

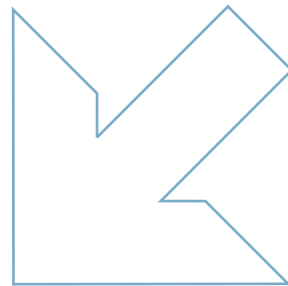


Computer mixability

An important issue



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1 | Introduction

Aircraft computers are subject to hardware and software evolutions, which generate different part numbers. Some of these are interchangeable, but are not necessarily mixable. Mixability, or compability, is about the ability of computers bearing different part numbers to interact correctly in a system. Part numbers, which are interchangeable but not mixable must therefore be changed as a set.

Non-compliance with this principle may lead to significant events, as illustrated by the three occurrences described in this article, where three aircraft were operated with an incorrect Flight Control Primary Computer (FCPC) configuration.

On review of these events, it appears worthwhile to repeat the importance of strictly adhering to the Illustrated Parts Catalog (IPC) when replacing any computer on an airplane.

2 | Description of the flight control computers operating mode

On the A330/A340 aircraft family, the flight controls are managed by five computers:

- Three Flight Control Primary Computers (FCPC or PRIM)
- Two Flight Control Secondary Computers (FCSC or SEC).

In normal operation, FCPC1 is declared to be master in law. It processes the pilot/ auto-pilot orders and sends them to the four other flight control computers (PRIM and SEC), which will then execute them on their related servo-controls.

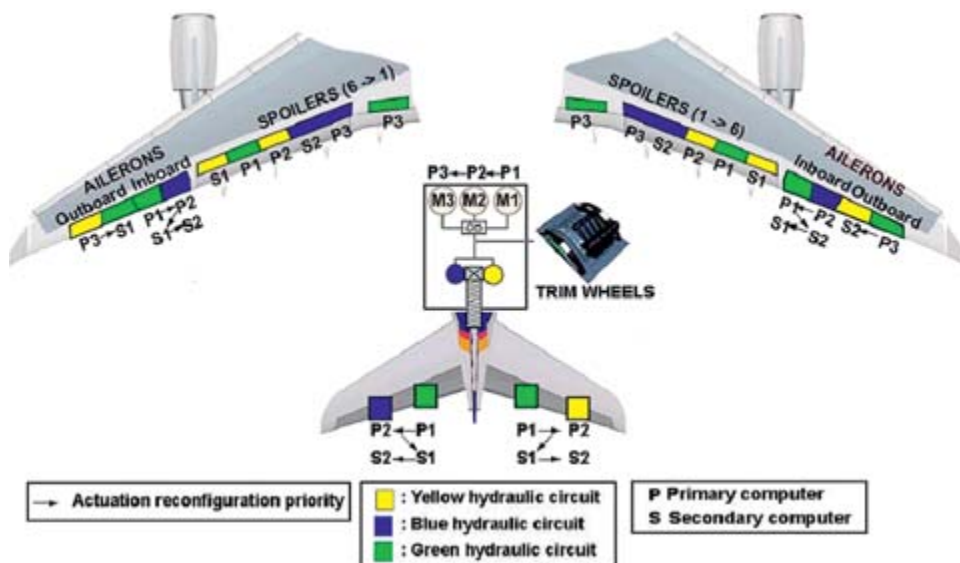
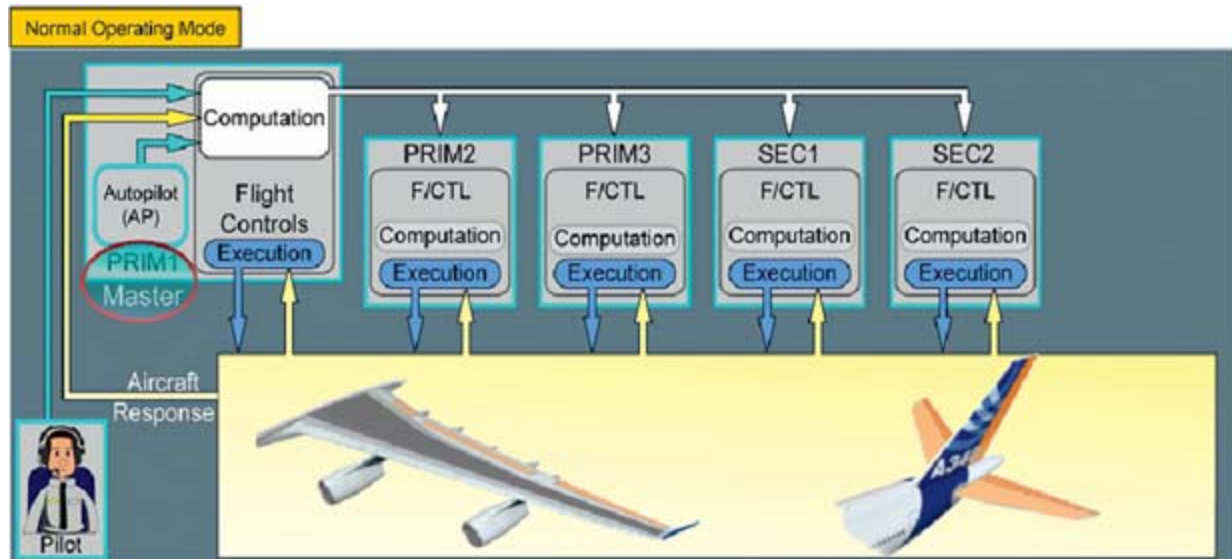
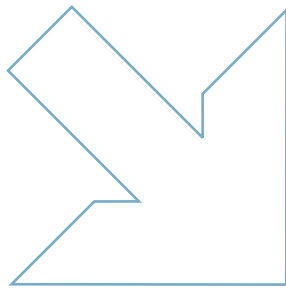


