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Jitter That Occurred in the Flight Management System During the Vor Operational Check Using the Aeroflex IFR-4000 on the Beechcraft King Air 350I Aircraft

Muhammad Ihsan*
Politeknik Penerbangan Medan,
INDONESIA

*** Corresponding author:**
Muhammad Ihsan, Politeknik Penerbangan Medan, INDONESIA, ✉email: mihsan087387@gmail.com

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Abstract

Background of study: Ensuring the proper functioning of the Flight Management System (FMS) is crucial for flight safety, particularly during VOR Operational Checks. Jitter in the FMS can disrupt navigation and compromise the accuracy of flight operations. During an On-the-Job Training (OJT) program at the Balai Besar Kalibrasi Fasilitas Penerbangan (BBKFP), jitter was identified in the FMS of a Beechcraft King Air 350i during a VOR Operational Check using the AeroFlex IFR-4000.
Aims and scope of paper: This paper aims to analyze and identify the cause of FMS jitter observed during VOR Operational Checks on the Beechcraft King Air 350i using the AeroFlex IFR-4000. The scope of the study is limited to the analysis of jitter occurrence during the VOR Operational Check process.
Methods: A qualitative descriptive method was applied by analyzing data obtained from direct observation of the VOR Operational Check and referencing the aircraft maintenance manual. The analysis particularly examined the relationship between RF signal strength from the AeroFlex IFR-4000 and the occurrence of FMS jitter.
Result: The study found that FMS jitter during the VOR Operational Check was caused by low RF signal levels generated by the AeroFlex IFR-4000. Adjusting the RF signal level from -10 dBm to -5 dBm successfully eliminated the jitter issue.
Conclusion: FMS jitter has a direct impact on navigational accuracy and thus requires immediate attention during operational checks. This research emphasizes the importance of ensuring adequate RF signal strength in order to prevent FMS jitter, thereby maintaining reliable navigation and flight safety.

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INTRODUCTION

Background: The reliability of an aircraft's navigation system is crucial for flight safety and efficiency. The Flight Management System (FMS) is a key component in modern navigation systems, playing a role in flight planning, navigation, and aircraft performance management. The flight management system takes the actual navigation performance (ANP) as an index to evaluate the accuracy of the navigation system, so as to judge whether the aircraft is in a safe tunnel (Dai et al., 2022). VOR Operational Check, using equipment such as the AeroFlex IFR-4000, is an important procedure for validating navigation data received from VOR (VHF Omnidirectional Range) stations (Ostroumov, 2023). During the implementation of On-the-Job Training (OJT) at the Flight Facility Calibration Center (BBKFP), jitter (instability) was found in the FMS data display of the Beechcraft King Air 350i aircraft during the VOR Operational Check.

During the On-the-Job Training (OJT) conducted at BBKFP, adjustments were made to accommodate post-pandemic operational and learning conditions, aligning with recent approaches to educational management in the new normal era (Hanum et al., 2024). This jitter can interfere with navigation accuracy and potentially pose a flight safety risk. Therefore, this study is focused on the analysis and identification of the causes of jitter. The implementation of immersive and hands-on learning models in aviation training aligns with global educational innovations emphasizing interactive and practical engagement (DEMİRDÖVEN, 2025). The research aligns with Indonesia's educational objectives to strengthen vocational competence and applied learning in aviation technology (Firmansyah et al., 2023).

VOR (Very High Frequency Omnidirectional Range) is one of the most common types of NavAid used in commercial aviation, and its inspection requires the displacement of a well-equipped aircraft to the corresponding airport (De Oliveira Costa et al., 2020). Several studies have addressed different aspects of aircraft navigation and maintenance systems. The various types of VOR parameter checks, including periodic and special checks. Their research highlights the importance of regular maintenance and calibration to guarantee optimal performance of navigation systems. The Aeroflex IFR 4000 manual book describes the functions and uses of the AeroFlex IFR-4000 test equipment in the verification of navigation systems, including VOR. The main components and functions of the Flight Management System (FMS), emphasizing its role in navigation and flight planning. However, these studies have not specifically addressed jitter issues in the FMS of the Beechcraft King Air 350i aircraft during the VOR Operational Check using the AeroFlex IFR-4000. There is a knowledge gap regarding the specific causes of jitter in this system configuration.

