

Airworthiness Approval and Operational Allowance of Aircraft RFID Devices

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Administration



Presentation Topics

- **Background**
- **Examples of RFIDs and their Operational Uses**
- **Certification of Installed RFID Devices**
 - Intended Functions
 - Certification Approach
- **Operational Allowance Considerations**
- **Examples of RFID RF spurious emissions testing**



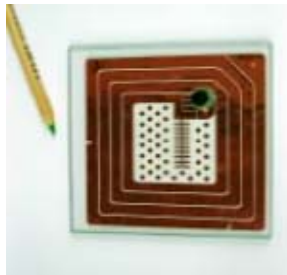
Background

- **The paper provides information, guidance, and methods related to the FAA Advisory Circular (AC) 20-162, “Airworthiness Approval and Operational Allowance of RFID Systems”, September 22, 2008—**
 - Information, guidance, and methods for an acceptable way to use RFID devices, readers or interrogators installed on aircraft, and to allow use of RFID devices on baggage, mail containers, cargo devices and galley/service carts, and use of portable RFID readers or interrogators carried onboard aircraft.
 - Guidance to manufacturers and modifiers of aviation products and equipment, who want to install RFID devices on aircraft, aircraft engines, or propellers; and equipment.
 - Guidance to aircraft operators, who want to use RFID devices on galley carts and baggage, passenger-convenience items (pillows, headsets, blankets and other items), and service provisions (towels, coffee service and other disposables) carried on-board an aircraft.
 - This paper covers only passive devices & Low-power RFID devices with batteries (active and battery assisted passive devices).
 - Reviews examples of RF emissions testing of RFID devices.