Figure 1: A330/A340 Flight control computers architecture

3 | Events

3.1 Untimely ground spoilers extension on ground

Two A340 operators reported events where all ground spoilers partially extended during the power-up sequence, whereas they should have remained fully retracted.

While troubleshooting the events, the following FCPC configuration was noticed:

- FCPC1: PN LA2K1A100220000 (Standard L15)
- FCPC2: PN LA2K1A100240000 (Standard L16A)
- FCPC3: PN LA2K1A100230000 (Standard L16).

According to the IPC and to the Airbus Service bulletins (SB), this mixed configuration was not authorized.

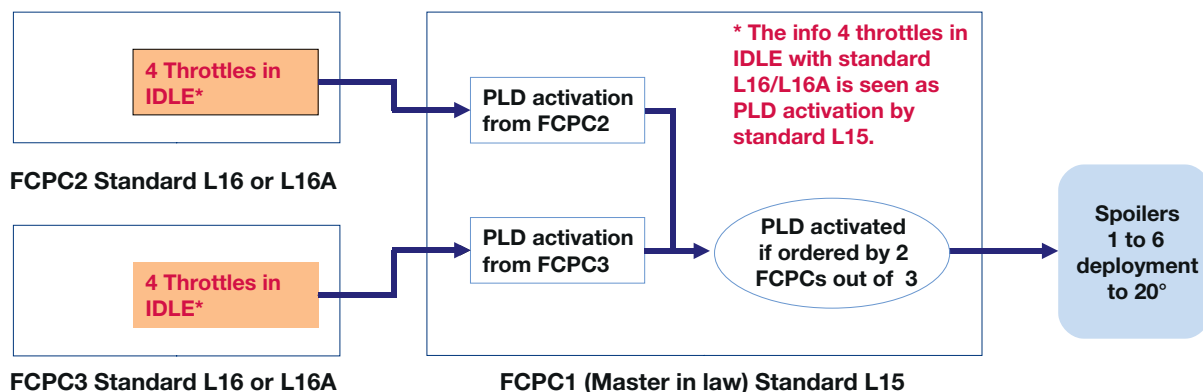
Indeed, in the above configuration, an incompatibility of the parameters exchanged between the three computers lead the “4 throttles in IDLE position” information sent by the two computers in standard L16/L16A to be interpreted as “Phased Lift Dumping (PLD) function activation” by the FCPC in standard L15.

According to the logics of the system, where a function is activated if ordered by at least two of

the three FCPC, FCPC1 ordered the partial deployment of the ground spoilers (Fig 2).

Note: The Phased Lift Dumping function allows the spoilers to deploy with a reduced deflection when only one main landing gear is on the ground and both throttles are in the idle/reverse position

With two FCPCs in standard L16 or L16A



With this incorrect FCPC configuration, when the 4 throttles are in IDLE position, spoilers 1 to 6 deploy to 20° (undue PLD function activation)

Figure 2: Untimely ground spoiler extension as a result of an unauthorized FCPC configuration

3.2 Hard landing

One A330 operator reported an event, which resulted in a severe hard landing and subsequent main landing gear replacement.