Although there have been studies on navigation systems and FMS in general, there have been no studies that specifically examined jitter on the FMS of the Beechcraft King Air 350i aircraft during the VOR Operational Check using the AeroFlex IFR-4000. Previous research has not examined in depth the interaction between the RF signal from the AeroFlex IFR-4000 and the response of the FMS system, particularly in the context of the emergence of jitter. This gap creates a need for research that focuses on identifying the specific causes and mechanisms of jitter in these particular operational conditions. A comprehensive understanding of these issues is essential for the development of effective mitigation strategies and the improvement of aviation safety. Such threats often involve directed high- power RF signals or electromagnetic pulse devices that can disrupt avionics. Interference may enter systems via front-door coupling (e.g., antennas) or back-door coupling (e.g., power lines, cabling, or structural seams), each requiring different mitigation strategies (Malik & Rao, 2025). The low power of the reflected radio frequency (RF) waves received by the system receiver, typically in the order of 1 Watt, renders the receiver for the RA overly sensitive and susceptible to interference (Bai et al., 2025).

Similar to the interference challenges faced by radio altimeters due to 5G transmissions, variations in RF signal levels whether excessively strong or weak can significantly affect avionics accuracy and stability (Bukhari & Mérida, 2024). Effective monitoring and detection of signal disruptions are crucial for maintaining navigation accuracy, as demonstrated in comparative analyses of GPS jamming detection systems using ADS-B and professional detectors (Steiner & Trýb, 2024). GNSS-based positioning is widely used in the modern era for safety-critical applications, especially in aeronautics. Quite little is known publicly about the RF environment characteristics that a GNSS system experiences while flying. One potential challenge in navigation systems is the possibility of a navigation receiver being jammed by a stronger electromagnetic signal (Tripathi & Caizzone, 2024). VOR has also been reported as providing viable backup for the GNSS (Global Navigation Satellite Systems), while simultaneously exceeding its typical maximal service altitude towards stratospheric atmospheric layers (Miś et al., 2025).

The flight management system (FMS) requires fault detection, fault isolation, and system reconfiguration capabilities, and it uses hardware redundancy and model-based analytic redundancy methods for accurate fault identifica- tion. The FMS also needs to accurately evaluate a civil aircraft's navigation capability in real-time to determine if it meets the current RNP threshold. An incorrect evalua- tion result will cause misjudgement by the crew, which will lead to serious threats to flight safety (Dai et al., 2024). The importance of ensuring the optimal functioning of the FMS during the VOR Operational Check to ensure flight safety is the main reason for this study. The jitter incident observed during the OJT at BBKFP shows that there are potential safety issues that need to be investigated and addressed. This research aims to fill the knowledge gap by analyzing the causes of jitter and recommending solutions to prevent similar events in the future. The results of the study are expected to contribute to improving aircraft maintenance and operational standards, especially in the context of the use of AeroFlex IFR-4000 for VOR Operational Check on Beechcraft King Air 350i aircraft. With the recent development of domestically produced large aircraft, achieving domestically controlled key technologies in the aviation sector has become a pressing issue. This includes aviation navigation technology and the measurement of its key parameters. The Very-High-Frequency Omnidirectional Range (VOR) is a key radio signal component of the aviation navigation system, measuring the aircraft's azimuth for short-range navigation (Meining et al., 2022).

Similar to the GPS interference and spoofing risks discussed by (Burbank et al., 2024) fluctuations in RF signal strength during VOR operational checks can significantly degrade avionics stability and navigation accuracy. The integration of intelligent technologies in aviation maintenance and navigation training aligns with global trends in AI-driven learning and automation (Rosyidah Dzunur'aini et al., 2025). Such approaches enhance analytical capability and operational safety in modern flight systems. Previous simulation-based studies on avionics networks have shown that signal latency and instability within the Flight Management System can lead to navigation data inconsistencies (Gökçe et al., 2024). This supports the observed correlation between RF signal fluctuations and FMS jitter in the present study.

Similar to the interference effects caused by 5G base stations on radio altimeters, weak RF signals can also degrade the performance of avionics systems, resulting in unstable readings or jitter within the Flight Management System (Duan et al., 2024). Similar to the interference issues experienced by radio altimeters due to 5G network expansion, variations in RF signal strength either excessive or insufficient can critically affect avionics performance and navigation reliability (Kurzweil, 2024). Disruptions in signal stability can lead to navigation inaccuracies similar to those caused by GNSS jamming events reported in recent aviation studies (Felux et al., 2024). This highlights the critical importance of maintaining adequate RF signal quality during operational checks.