Passive RFID Tag Examples

13.56 MHz



915 MHz



2.45 GHz



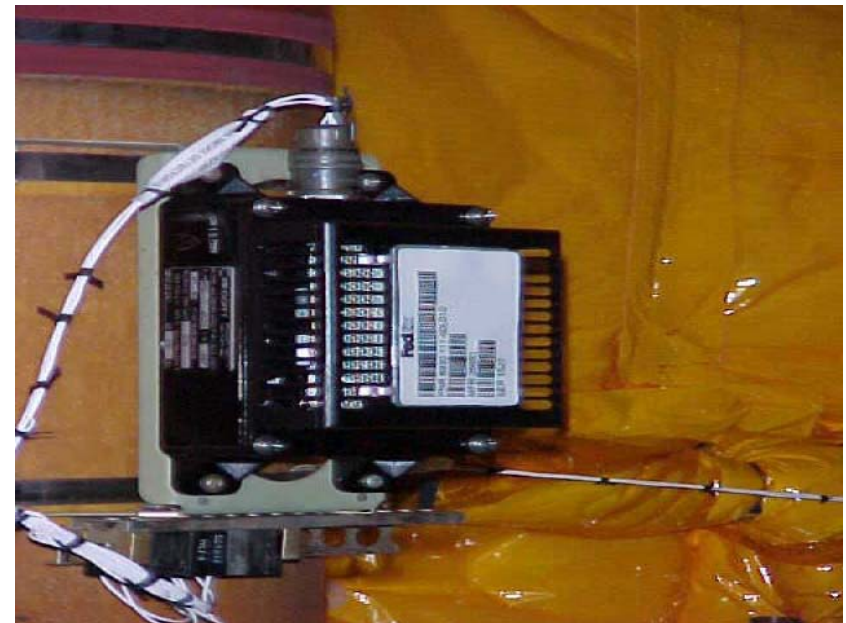
Active RFID Tag Examples



Air Data Inertial Reference Unit



Smoke Detector

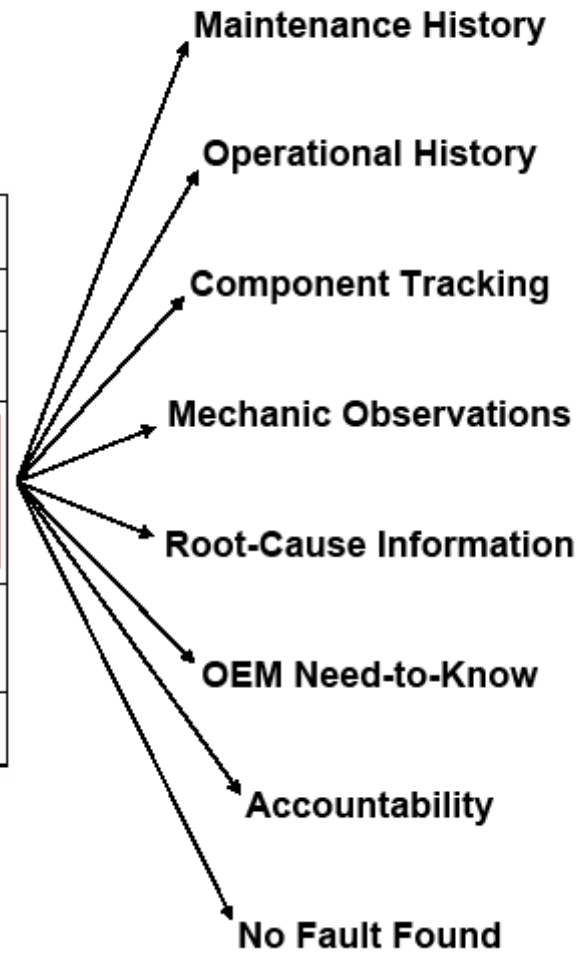


Examples of Operational Uses

Current State

Desired State

FAA FORM 8130-3 AIRWORTHINESS APPROVAL TAG U.S. Department of Transportation FEDERAL AVIATION ADMINISTRATION							Aircraft Identification	
1. Description							2. Manufacturer or Vendor Name	
3. Make	4. Description	5. Part Number	6. Part Name	7. Quantity	8. Date of Issue	9. Issue Number	10. Issue Date	
<p>inop, broke, failed, etc...</p>								
<p>NOTE: In case of parts to be repaired, the needs requirements of the receiving aircraft are to be followed.</p>								
11. Signature				12. Authorizing Title		13. Address (Optional)		
14. Name (Optional)				15. Title		16. Date (Optional)		



Certification of Installed RFIDs

- **Airworthiness Concerns about RFID devices installed on aircraft include—**
 - Integrity, accuracy, and authenticity of both safety-related and identification data from RFID devices.
 - Fire and electrical safety, crashworthiness, and environmental effects.
 - RFID device-generated RF intended transmissions or spurious emissions, both of which can interfere with aircraft electrical and electronic systems and components, and
 - Maintenance required for RFID devices and readers.

Certification of Installed RFIDs

- **If you're applying for certification, define the intended function of the installed RFID devices—**
 - Ancillary part marking.
 - Other RFID device functions include temperature logging, vibration monitoring, weight records, or time-in-service computation done by the RFID device itself.
- **Evaluate the intended functions performed by RFID devices to determine any adverse effects from device installation and function.**
 - Consider those adverse effects in your overall aircraft safety assessment according to 14 CFR § 23, 25, 27, or 29.1309.
 - RFID device functions with adverse effects that could cause catastrophic, hazardous/severe-major, or major failure conditions are outside the scope of this paper. Address them in a specific certification plan.

Certification of Installed RFIDs

- **Performance.** For passive RFID installations, recommend meet the performance standards described in the SAE AS5678A, “Passive RFID Devices Intended for Aircraft Use”.
- **Minor design change.** Installing passive RFID devices on approved aircraft parts, equipment, structure, engine, or propeller components, cabin furnishings including galley/service carts is a minor design change. It does not invalidate the existing airworthiness approval of the equipment/parts. A part number roll is not required.
- **Configuration control.** To ensure RFID device and system interoperability or compatibility between those components, it may be necessary to enter the RFID device(s) make, model, part number, and perhaps serial number into the product or equipment ICA. In addition, if there are particular details and requirements about how the device is mounted, located, oriented and used where configuration control is significant, ensure that you enter those details in the ICA.