During the flare phase, the elevators remained in the neutral position for several seconds in spite of side stick pitch movement orders by the pilot.

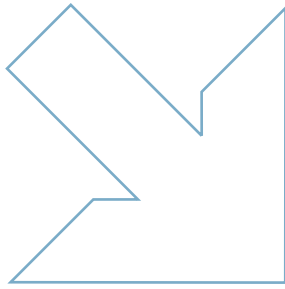
Investigation revealed that while two FCPC - of the same standard and same part number -

were fitted in the first and third computer installation position, the computer in the second position differed in both respects:

- FCPC1 and FCPC3: PN LA2K1A100DA0000 (Standard P8/M17)
- FCPC2: PN LA2K2B100D80000 (Standard P7/M16).

This incorrect FCPC configuration had no consequences on the elevators control during the flight as long as the flight controls were operating in “normal” mode.





In “normal” mode, the FCPC1 transmits the elevator movement orders to its related servo-controls. In parallel it sets the adjacent servo-controls, controlled by FCPC2, in “damping” mode.

In “damping” mode, the adjacent servo-controls ignore the permanent steady-state order sent by FCPC2.

Normal operation is illustrated in fig 3.

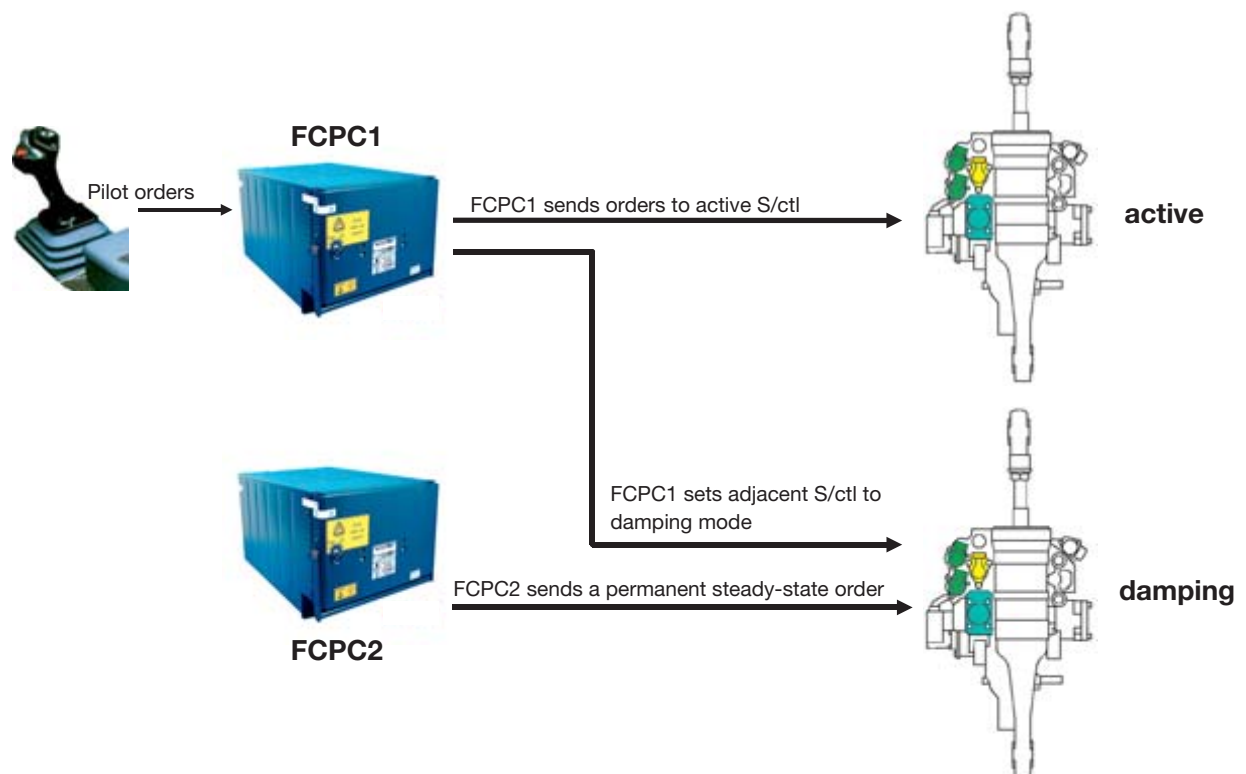


Figure 3: Normal operation

On landing, the Captain started the flare late (height of approximately 20-30ft) and pulled the stick Full Aft. This resulted in a commanded rate of elevator’s deflection of more than 30°/sec, and the consequent activation of the “double pressurization” mode.

