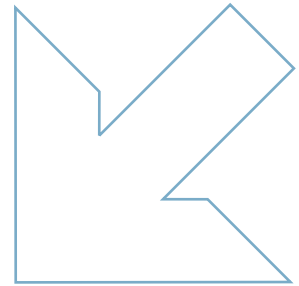




# Braking system cross connections



**By: Thierry THOREAU**  
*Director, Flight Safety*

## 1 | Introduction

The braking system cross connections have generated a few incidents over the years. The worst case experienced on the Airbus fleet further to a case of braking system cross connections, led the airplane to stop around 150 feet from the extended runway centerline. An emergency evacuation was initiated and everybody escaped safely, without serious injuries. The aircraft sustained some damages.

This document will present:

- The two types of cross connections reported and their consequences
- The existing prevention measures
- The operational procedure to mitigate them
- And finally the improvements already implemented, or contemplated.

Increased awareness on these possible maintenance errors should help avoiding or mitigating further events.

## 2 | Type of events reported on the Single Aisle aircraft family

- A few cases of Main Landing Gear — MLG — tachometer cross connections have been reported. These cross connections were done at the level of the wheels axis, as shown on figure 1.

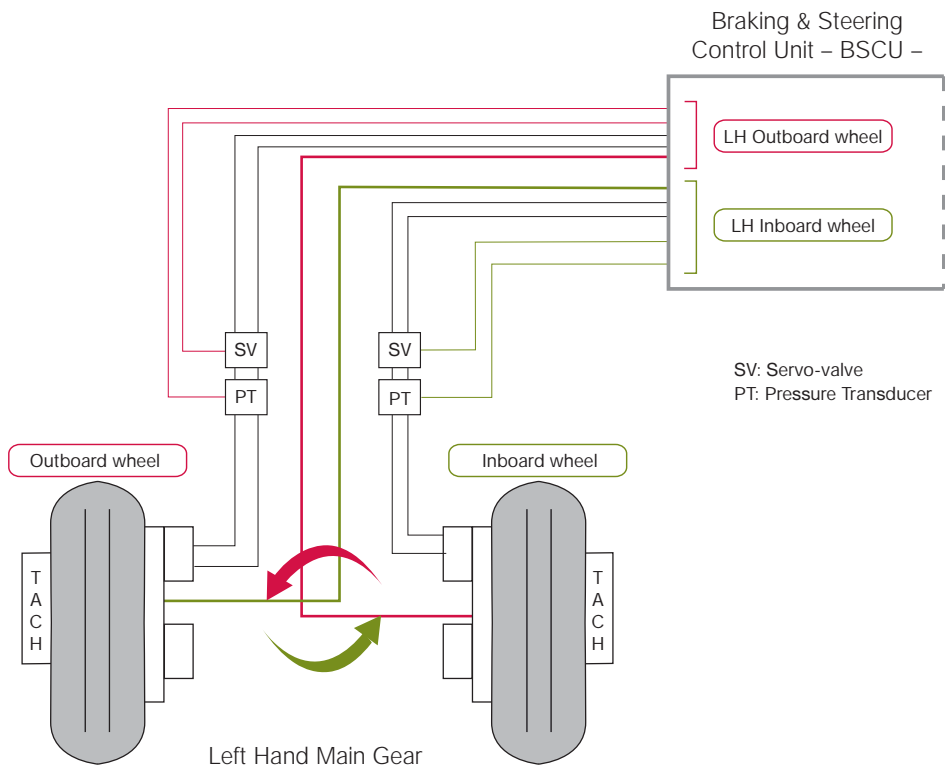


Figure 1: Schematic of tachometer cross connections

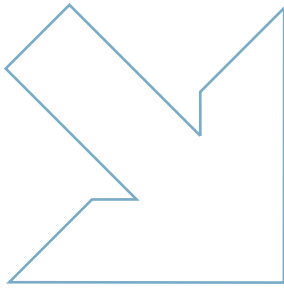
Figure 2 shows an actual cross connection on the right hand side main gear. The cable labelled 19GG-A/22GG-A connected to the tachometer (the blue cylindrical equipment

which can be partially seen on the right hand side of the picture), should in fact have been the cable 20GG-A/21GG-A.



