/right mouse clicks to decrease/increase value

EICAS and MFD: PIT, AIL and RUD now correctly show trims rather than control positions.



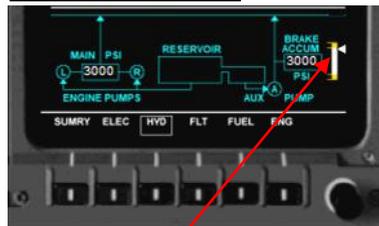
But can be switched, with a right-click on the FLT button, to show control positions. (Useful in FS)

EICAS updated ELEC screen



Electrics changed from 12V to 24V. Readouts turn amber when voltages low. Added Battery Temperatures.

EICAS new HYD screen



Brake Accumulator Indicator.

EICAS updated FLT screen



Takeoff Pitch Trim Range.

Aileron and Rudder now have digital readouts. Analogue needles now deflect correctly. Readouts turn amber if deflected more than 5.0.

Amber flap lever position. White actual flap position. Dual independent spoiler position indicators.

MFD

Now has drift bug. (track bug.)



Heading Bug now correct colour

If in Track mode has heading indicator.

Map now has facilities annunciator.



New menu items

TERRAIN, AIRSPACE and COMPASS. (TERRAIN can be OFF (default), SEA only, or FULL.) (COMPASS can be HDG (default) or TRK)

RMUs - Radios (Honeywell RM-855B Radio Management Units)

RMUs now have correct white labels.

Click for TCAS
NORMAL (± 2700 ft),
ABOVE (+7000, -2700 ft),
or BELOW (-7000, +2700 ft).

Now has ADF2 radio.

Line select radio, transponder, or TCAS range. (Yellow box.)

Left/right mouse clicks on outer and inner knobs to change frequency, transponder code, or TCAS range.

Crew Warning Panel (CWP) (Annunciator)

Press to test. Also tests Master Warning/CAUTION.

Click to reset.

Master Warning/CAUTION

New Master Warning/CAUTION indicators with improved functionality. Has many spoken audible warning

Standby Instruments

Independently Adjustable ASI Bug

New Standby ASI with functional MACH scale.

Updated colours on Standby AI.

Clock

The Davtron M850 Clock has improved functionality.

Click for Local Time/GMT/ Automatic Flight Time/ Elapsed Time (Stopwatch).

Click to Start/Stop/Reset the stopwatch.

Switch Panel and Throttle Quadrant

New Throttle Quadrant.

No Smoking/
Belts Switch.



Engine De-Ice shows NAC (Nacelle Anti-Ice) In EICAS.

Click for functional Wing/Structural/Airframe De-Ice.

EICAS has engine START indicator.



Improvements to the Autopilot

Background

The default Flight Simulator (FS2004 and FSX) autopilot seems to have a number of issues. During development of my KAP150, KFC150, KAP140 and KFC225 autopilots a number of issues (faults?) with the Flight Simulator autopilot were noted.

Three examples:

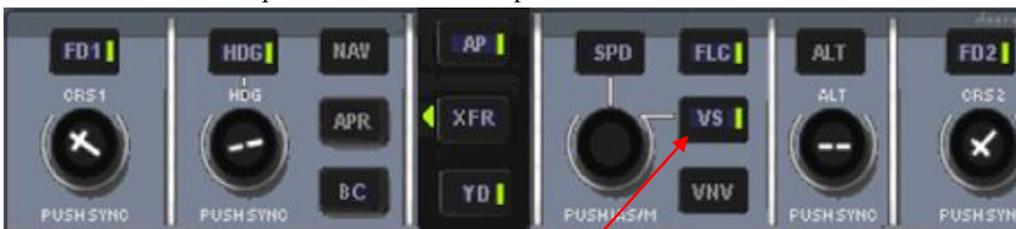
1. All real autopilots (except one-axis autopilots) have a roll mode and a pitch mode.
When first engaged, the Flight Simulator autopilot engages in Wing Leveller mode and Pitch Hold mode.
If select HDG mode, then press the HDG button to de-select it, the AP does not go back to the Wing Leveller mode, but completely disengages the autopilot roll mode!
The autopilot is half engaged! It is engaged in a pitch mode, but disengaged in a roll mode. No real life autopilot would be half engaged like this!
2. When first engaged, the autopilot engages in Wing Leveller mode and Pitch Hold mode.
If select ALT mode, then press the ALT button to de-select it, the AP does not go back to the Pitch Hold mode, but instead completely disengages the autopilot pitch mode!
The autopilot is half engaged! It is engaged in a roll mode, but disengaged in a pitch mode. No real life autopilot would be half engaged like this!
Both of the above can be seen in the default Cessna 172S.
3. Flight Simulator does not support a "proper" vertical speed mode.
Flight Simulator only lets you adjust a vertical speed if climbing or descending towards a target altitude.
(When you select a target altitude, the aircraft immediately starts to climb or descend towards the target altitude - not realistic.)
If climbing towards a target altitude you can adjust the vertical speed, but only for a positive vertical speed.
If descending towards a target altitude you can adjust the vertical speed, but only for a negative vertical speed.
Once you reach the target altitude, the vertical speed falls to zero, and you can't adjust it any more.
All this can be seen in the default Beechcraft King Air.