In “double pressurization” mode, FCPC1 transmits the elevator movement orders to its related servo-controls and sets the adjacent servo-controls, controlled by FCPC2, in “active” mode. In parallel, it sends a request to FCPC2 to send elevator movement orders to its own related servo-controls. Double pressurization operation is illustrated in fig 4.

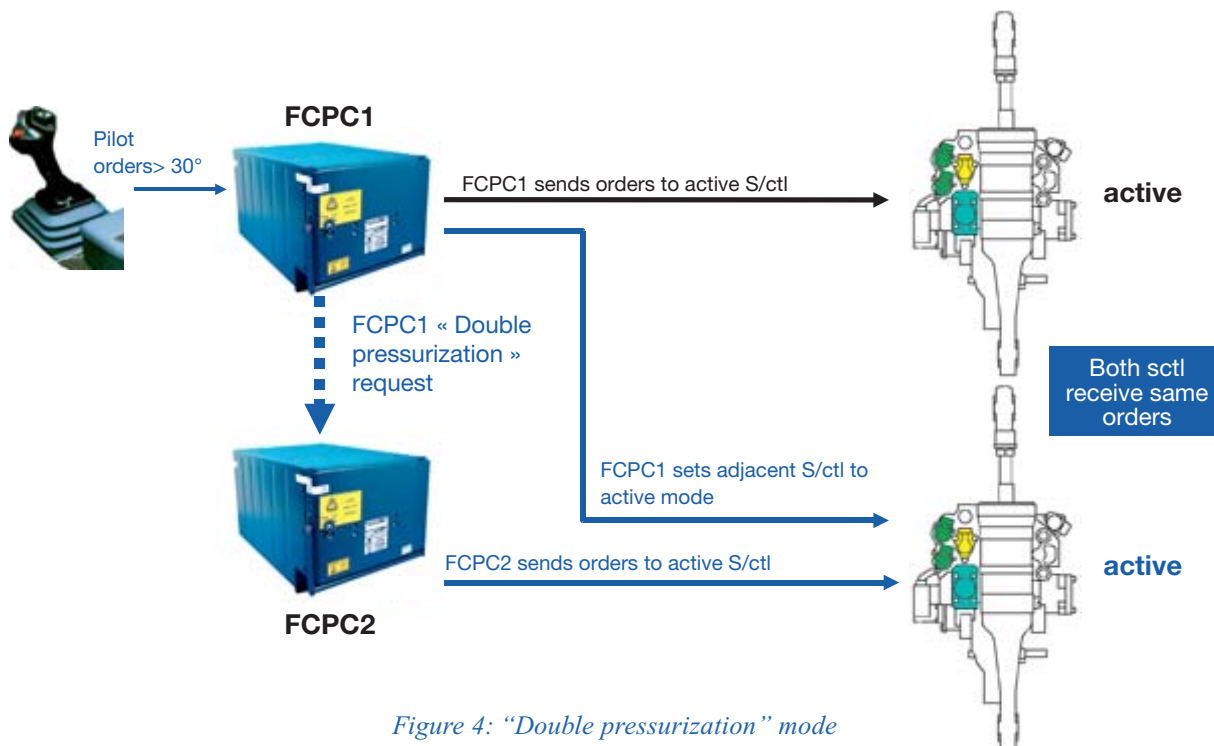


Figure 4: "Double pressurization" mode

In the described occurrence, FCPC2 did not receive the double pressurization request from FCPC1, because of the incorrect FCPC configuration.

FCPC2 therefore continued to send the "by default" steady state order to its servo-controls. This led to "force fighting" between the elevator

servo-controls receiving their orders from FCPC1 and those receiving theirs from FCPC2.

This "force fighting" prevented the elevators to move, thereby contributing to the hard landing. This "double pressurization mode" with incorrect FCPC configuration is illustrated in Fig 5.