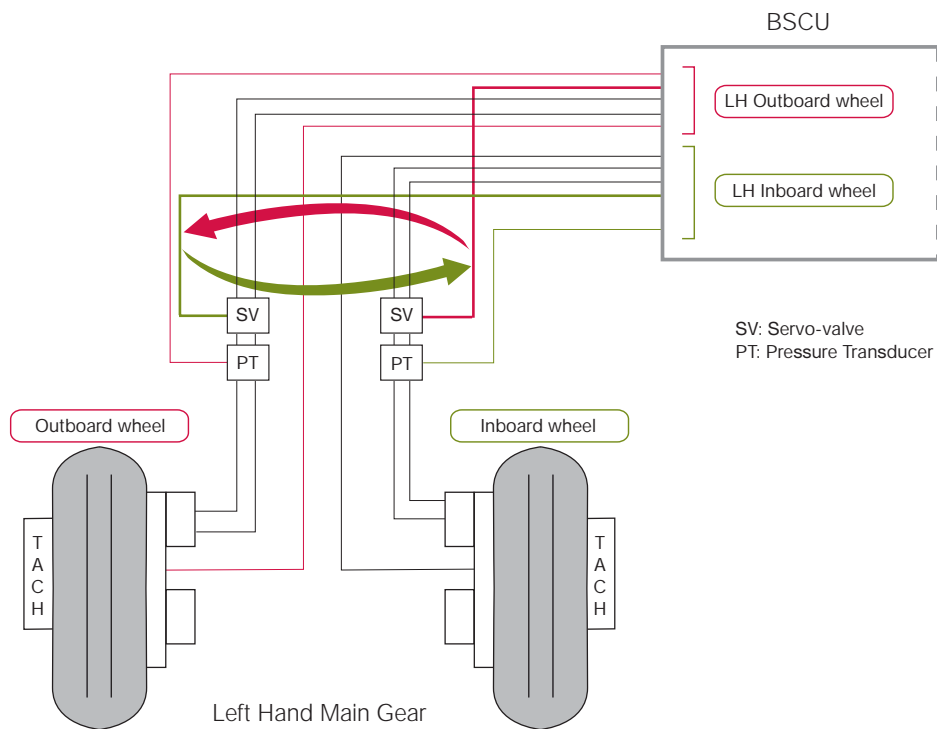
Figure 2: Picture of tachometer cross connections





- Even if only two cases have been reported to Airbus, it is worth mentioning the other type of cross connections experienced so far.

It involves the connections to the servo-valves, as shown on figure 3.



*Figure 3: Schematic of servo-valve cross connections*

The lower number of cases that have been reported can be explained by the fact that the flanges supporting the servo-valve cables have different lengths. This type of cross connections are thus more difficult to realize.

Figure 4 shows an example of servo-valve cross connections.

It shows that the flange supporting the cable to the lower servo-valve allows an easy connection only on the lower servo-valve.

In this case, the flange forced the cable wrongly connected to the upper servo-valve to make an excessively sharp bend.