Learjet 45DDJD Autopilot

Code has been developed to try to fix these, and other, issues.

"True" Vertical Speed Mode

Also a "true" Vertical Speed mode has been implemented.



To engage the Vertical Speed mode simply press the VS button. The current vertical speed is captured, and you can then adjust the required vertical speed, positive or negative, at will. (You don't need to be climbing or descending towards a target altitude.) (When in Vertical speed mode (VS indicator lit) the adjacent knob will adjust the vertical speed. When not in Vertical speed mode (VS indicator not lit) the adjacent knob will adjust IAS.)

Go-Around Mode

Go-around mode raises the flight director pitch bars to an 8° climb attitude and disengages the autopilot.

To engage the go-around mode click the hidden click-spot on the main panel, or press CTRL+SHIFT+G, or better still assign this function to a convenient joystick button.

Takeoff Monitor

Prior to takeoff the flaps should be set to the 8° or 20° position, the pitch trim should be set in the white band (see above), the spoilers should be retracted, the pitot heat should be on and the parking brake should be released.
(There should be no CAS warnings (red), cautions (amber) or advisories (white) prior to takeoff.)

1. FLAPS

If the flaps are not set for takeoff as described above, a white box will be drawn around the FLAPS digital readout.
If the throttles are opened, the box turns red (see FLAPS CONFIGURATION WARNING above), and an audible spoken "Configuration" warning will sound.

2. PITCH TRIM

If the trim is not set for takeoff as described above, a white CAS advisory "TAKE OFF TRIM" will be shown.
If the throttles are opened, "TAKE OFF TRIM" turns red, and an audible spoken "Configuration" warning will sound.

3. SPOILERS

If the spoilers are extended, a white CAS advisory "SPOILERS EXT" will be shown.
If the throttles are opened, "SPOILERS EXT" turns red, and an audible spoken "Configuration" warning will sound.

4. PARKING BRAKE

If the parking brake is set, a white CAS advisory "EMER/PARK BRAKE" will be shown.
If the throttles are opened, "EMER/PARK BRAKE" turns red, and an audible spoken "Configuration" warning will sound.

There are many other visual and audible warnings, see Table 1 below.

Ice and De-ice

Ice.

Contrary to popular opinion, icing (wing ice/airframe ice/structural ice) does work in flight simulator.
To experience icing conditions fly in a cloud layer with ICING set to SEVERE, and with a temperature at your altitude below freezing.
(In aeronautical terms: fly into "known icing conditions" above the "freezing level".)
After a short time a white CAS message "ICE DETECTED" will appear. Some time later the increased ice build-up will result in the CAS message turning amber. Later still it will turn red, indicating a very dangerous weight of ice on the airframe.
At that point you must do something! If you fly out of the icing layer the ice will very gradually dissipate, the CAS "ICE DETECTED" message will eventually turn amber, and some time later turn white, and later still will disappear, indicating that all the ice has melted

De-ice.

Alternatively, if you remain in the layer turn on the WING DEICE switch. After a delay proportional to the weight of ice on the aircraft, the ice will be cleared. In fact on the real Learjet the WING DEICE switch should be used as a preventative measure. If you fly into known icing conditions, turn WING DEICE on and leave it on. This works in this simulation also.
Our friends at Microsoft did not configure the FS2004 Lear45.air file to allow de-icing to work. I have included a suitably modified Lear45.air file in this package which makes it function. Just copy it into your Lear45_DDJD folder overwriting the existing file.

Ground Proximity Warning System (GPWS)

The real Learjet 45 can have GPWS as an option.
I can recommend Rob Barendregt's GPWS freeware package: rcbgp-33.zip. This works very well with the Learjet45_DDJD.