Certification of Installed RFIDs

- **Software and complex hardware.** Consider software level per RTCA/DO-178B, for RFID devices using software. If the application uses complex electronic hardware, consider hardware level per AC 20-152, “RTCA, Inc. Document RTCA/DO-254”.
- **Environmental qualification (other than EMC).** Follow SAE AS 5678A, Section 5.3.6, for other environmental qualifications of RFID devices.
- **Battery safety.** For batteries in RFID devices with batteries, safety concerns include the possibility of explosion caused by failures of lithium ion or nickel metal hydride batteries. Batteries must prevent explosion if they fail, and meet the explosion proofness requirements of RTCA/DO-160F, Section 9.
- **Flammability and fire safety.** Batteries in active RFID devices, together with the RFID device itself, must meet the flammability requirements of 14 CFR § 25.853(a) and appendix F, part I.

Certification of Installed RFIDs

- **Mounting and attachment integrity.** The RFID installation must be a permanent one. Installers of RFID devices should comply with 14 CFR §§ 23, 25, 27, or 29.301, .303, .305, .307, .471, .561, .601, and .609, and §§ 23 or 25.333 by design data review, analysis and/or test. Document the method you used, and that we agreed on, before you submitted your request for finding compliance. See 14 CFR § 25.789 and § 23, 25, 27, or 29.787. Compliance to these requirements can be demonstrated with by reviewing and analyzing the design data.
- **ICA.** If the RFID device has a service life limit, state it in the ICA. State if and when the RFID device requires battery replacement, recharging, or other periodic maintenance. State whether the RFID device, if malfunctioning, must be removed from the aircraft and replaced with one of the same type and configuration. The responsible FAA aircraft certification office will use FAA Order 8110.54, “Instructions for Continued Airworthiness Responsibilities, Requirements, and Contents”, to give further requirements or details for preparing an ICA.



FAA EMC Regulation

- **The FAA requires electronic equipment installed on-board aircraft to:**
 - Be electromagnetically compatible with other installed equipment (non-interference)
 - Function as intended under any foreseeable operating condition
- **Ensure no interference from portable RFID devices on the existing airplane systems**
 - Use 14 CFR § 91.21, AC 91.21-1B, RTCA/DO-160F, and DO-294C as compliance basis

Typical Airplane RF Environment

> Communications and Navigation Systems

- HF Voice / Data Link2 – 30 MHz
- Marker Beacon75 MHz
- ILS Localizer & VHF Data Broadcast 108 – 112 MHz
- Omnirange (VOR)108 – 118 MHz
- VHF Voice Communication118 – 137 MHz
- Glide Slope329 – 335 MHz
- Distance Measuring Equipment (DME)962 – 1213 MHz
- Universal Access Transceiver (UAT)982 MHz
- Mode S and A/C Transponders (Receiver)1030 MHz
- TCAS Interrogator (Receiver)1090 MHz
- GNSS L5/E5.....1164-1215MHz
- SATCOM1530 – 1559 MHz
- GNSS L1.....1559 – 1610 MHz
- Radio Altimeter4200 – 4400 MHz
- Microwave Landing System (MLS)5030 – 5090 MHz
- Weather Radar5350 – 5470 MHz