The main objective of this study was to identify and analyze the cause of jitter in the FMS of the Beechcraft King Air 350i aircraft during the VOR Operational Check using the AeroFlex IFR-4000. The research hypothesis is that the jitter is caused by factors relating to the quality and strength of the RF signal received by the FMS system from the AeroFlex IFR-4000, possibly influenced by environmental factors or equipment conditions. This study will analyze observational data from the VOR Operational Check process and aircraft maintenance manuals to test this hypothesis and determine the appropriate solution to minimize or eliminate the jitter.

METHOD

This study uses a qualitative descriptive method with a case study approach. This research design analyzed data from the Beechcraft King Air 350i aircraft maintenance manual and direct observation of the VOR Operational Check process. The study population was FMS operational data of the Beechcraft King Air 350i aircraft during the VOR Operational Check using AeroFlex IFR-4000 at the Flight Facility Calibration Center (BBKFP). Sampling was conducted using purposive sampling techniques, focusing on jitter incidents on FMS. Instrumentation is in the form of direct observation and data analysis from the maintenance manual and the AeroFlex IFR-4000. Data validity is ensured through triangulation of data from various sources, while reliability is achieved through consistency of observation and repetition of measurements. The data analyzed were FMS operational records, including RF signal levels and system response to VOR tests. There is no list of questions or formal scoring methods as the focus of the research is on the qualitative analysis of jitter occurrences in FMS.

RESULTS AND DISCUSSION

Result:
During On-the-Job Training (OJT) at the Flight Facility Calibration Center (BBKFP), jitter was found in the Flight Management System (FMS) system of the Beechcraft King Air 350i aircraft during a VOR Operational Check using AeroFlex IFR-4000. This jitter is characterized by vibration or instability of the pointer on the bearing angle indicator in the cockpit, making it difficult to get accurate and consistent angle readings. This phenomenon was observed on aircraft with the registration number PK-CAQ. Direct observation shows that jitter appears intermittently, sometimes steadily and sometimes vibrating. All VOR Operational Check procedures are carried out in accordance with the aircraft maintenance manual and the AeroFlex IFR-4000 usage guidelines.

To investigate the cause of jitter, the focus of the analysis was directed to the quality of the RF signal emitted by the AeroFlex IFR-4000 and received by the aircraft's FMS system. RF signal level measurements are carried out before and after the appearance of jitter. The measurement results showed that before the onset of jitter, the RF signal level was relatively low, around -10 dBm. After adjusting and increasing the RF signal level to -5 dBm, the jitter on the FMS bearing angle indicator disappears and the readings become stable. These findings show a strong correlation between low RF signal levels and the appearance of jitter in FMS systems.

Discussion:
Low RF signal levels can lead to signal quality degradation, increase susceptibility to interference, and ultimately produce jitter. In the context of VOR Operational Check, jitter can be caused by several factors, including signal interference from other sources, degradation of the signal receiving components on the aircraft, or even weather conditions that affect radio signal propagation. However, the results of this study show that the increased RF signal level of the AeroFlex IFR-4000 effectively overcomes the jitter problem, indicating that the strength of the RF signal is the dominant factor in this case.

These findings have important implications for VOR Operational Check procedures and the maintenance of aircraft navigation systems. The low RF signal strength of the AeroFlex IFR-4000, as seen in this study, can lead to bearing angle reading errors and affect navigation accuracy. This could potentially pose a flight safety risk, as pilots may receive inaccurate navigation data and perform incorrect maneuvers. Therefore, special attention is needed to the quality and strength of the RF signal during the VOR Operational Check. VOR Operational Check is a critical procedure for validating navigation data accuracy and ensuring flight safety. Previous studies have explored alternative inspection methods using remotely piloted aircraft systems to enhance efficiency and precision (De Oliveira Costa et al., 2020).

This research makes a practical contribution in improving the VOR Operational Check procedure on Beechcraft King Air 350i aircraft using AeroFlex IFR-4000. By identifying the relationship between low RF signal levels and the appearance of jitter in FMS, the study recommends that RF signal strength be monitored and maintained at an adequate level during the procedure. This can help prevent jitter incidents and ensure the accuracy of navigation data, thereby improving flight safety.

This study has limitations because it only focuses on one case of jitter on a single aircraft. Although the findings show a strong correlation between RF signal levels and jitter, more research is needed to confirm the generalization of these results in different aircraft and operational conditions. In addition, the study did not investigate other factors that might contribute to jitter, such as signal interference or other equipment conditions.