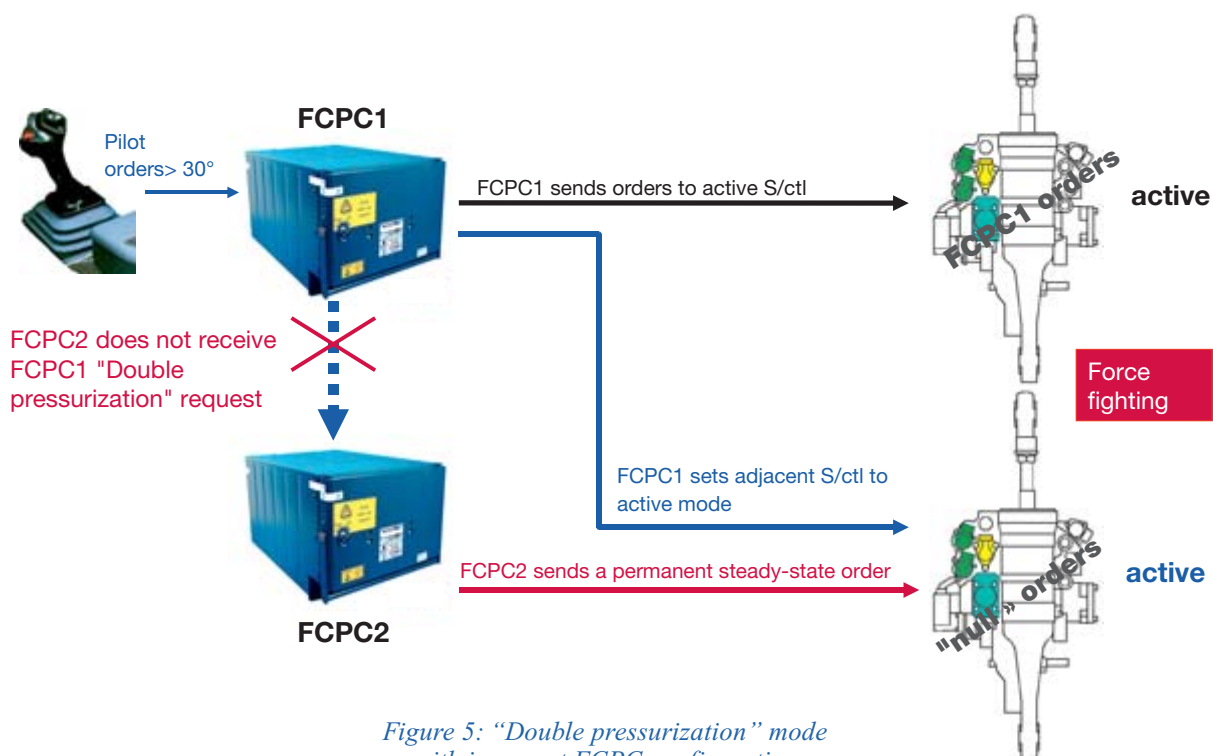


Figure 5: "Double pressurization" mode with incorrect FCPC configuration

4 | A330/A340 FCPC Enhancements

Airbus has developed a new FCPC mixability monitoring to avoid an incorrect FCPC configuration. This monitoring is based on a “compatibility” code exchanged and compared between the FCPC.

With this monitoring, the FCPC will not start with an unauthorized configuration.

A caution is triggered on the Electronic Centralized Aircraft Monitoring (ECAM), associated to a “FAULT” message on the Central Maintenance System (CMS).