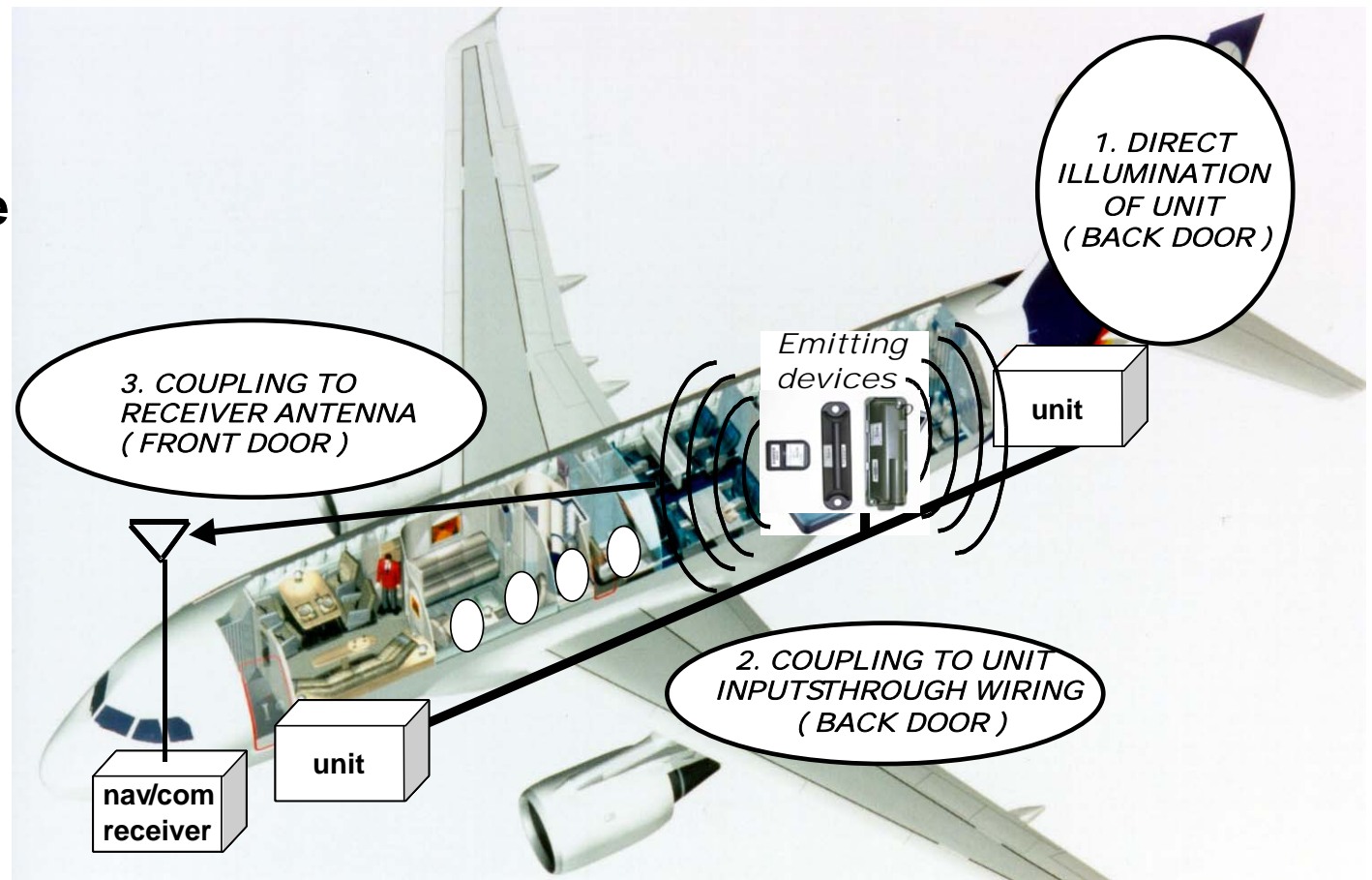


RF Inside the Airplane:

> How RFID device emissions may interfere with Airplane Systems

- Airplane systems may be vulnerable to emissions from installed or portable RFID devices

- Front Door
- Back Door



EMC Requirements for Passive RFID Devices

- **No laboratory RF emissions tests, like those in RTCA/DO-160F, “Environmental Conditions and Test Procedures for Airborne Equipment”, are required for installed passive RFID devices.**
- **No aircraft EMC tests are required for passive RFID devices installed on aircraft, aircraft engines, or propellers and the equipment, components, or parts of these aircraft, engines and propellers, or for passive RFID devices permanently installed on galley carts.**

