

Learjet 45 DDJD Revision 2 Documentation

Jon Dyer 31 January 2021

Updated 12 February 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.



Autopilot

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

Hidden hotspot for GA Mode.

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.

All knobs use left/right clicks to decrease/increase

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.

FMS

NAV

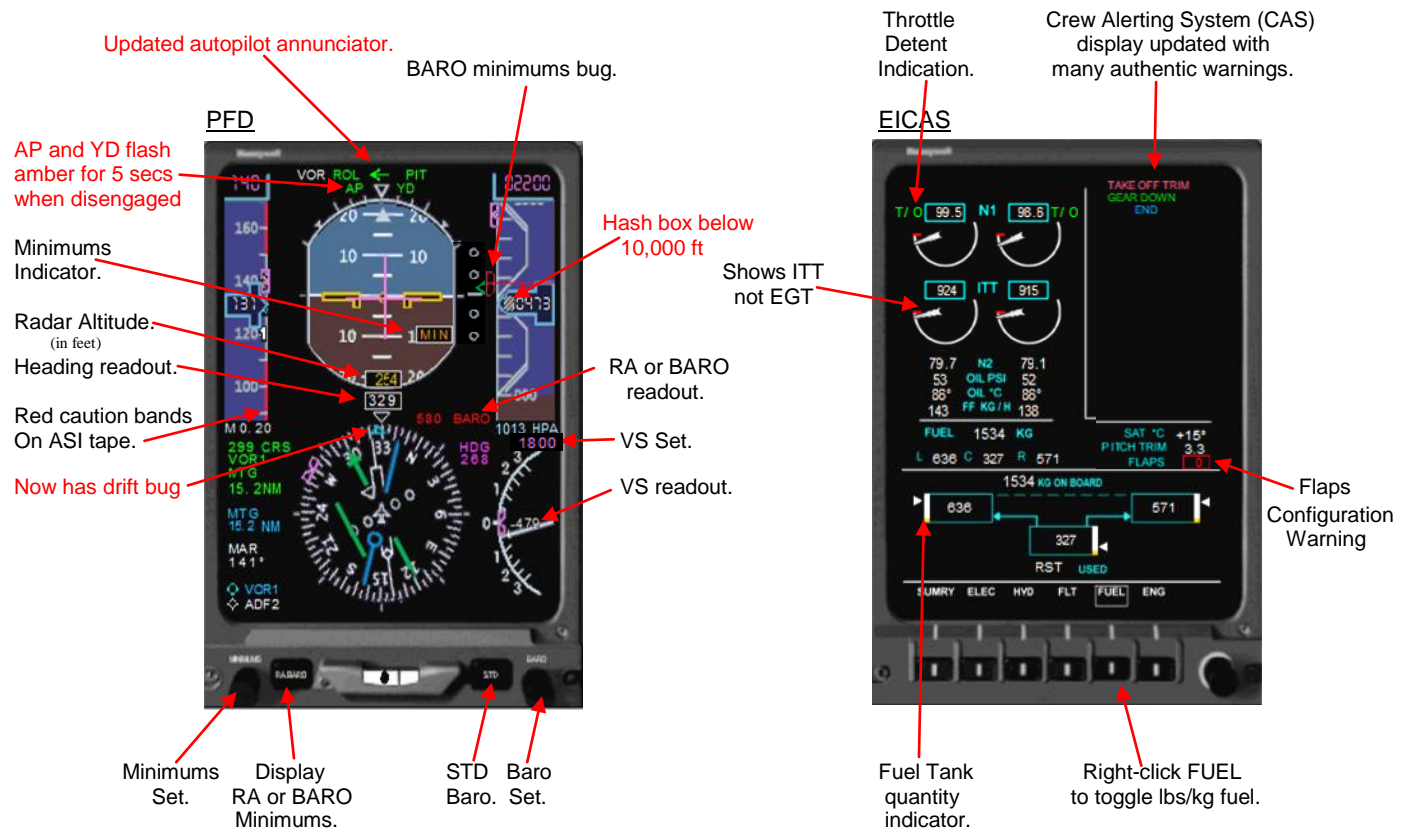
FMS and NAV together form the "NAV/GPS" switch. NAV1 or NAV2 radios can drive the HSI and autopilot. Click on NAV to toggle between NAV1 and NAV2.

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.



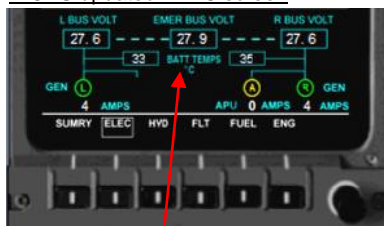


All knobs use left/right mouse clicks to decrease/increase value

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

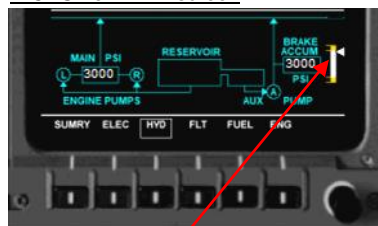


EICAS updated ELEC screen



Electrics changed from 12V to 24V. Added Battery Temperatures.

EICAS new HYD screen



Brake Accumulator Indicator.

EICAS updated FLT screen

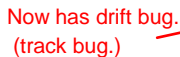


Takeoff Pitch Trim Range.

Aileron and Rudder now have digital readouts. Analogue needles now deflect correctly.

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

MFD

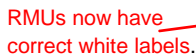


If in Track mode has heading bug.

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)



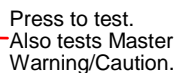
Click for TCAS
NORMAL, ABOVE
or BELOW.

- Now has ADF2 radio.

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

Left/right mouse clicks
to change frequency,
transponder code
or TCAS range.

Crew Warning Panel (CWP) (Annunciator)

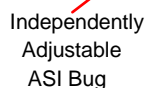


Click to reset.

Master Warning/Caution

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

Standby Instruments



New Standby ASI with functional MACH scale.

Updated colours on
Standby AI.

Clock

The Davtron M850 Clock has improved functionality.



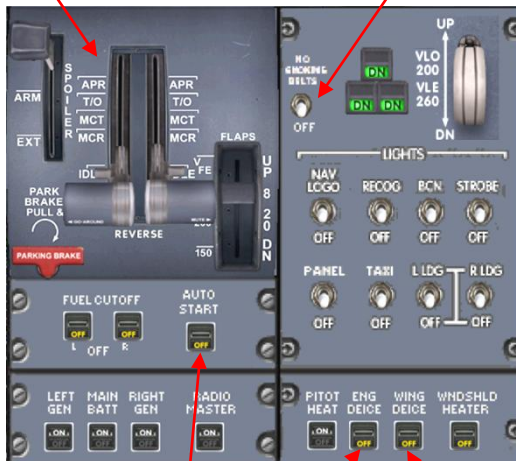
Click for
Local Time/GMT/
Automatic Flight Time/
Elapsed Time (Stopwatch).

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

I have developed code to try to fix these, and other, issues.

"True" Vertical Speed Mode

I have also implemented a “true” Vertical Speed mode.



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 (see “Learjet 45 DDJD rev1 Additional JD Documentation.docx”), 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.

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 (>L:GPWS_BasicRALT,number) (* Basic R-Alt when aircraft on ground (feet) changed from 10 to 4 *)
-4000 (>L:GPWS_UpperVS_H,number) (* Upper V/S threshold (ft/min) over UpperAlt changed from 2500 to 4000 *)
-5000 (>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 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 >2%	Warning	ICE DETECTED		
Ice detected 1 to 2%	Caution	ICE DETECTED		
Ice detected <1%		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