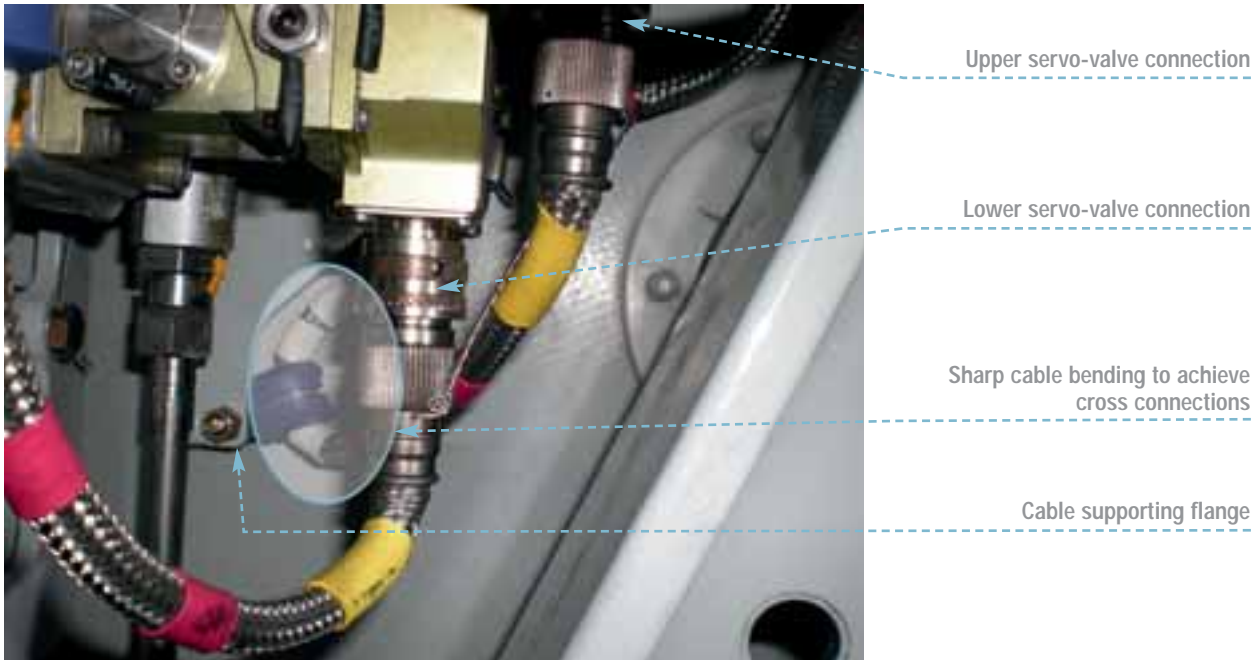


Figure 4: Picture of servo-valve cross connections

### 3 Existing measures on the Single Aisle aircraft family

The Braking & Steering Control Unit – BSCU – (3GG), the servo-valves (15 GG, 16 GG, 17GG, 18GG) and the tachometers (19GG, 20GG, 21GG, 22GG) are the key components of the braking system. They must be properly connected to ensure efficient braking.

The BSCU compares each wheel speed to a computed reference speed and releases associated brake pressure if need be.

**In case of cross connections**, the braking performance will not be impacted as long as the anti-skid function is not activated. **If the anti-skid function is activated**, the BSCU will release the brake pressure on the opposite wheel, while maintaining the brake pressure on the already skidding wheel. **The braking performance will then be significantly affected.**

*Note: Use of differential braking to correct the yaw tendency might be useless in this case, as the anti-skid system still provides braking orders to the wrong wheel.*

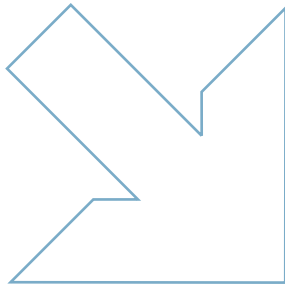
In the majority of the reported cases, cross connections were evidenced further to tyres abnormal wear (flat spots) or bursts, and did not lead to serious incidents. However in a few cases these cross connections led to runway excursions.


This is why it is important to keep in mind existing measures.

#### Maintenance

The Aircraft Maintenance Manual – *AMM – task 32-42-00-720-002* is specifically designed to detect cross connections.

AMM indicates in a specific note that: *“You must do this test if there is a risk of wiring cross connections between two tachometers (replacement of the MLG or of the electrical harness of the MLG)”.*



<b>AIRBUS TRAINING</b>  <b>A320</b> SIMULATOR	<b>EMERGENCY PROCEDURES</b>	REV 36	<b>1.13</b>
		SEQ 001	

<b>LOSS OF BRAKING</b>	
<ul style="list-style-type: none"><li>• <b>IF AUTOBRAKE IS SELECTED:</b><ul style="list-style-type: none"><li>- BRAKE PEDALS . . . . . PRESS</li></ul></li><li>• <b>IF NO BRAKING AVAILABLE:</b><ul style="list-style-type: none"><li>- REV . . . . . MAX</li><li>- BRAKE PEDALS . . . . . RELEASE</li><li>- A/SKID &amp; N/W STRG . . . . . OFF</li><li>- BRAKE PEDALS . . . . . PRESS</li><li>- MAX BRK PR . . . . . 1000 PSI</li></ul></li><li>• <b>IF STILL NO BRAKING:</b><ul style="list-style-type: none"><li>- PARKING BRAKE . . . . . SHORT AND SUCCESSIVE APPLICATIONS</li></ul></li></ul>	

Figure 5: Loss of braking “memory item” procedure

### Operations

Should there be cross connections and an anti-skid function activation during the landing roll, the crew will perceive two things:

- A yawing tendency, and
- An unusually small deceleration.

While controlling the lateral trajectory, if the aircraft's deceleration rate is perceived as significantly below expectation, the crew must apply the Loss of Braking “memory item” procedure shown on figure 5.

The procedure calls for the anti-skid function to be turned OFF, thereby eliminating the major consequence of the cross connections.

It is worth mentioning that in these circumstances, it might be appropriate for the flight crew to maintain full reverse thrust below the SOP minimum recommended speed for full reverse use. The Standard Operating Procedure for Landing will be updated accordingly at the next general revision to indicate that, in case of emergency, maximum reverse thrust might be used until a complete stop.

## 4 | Maintenance documentation improvements

Recently, the AMM task 32-42-00-720-002 has been amended to include the monitoring of the brake's wear pin and brake unit deflection, in addition to the previous monitoring of the brake's piston movements, as additional means to determine proper brake operation.