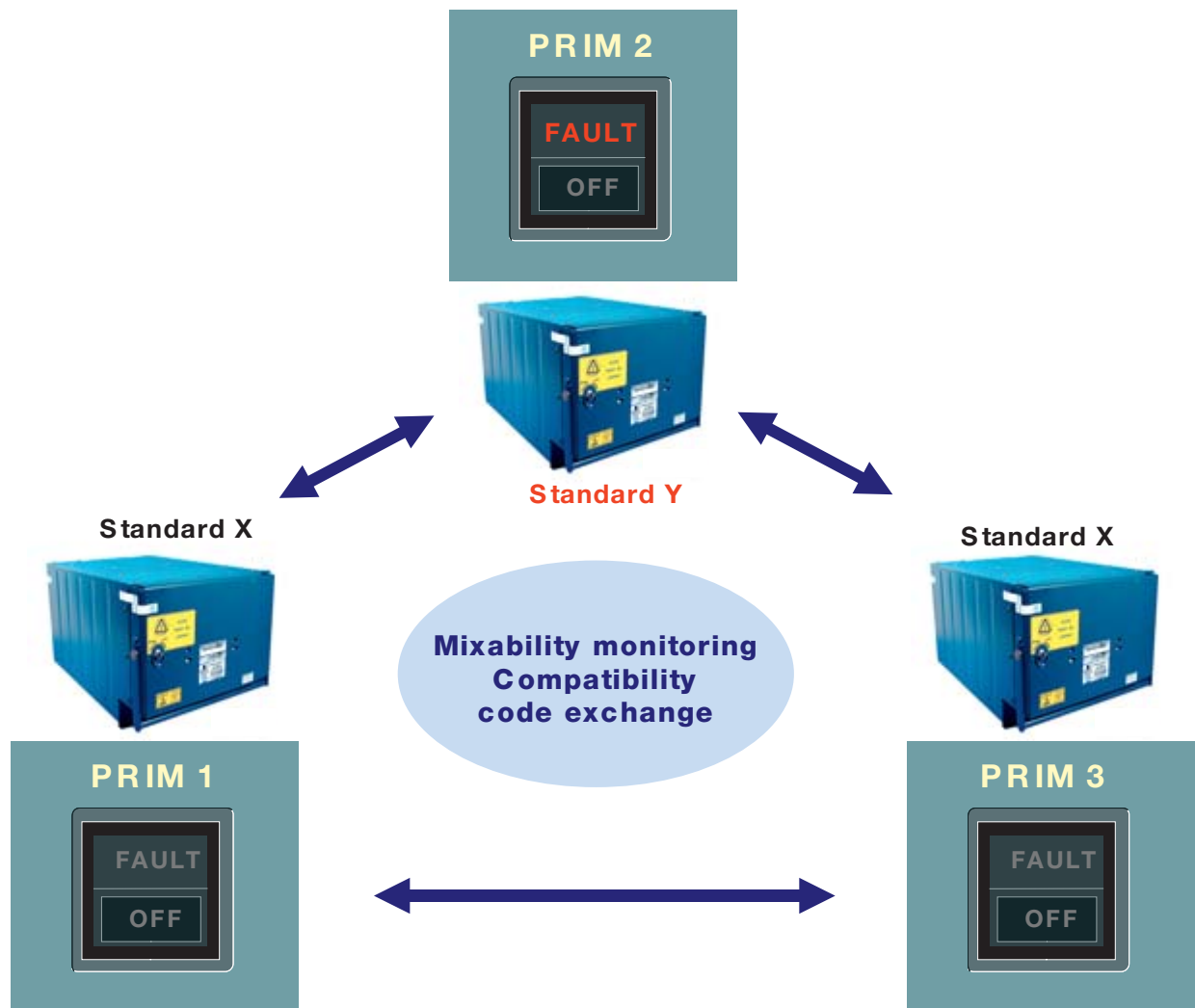


Figure 6: A330/A340 FCPC mixability monitoring

This new monitoring is currently available on all A340-500/600 (FCPC standard W9, PN: LA2K2B100G80000, since Oct. 2005).

Similar monitoring has been developed for all A330/A340 aircraft and will be available with the following FCPC standards:

	Basic (pre mod 49144)		Enhanced (post mod 49144)	
	A330	A340	A330	A340
FCPC standard	P10/M19	L20	P9/M18	L19
Service bulletin	27-3144	27-4144	27-3148	27-4148

Note: A similar monitoring is available on all A380 FCGU (Flight Control and Guidance Unit).

5 | Conclusion

Incorrect A330/A340 FCPC configurations may lead to undesirable operational situations. A new monitoring function has therefore been developed which will, in case of unauthorized configuration, prevent the starting of the FCPC.

SIL 27-150 with detailed flowcharts has been issued as an additional help to quickly determine the interchangeability status of the FCPC Part Numbers.

A wide-ranging lesson may be learned from these particular occurrences, which pertains to all calculators aboard all types of aircraft:

It is important, when replacing computers, to adhere to the interchangeability and mixability rules laid out in the Illustrated Parts Catalog (IPC) and Service Bulletins.

This insures that the aircraft remains in a certified configuration. Deviation from these rules means flying in an uncertified configuration that may result in unexpected operation of the systems.

Operator Information Telex (OIT) Ref. 999.0085/04, Ref. 999.0079/08 and EASA Safety Information Bulletin Ref. 2008-86 were issued to remind operators of the importance of adhering to the interchangeability and mixability rules that are given in the IPC and Airbus Service Bulletins.





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