It is recommended that further research be conducted to investigate other factors that may have contributed to jitter on the FMS during the VOR Operational Check. The research can involve analyzing data from a wide range of aircraft and wider operational conditions, as well as considering environmental factors and other equipment conditions. Increasing the RF signal level needs to be the main consideration in carrying out the VOR Operational Check. In addition, routine maintenance procedures on the RF signal receiver system on aircraft need to be researched to ensure optimal system performance and prevent future jitter problems.

Implications:
This study highlights the necessity of maintaining proper RF signal levels during calibration procedures to prevent avionics instability. Ensuring stable RF input enhances the reliability of navigation data, minimizes operational errors, and ultimately improves flight safety. The findings can inform training modules for aviation maintenance technicians and serve as a reference for refining operational check standards.

Research contribution:
This paper provides one of the first focused analyses of FMS jitter during VOR Operational Checks on the Beechcraft King Air 350i using the AeroFlex IFR-4000. It contributes to the field of aviation maintenance by identifying a direct relationship between RF signal strength and avionics stability. The research also offers a practical improvement to standard operational procedures that can be replicated in other aircraft systems.

Limitations:
This study was limited to a single aircraft and specific operational conditions at BBKFP. Other potential causes of jitter, such as electromagnetic interference from external sources or internal equipment degradation, were not extensively examined. Additionally, the study relied on qualitative observation without advanced instrumentation for real-time RF spectrum analysis.

Suggestions:
Future research should expand to multiple aircraft models and varied environmental conditions to validate the generalization of these results. Investigations incorporating RF spectrum analyzers and interference mapping are recommended to explore additional jitter causes. Furthermore, developing an early warning or automated signal calibration system within the FMS could enhance detection and prevention of similar anomalies in real flight operations.

CONCLUSION

This study successfully identified that jitter in the Flight Management System (FMS) of the Beechcraft King Air 350i aircraft during the VOR Operational Check using the AeroFlex IFR-4000 was caused by a low level of Radio Frequency (RF) signal. Increasing the RF signal level from -10 dBm to -5 dBm effectively eliminates jitter, demonstrating a direct correlation between signal strength and system stability. These findings have important implications for the VOR Operational Check procedure, emphasizing the need to monitor and maintain RF signal strength to ensure navigation accuracy and flight safety. These results reveal the importance of paying attention to RF signal quality in aircraft navigation system operations and demonstrate the need for more thorough maintenance procedures for RF signal receiving components.

Further research can expand the scope by investigating other factors that may contribute to jitter, such as signal interference or other component conditions, in addition to RF signal strength. A more comprehensive study could involve different aircraft types and different operational conditions to test the generalization of these findings. In addition, the research could be developed to develop more advanced jitter detection and mitigation algorithms, or integrated with aircraft early warning systems to improve flight safety more effectively. Practical applications of these findings could be recommendations for adjusting VOR Operational Check procedures to ensure strong RF signals and training for maintenance technicians to diagnose and address jitter problems.

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AUTHOR CONTRIBUTION STATEMENT

Author Contribution Statement: M. Ihsan is responsible for the planning and implementation of research, data collection and analysis, and manuscript writing.

REFERENCES

Bai, J., Yuan, S., & Duan, Z. (2025). Research on the Interference Effects of 5G's Key Parameters on Radio Altimeters. *Aerospace*, *12*(1), 1–16. https://doi.org/10.3390/aerospace12010016

Bukhari, J., & Mérida, W. (2024). 5G interference with aviation altimeters: technology and policy recommendations for coexistence. *Transport Policy*, *153*, 1–11. https://doi.org/10.1016/j.tranpol.2024.04.011

Burbank, J., Greene, T., & Kaabouch, N. (2024). Detecting and Mitigating Attacks on GPS Devices. *Sensors*, *24*(17). https://doi.org/10.3390/s24175529

Dai, Y., Lai, J., Zhang, Q., Li, Z., & Liu, R. (2024). Adaptive Navigation Performance Evaluation Method for Civil Aircraft Navigation Systems with Unknown Time-Varying Sensor Noise. *Sensors*, *24*(16). https://doi.org/10.3390/s24165093

Dai, Y., Lai, J., Zhu, B., Li, Z., Sun, X., & Lv, P. (2022). Three-Dimensional ANP Evaluation Method Based on Spatial Position Uncertainty under RNP Operation. *Aerospace*, *9*(11). https://doi.org/10.3390/aerospace9110703