This task is now also required further to the installation of servo-valves.

## 5 | Future improvements

- The Trouble Shooting Manual (TSM) will be enhanced to include an entry point in case of tyre flat spot(s), to look for possible cross connections
- On the Single Aisle (SA) family, cable colour coding is currently under review to avoid crossing cables.

*Note: All SA family changes*

- *introduced (addition of warnings in AMM, monitoring of the brake's wear pin and brake unit deflection to determine brake operation)*
  - *planned (TSM entry in case of tyre flat spots)*
  - *or under review (cable colour coding)*
- are being considered as well on the other families of Airbus aircraft fitted with boogie gears. On these types of landing gear, the consequences of cross connections are reduced compared to the diablo versions.*

## 6 | Conclusion

Crossed cables in the braking system have, in the past, caused incidents. It is therefore important to comply strictly with the published maintenance procedure.

Pilots facing a situation where the airplane yaws to one side and the aircraft's deceleration rate is perceived as significantly below normal, may suspect brake cross connections. They should apply the Loss of Braking "memory item", which calls for the anti-skid function to be turned OFF.

### REFERENCE

*Operator Information Telex (OIT) ref 999.0133/07/LB Rev 01 issued on the 30<sup>th</sup> of April 2008, reminds the operators to strictly adhere to the AMM task 32-42-00-720-002 "Functional Test of Tachometers" whenever it needs to be applied.*





# Safety First

The Airbus Safety Magazine  
For the enhancement of safe flight through  
increased knowledge and communications.

Safety First is published by the Flight Safety Department of Airbus. It is a source of specialist safety information for the restricted use of flight and ground crew members who fly and maintain Airbus aircraft. It is also distributed to other selected organisations.

Material for publication is obtained from multiple sources and includes selected information from the Airbus Flight Safety Confidential Reporting System, incident and accident investigation reports, system tests and flight tests. Material is also obtained from sources within the airline industry, studies and reports from government agencies and other aviation sources.

All articles in Safety First are presented for information only and are not intended to replace ICAO guidelines, standards or recommended practices, operator-

mandated requirements or technical orders. The contents do not supersede any requirements mandated by the State of Registry of the Operator's aircraft or supersede or amend any Airbus type-specific AFM, AMM, FCOM, MEL documentation or any other approved documentation.

Articles may be reprinted without permission, except where copyright source is indicated, but with acknowledgement to Airbus. Where Airbus is not the author, the contents of the article do not necessarily reflect the views of Airbus, neither do they indicate Company policy.

Contributions, comment and feedback are welcome. For technical reasons the editors may be required to make editorial changes to manuscripts, however every effort will be made to preserve the intended meaning of the original. Enquiries related to this publication should be addressed to:

## Airbus

Product Safety department (GS)  
1, rond point Maurice Bellonte  
31707 Blagnac Cedex - France  
Fax: +33(0)5 61 93 44 29  
[safetycommunication@airbus.com](mailto:safetycommunication@airbus.com)



Safety First  
# 07 February 2009

Safety First is published  
by Airbus S.A.S  
1, rond point Maurice Bellonte  
31707 Blagnac Cedex / France

**Editor:**  
Yannick Malinge,  
Vice President Flight Safety

**Concept Design** by  
MULTI MEDIA SUPPORT 20090053

**Computer Graphic** by Quat'cou

**Copyright:** GSE 420 0046/09

Photos copyright Airbus  
Photos by  
ExM: Hervé Berenger, Philippe  
Masclat, Hervé Goussé.  
Photo copyright Germanwings

Computer rendering by ABAC

Printed in France by AMADIO

© Airbus S.A.S. 2009 – All rights reserved. Confidential and proprietary documents.

By taking delivery of this Brochure (hereafter "Brochure"), you accept on behalf of your company to comply with the following guidelines:

- > No other intellectual property rights are granted by the delivery of this Brochure than the right to read it, for the sole purpose of information.
- > This Brochure and its content shall not be modified and its illustrations and photos shall not be reproduced without prior written consent of Airbus.
- > This Brochure and the materials it contains shall not, in whole or in part, be sold, rented, or licensed to any third party subject to payment.

This Brochure contains sensitive information that is correct at the time of going to press. This information involves a number of factors that could change over time, effecting the true public representation. Airbus assumes no obligation to update any information contained in this document or with respect to the information described herein.

Airbus SAS shall assume no liability for any damage in connection with the use of this Brochure and of the materials it contains, even if Airbus SAS has been advised of the likelihood of such damages.