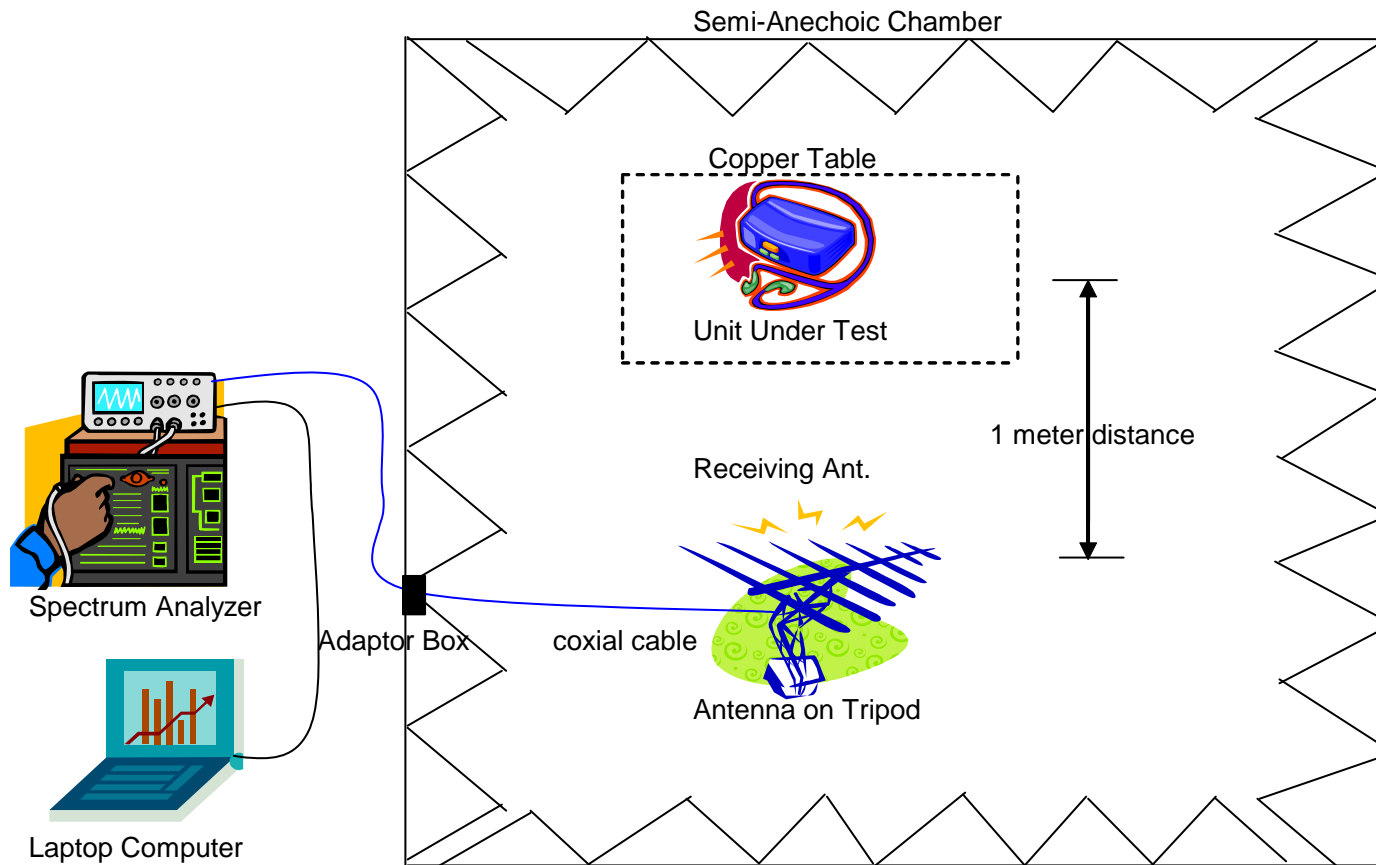
EMC Requirements for Active RFID Devices

- **Use laboratory RF emissions tests and aircraft EMC tests to demonstrate that operation of the active RFID devices does not adversely affect other aircraft electrical, electronic and radio systems—**
 - Perform laboratory RF emission tests per RTCA/DO-160F, Section 21. Use Section 21, Categories M, H, or P.
 - Ground-test aircraft EMC with the active RFID devices installed on the aircraft, aircraft engines, propellers, and the equipment, components, or parts of these aircraft, engines and propellers, or permanently installed on galley carts.
 - Ground-test the aircraft EMC with the active RFID devices, both when the RFID device transmits and when it's not transmitting.
 - The results of the laboratory RF emissions tests may be used to select frequencies or systems to be monitored during the EMC ground test.
 - Base the aircraft EMC ground tests on a source-victim analysis matrix and evaluate functional performance of the potential aircraft victim systems.