De Oliveira Costa, D., Oliveira, N. M. F., & d'Amore, R. (2020). The feasibility of remotely piloted aircrafts for VOR flight inspection. *Sensors (Switzerland)*, *20*(7). https://doi.org/10.3390/s20071947

DEMİRDÖVEN, G. H. (2025). CEFR updates (2020)-based next-gen immersive learning in 5 steps. *Frontiers in Education*, *10*. https://doi.org/10.3389/feduc.2025.1567249

Duan, Z., Ma, Z., Bai, J., Wang, P., Xu, K., & Yuan, S. (2024). Deployment Protection for Interference of 5G Base Stations with Aeronautical Radio Altimeters. *Sensors*, *24*(7), 1–25. https://doi.org/10.3390/s24072313

Felux, M., Fol, P., Figuet, B., Waltert, M., & Olive, X. (2024). Impacts Aviation. *Navigation, Journal of the Institute of Navigation*, *71*(3). https://doi.org/10.33012/navi.657

Firmansyah, M. Z., Sa'duh, S., Hasibuan, R. P., & Gusmaneli, G. (2023). Meningkatkan Kualitas Pendidikan di Indonesia: Peran Sentral Pilar-Pilar Pendidikan dalam Membentuk Generasi Unggul. *AL-IMAM: Journal on Islamic Studies, Civilization and Learning Societies*, *4*, 57–66. https://doi.org/10.58764/j.im.2023.4.43

Gökçe, P., Üçüncü, M., & Schmidt, E. G. (2024). OMNeT++ Simulation Framework for Avionics Full-Duplex Switched Ethernet. *Journal of Aerospace Information Systems*, *21*(5), 443–454. https://doi.org/10.2514/1.I011351

Hanum, G. K., Prayitno, H., Mubarok, A., Pasongli, H., & Mendrofa, N. K. (2024). Education management in the new normal era: a literature study. *Academy of Education Journal*, *15*(1), 1028–1035. https://doi.org/10.47200/aoej.v15i1.2357

Kurzweil, L. (2024). Interference of 5G with aircraft radio altimeters: How to protect aviation safety in rapidly changing environment of expanding C-band networks. *Aerospace Traffic and Safety*, *1*(2), 155–164. https://doi.org/10.1016/j.aets.2024.12.003

Malik, A., & Rao, M. (2025). Radio Frequency Interference, Its Mitigation and Its Implications for the Civil Aviation Industry. *Electronics (Switzerland)*, *14*(12), 1–22. https://doi.org/10.3390/electronics14122483

Meining, N. I. E., Yongmei, Z., Wei, J., Xin, L. I., Zilong, Z., Fei, T., & Zhao, H. E. (2022). *VOR 参数测量能力计量比对分析 Comparative Analysis of the Measurement Capability of VOR Parameter*.

https://doi.org/10.12338/j.issn.2096-9015.2021.0613

Miś, T. A., Kazubski, W., & Zieliński, M. (2025). Preliminary Analysis of Atmospheric Front-Related VHF Propagation Enhancements for Navigation Aids. *Sensors*, *25*(14), 1–15. https://doi.org/10.3390/s25144455

Ostroumov, I. (2023). *Performance Evaluation of Positioning Methods Used in the Flight Management System BT - Proceedings of the International Workshop on Advances in Civil Aviation Systems Development* (I. Ostroumov & M. Zaliskyi (eds.); pp. 3–16). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-38082-2_1

Rosyidah Dzunur'aini, Abroto, Abduhakim Kaje Yamkee, Yessika Destiana Lahabu, & Intan Dewi Mawardini. (2025). The Age of Full AI in Education: Redefining Learning through Intelligent Technology. *International Journal of Basic Educational Research*, *2*(2), 45–56. https://doi.org/10.14421/ijber.v2i2.11840

Steiner, J., & Trýb, J. (2024). GPS jamming detection: ADS-B vs professional detector comparison. *Transportation Research Procedia*, *81*, 328–336. https://doi.org/10.1016/j.trpro.2024.11.034

Tripathi, V., & Caizzone, S. (2024). Virtual Validation of In-Flight GNSS Signal Reception during Jamming for Aeronautics Applications. *Aerospace*, *11*(3), 1–13. https://doi.org/10.3390/aerospace11030204