

*International Civil Aviation Organization*



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**THE FOURTH MEETING OF MODE S DOWNLINKED  
AIRCRAFT PARAMETERS WORKING GROUP  
(MODE S DAPs WG/4)**

Video Teleconference, 29 – 31 March 2021

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**Agenda Item 4:** Mode S monitoring and analysis

**ANALYSIS OF FALSE SFL MISMATCH ALARM IN ATM AUTOMATION SYSTEM**

(Presented by China)

**SUMMARY**

This paper described the phenomenon and impact of false SFL mismatch alarm in the ATM automation system, analyzes the causes of false SFL mismatch alarm, and proposes corresponding control measures in Mode S radar and automation system respectively.

**1. INTRODUCTION**

1.1 At present, in China, more and more ATM automation systems can process EHS information from Mode S radar through functional improvements. The SFL data in BDS code 4,0 is used for supplementary information display in the label and calculation of the SFL mismatch alarm.

1.2 Recently, a few false SFL mismatch alarms occurred in the Chengdu ATM automation system. By further analysis, these false alarms are caused by the erroneous BDS code 4,0 data received by the ATM automation system, which was sent by Mode S radar.

**2. DISCUSSION**

False SFL mismatch alarm

2.1 An SFL mismatch alarm occurred in the automation system indicating the SFL and the CFL of the aircraft deviated, while the controller did not perform any CFL operation in the automation system, and did not issue an altitude change to the crew. Meanwhile, the controller confirmed to the crew via voice that the crew did not perform the SFL change operation. In this situation, this SFL mismatch alarm is believed to be a false alarm.

2.2 After analyzing the data of the false SFL mismatch alarms in the ATM automation system, it is confirmed that the SFL data of the aircraft received by the ATM automation system has indeed changed at that time. These changed SFL data are derived from the erroneous BDS code 4,0 data sent by the Mode S radar.

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2.3 According to the statistics, there were about 14 false SFL mismatch alarm cases that occurred in the Chengdu ATM automation system from December 1 to December 7, 2020. Frequent false SFL mismatch alarms would reduce the vigilance of the controller to the alarm and delay the handling actions.

BDS SWAP phenomenon

2.4 After further analysis of the raw data received by the ATM automation system, it is found that in most cases, the erroneous BDS code 4,0 data only appear in a single antenna cycle of a single radar. The aircraft's BDS code 4,0 data received in the automation system returned to normal in the next cycle and the alarm would disappear. In addition, the erroneous BDS code 4,0 data is often consistent with the data in other BDS registers of the same flight at the same time. Therefore, based on this phenomenon, it is highly suspected that this kind of error is caused by the BDS SWAP problem, which is described in the Mode S DAPs IGD (APPENDIX 2: LIST OF IDENTIFIED ISSUES).

2.5 Several sets of erroneous data suspected to be BDS SWAP show as below (The statistics are derived from the radar data received by the automation system):

| Time       | Radar  | Register     | Data          |
|------------|--------|--------------|---------------|
| 19: 22: 46 | YBNINR | BDS code 4,0 | FFB3B2F6004E9 |
| 19: 22: 46 | GUIGLR | BDS code 5,0 | FFB3B2F6004E9 |
| Time       | Radar  | Register     | Data          |
| 13: 04: 35 | TORINR | BDS code 1,7 | FE81C30000000 |
| 13: 04: 38 | GUIGLR | BDS code 1,7 | FE81C30000000 |
| 13: 04: 45 | KWLSLX | BDS code 4,0 | FE81C30000000 |

| Time       | Radar  | Register     | Data          |
|------------|--------|--------------|---------------|
| 19: 07: 45 | FDSTHA | BDS code 4,0 | 8056D33FFFFCE |
| 19: 07: 45 | GUIGLR | BDS code 5,0 | 8056D33FFFFCE |

| Time       | Radar  | Register     | Data           |
|------------|--------|--------------|----------------|
| 00: 19: 39 | YBNINR | BDS code 4,0 | FFB2D3442004D8 |
| 00: 19: 39 | GUIGLR | BDS code 5,0 | FFB2D3442004D8 |

| Time       | Radar  | Register     | Data          |
|------------|--------|--------------|---------------|
| 17: 52: 28 | TORINR | BDS code 5,0 | FF2D3456004E3 |
| 17: 52: 30 | GUIGLR | BDS code 5,0 | FF2D3456004E3 |
| 17: 52: 33 | YBNINR | BDS code 4,0 | FF2D3456004E3 |
| 17: 52: 34 | FDSTHA | BDS code 5,0 | FF2D3456004E3 |
| 17: 52: 36 | TORINR | BDS code 5,0 | FF2D3456004E3 |

2.6 In the DAPs WG/1 meeting, the IP10-SSR MODE S DAPS VALIDATION AND EVALUATION CONDUCTED BY ENRI submitted by Japan had mentioned this phenomenon. The interrogations issued by two different radars reached the aircraft almost simultaneously, and only one reply was generated by the aircraft (Transponder usually reply to the interrogation which has a stronger signal). After the reply received by these two radars, the data received by one radar is inconsistent with the data register it requested. According to the current Mode S radar working mechanism, the radar itself is not able to recognize this kind of erroneous data. (There is no PI-parity/interrogator identifier item in the current DF20 and DF21 data)

2.7 According to the principle, the probability of BDS SWAP is closely related to the situation of radar multiple coverages and the radar interrogation strategy. In a specific area, the probability of BDS SWAP will increase significantly as the overall interrogation times increase. In the area where this problem frequently occurs in the Chengdu automation system, there are currently multiple Mode S radars, and some high-altitude areas are even covered by more than 7 Mode S radars.

2.8 According to the recommendations in the Mode S DAPs IGD and the analysis of data processing logic in the automation system, there are two aspects of methods to reduce the false SFL mismatch alarms in the ATM automation system:

2.9 For Mode S Radars:

- Mode S radar deploying strategy adjustment, the operational environment should be considered comprehensively to reduce the unnecessary expansion of radar coverage.
- Mode S radar interrogation strategy adjustment, reducing the frequency of interrogation for specific BDS without impact on the ability to provide timely and effective data.

2.10 For ATM automation systems:

Because the erroneous data caused by BDS SWAP usually appears only in one single radar for one single antenna period, the processing logic of the SFL mismatch alarms could be improved accordingly:

- In the case that there are multiple data sources for the aircraft's BDS code 4,0, add a multi-data sources confirmation mechanism.
- In the case that there is only a single data source for the aircraft's BDS code 4,0, a multi-period confirmation mechanism.

As the modification of the processing logic may affect the timing of the SFL mismatch alarm, there should be an evaluation before the ATM automation system is modified accordingly.

### **3. ACTION BY THE MEETING**

3.1 The meeting is invited to:

- a) note the information contained in this paper;
- b) discuss any relevant matters as appropriate.

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