Operational Allowance of Portable RFIDs

- **If you're an aircraft operator, operational allowance approach will help you comply with 14 CFR § 91.21—**
 - Determine that the RFID device and reader will not cause interference with the navigation or communication system of the aircraft on which it is used. See AC 91.21-1B, “Use of Portable Electronic Devices Aboard Aircraft”.
 - Determine if the devices interfere with aircraft electrical/electronic systems with failure classifications that are major, hazardous/severe-major, or catastrophic, or with devices required by regulations, such as flight data/voice recorders. Make the assessment by using either the certification approach described in this paper or by following RTCA/DO-294C, “Guidance on Allowing Transmitting Portable Electronic Devices”.

DO-160 Test Setup – Emission of Radio Frequency Energy, Radiated



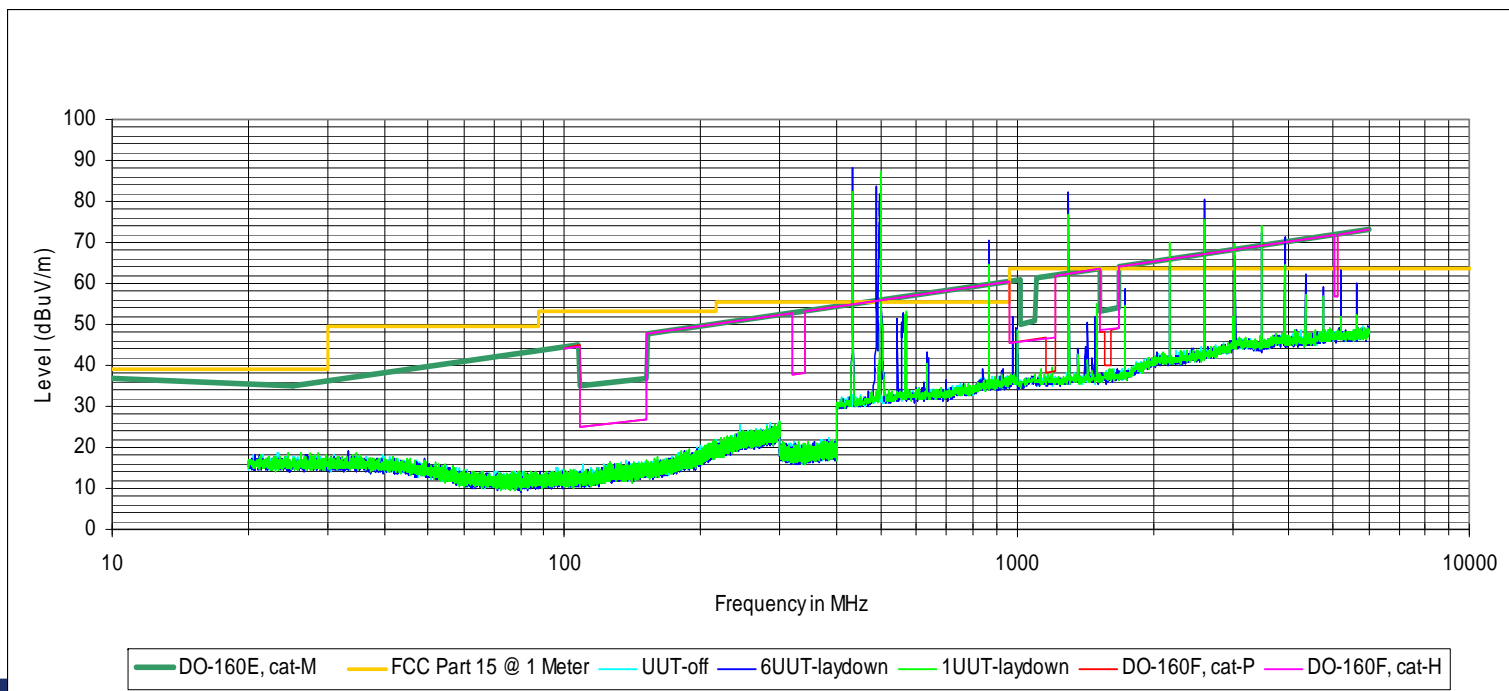
RF Emissions - Radiated - Setup - 290 MHz to 2 GHz – Vertical