I advise making the following configuration changes to the code, as more appropriate for the high performance Learjet:

```
4 (&gt;L:GPWS_BasicRALT,number) (* Basic R-Alt when aircraft on ground (feet) changed from 10 to 4 *)
-4000 (&gt;L:GPWS_UpperVS_H,number) (* Upper V/S threshold (ft/min) over UpperAlt changed from 2500 to 4000 *)
-5000 (&gt;L:GPWS_LowerVS_H,number) (* Lower V/S threshold (ft/min) over UpperAlt changed from 4000 to 5000 *)
```

Table 1. Warning/Caution displays, associated CAS*/CWP displays, and audible warnings

| <u>Condition</u> | <u>Warning/ Caution Indicator</u> | <u>CAS readout</u> | <u>CWP Annunciator</u> | <u>Audible Warning</u> |
|-------------------------------------|---|------------------------|----------------------------|--------------------------------------|
| Master Warning | Warning | | | Three Chimes |
| Master Caution | Caution | | | Single Chime |
| Mach >0.82 | Warning | MACH | | Overspeed, Overspeed** |
| Mach >0.81 AND < 0.82 | Caution | MACH | | |
| IAS > 330 Kts, flaps up | Warning | OVERSPEED | | Overspeed, Overspeed** |
| IAS > 250 Kts, flaps 8° | Warning | OVERSPEED | | Overspeed, Overspeed** |
| IAS > 200 Kts, flaps 20° | Warning | OVERSPEED | | Overspeed, Overspeed** |
| IAS > 150 Kts, flaps 40° | Warning | OVERSPEED | | Overspeed, Overspeed** |
| IAS < 110 kts AND not on ground | Caution | AIRSPEED | | |
| Stall | Warning | STALL | | Stall, Stall, Stall** + Stick Shaker |
| Takeoff Trim not set, power set | Warning | TAKE OFF TRIM | | Configuration** |
| Takeoff Trim not set, power not set | | TAKE OFF TRIM | | |
| Flaps not set to takeoff | Warning | FLAPS | | |
| Configuration** | | | | |
| Spoilers, power set | Warning | SPOILERS EXT | | Configuration** |
| Spoilers, and flaps not up | Caution | SPOILERS EXT | | |
| Spoilers, power not set | | SPOILERS EXT | | |
| Spoilers armed | | AUTOSPLR ARMED | | |
| Left autospoiler activated | | L SPOILER | | |
| Right autospoiler activated | | R SPOILER | | |
| Gear up, power<65%, <500 ft RA | Warning | GEAR | GEAR | Gear, Gear, Gear** |
| Gear up, flaps 20 or 40 | Warning | GEAR | GEAR | Gear, Gear, Gear** |
| Gear down, IAS >210 kt | Caution | GEAR | | Gear** |
| ITT > 950°C | Warning | L ITT, R ITT | | |
| ITT >1000°C | Warning | L ITT, R ITT | L ENG FIRE, R ENG FIRE | |
| N1 >104% | Caution | L N1, R N1 | | |
| Left engine low oil pressure | Warning | L OIL PRESS LOW | L OIL PRESS LOW | |
| Right engine low oil pressure | Warning | R OIL PRESS LOW | R OIL PRESS LOW | |
| Left engine low fuel pressure | Warning | L FUEL PRESS LOW | L FUEL PRESS LOW | |
| Right engine low fuel pressure | Warning | R FUEL PRESS LOW | R FUEL PRESS LOW | |
| Parking Brake set, power set | Warning | EMER/PARK BRAKE | | Configuration** |
| Parking Brake set, power not set | | EMER/PARK BRAKE | | |
| Gear in motion | Warning | GEAR UNSAFE | | |
| Emergency Battery <22V | Warning | EMER BATT LOW | EMER BATT | |
| Generator Fail (both) | Warning | L/R GENERATOR FAIL | GEN FAIL | |
| Pitot heat off | Warning | PITOT HEAT | | |
| Pitot heat off | Warning | STBY PITOT HEAT | | |
| Within 1000 ft of target altitude | | | | Quiet Horn |
| Departing target altitude by 200 ft | | | | Horn |
| AP disconnect | | | | Cavalry Charge |
| Minimums RA | | | | Minimums. Minimums** |
| Minimums Baro | | | | Minimums. Decide** |
| TCAS Traffic | | | | Traffic, Traffic** |
| No Smoking/Belts switch on | Warning | SEATBELT, NO SMOKING | | Ding dong |
| Door open | Warning | ENTRY DOOR | ENTRY DOOR | |
| Ice detected, heavy icing | Warning | ICE DETECTED | | |
| Ice detected, moderate icing | Caution | ICE DETECTED | | |
| Ice detected, light icing | | ICE DETECTED | | |
| Landing lights on | | LANDING LIGHTS ON | | |
| Taxi lights on | | TAXI LIGHTS ON | | |
| Wing de-ice on | | WING DE-ICE | | |
| IAS Hold | | IAS HOLD | | |
| Mach hold | | MACH HOLD | | |
| Left starter activated | | L START | | |
| Right starter activated | | R START | | |
| Gear down | | GEAR DOWN | | |

*Not an exhaustive list, there are many more CAS readouts!

** Spoken warning