Examples of RF Radiated Emissions Test Results – RTCA/DO-160F

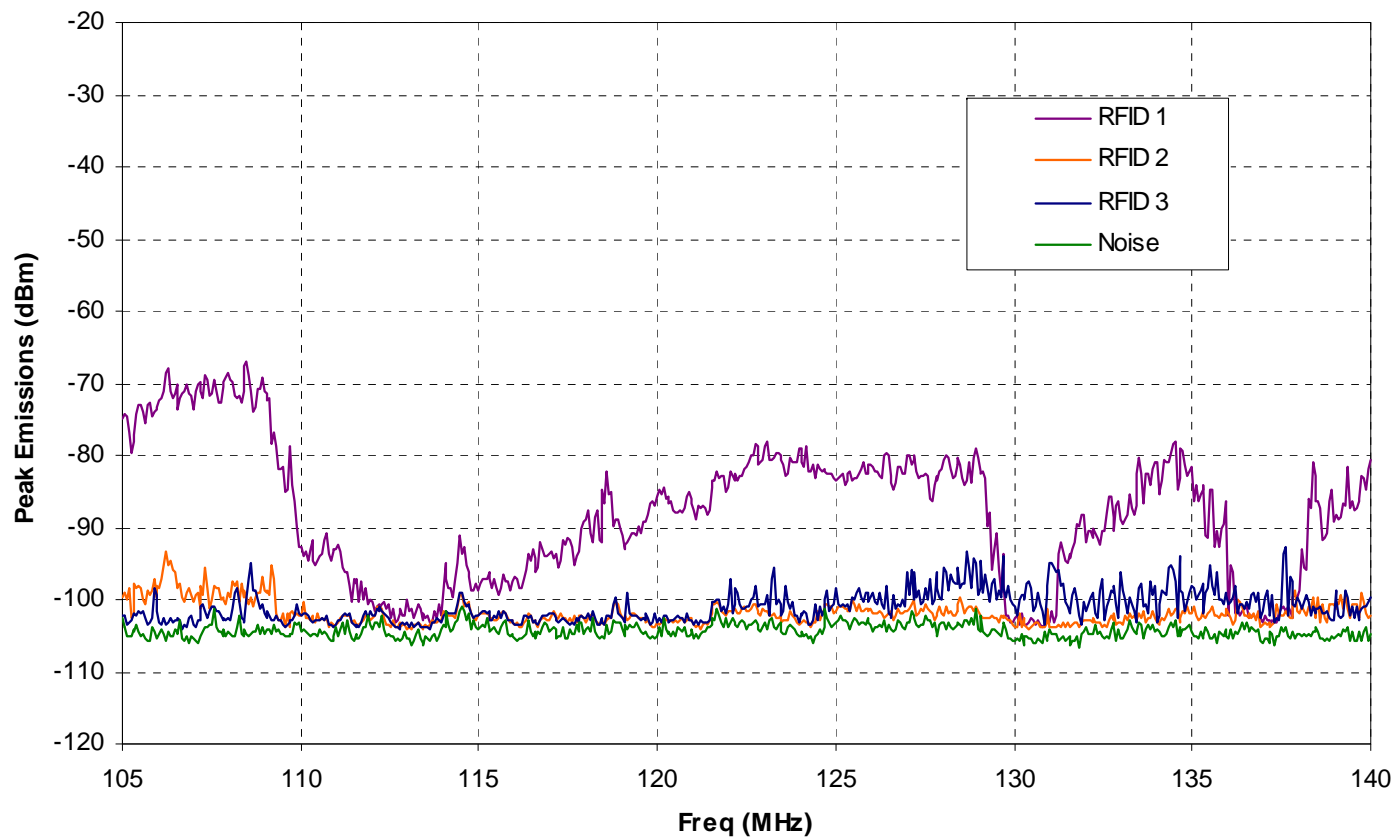
- RTCA/DO-160F, Section 21 conducted emissions tests were not performed, since there are no interconnecting wires/power wires for this low duty factor transmitter, and the intentional transmitted power from the transmitter is very low.

Test Name	Test Description	Results
Section 21, Radiated RF Emissions; Low duty factor transmitter	Categories M and P, 2 MHz to 6 GHz	Fail



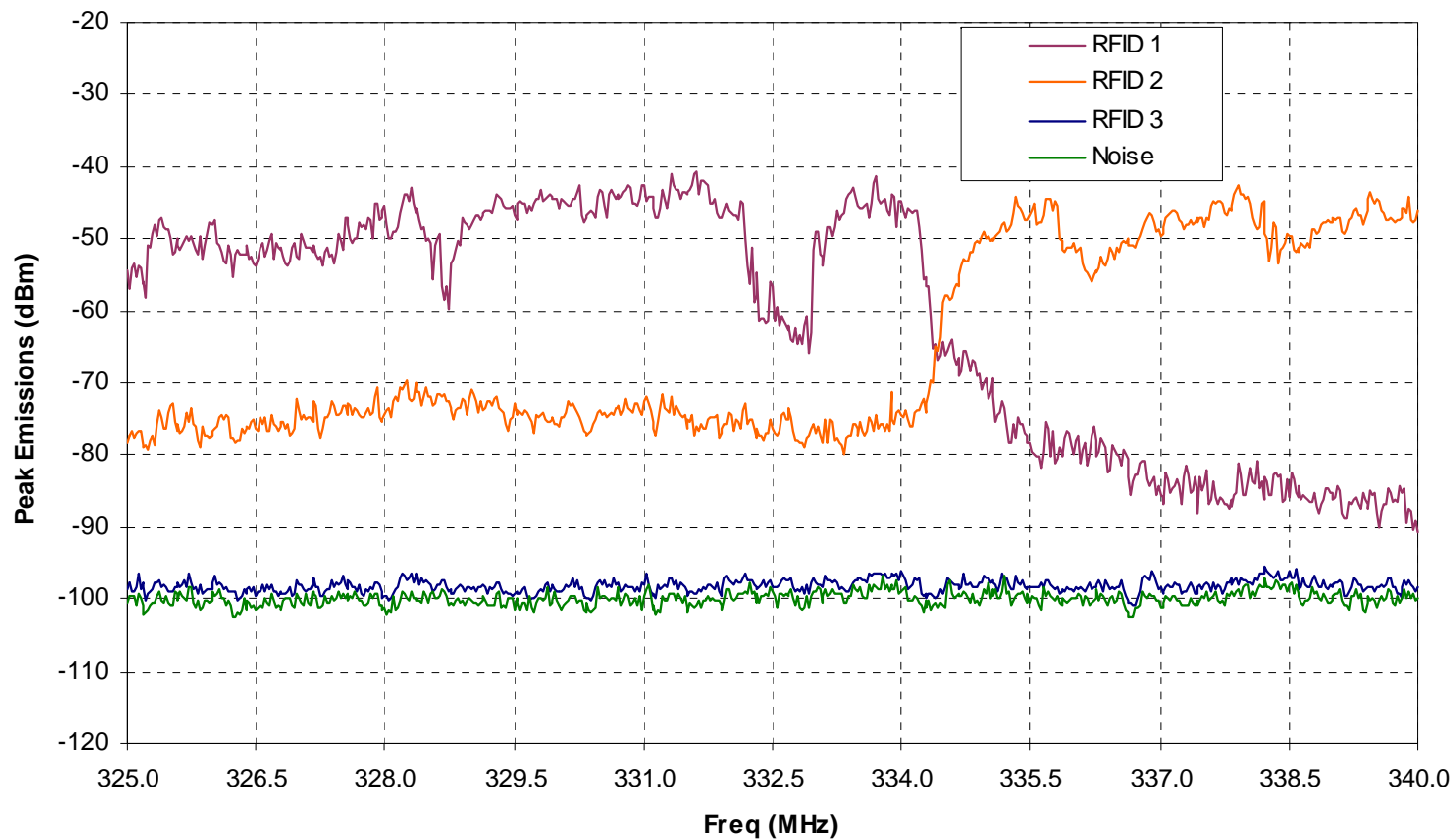
Examples of DO-160 RF Radiated Emissions Test Results—Active RFID

T. X. Nguyen, J. J. Ely, R. A. Williams, S. V. Koppen, M. T. Salud, “RFID Transponders’ Radio Frequency Emissions in Aircraft Communication and Navigation Radio Bands”, NASA/TP-2006-214295, March 2006



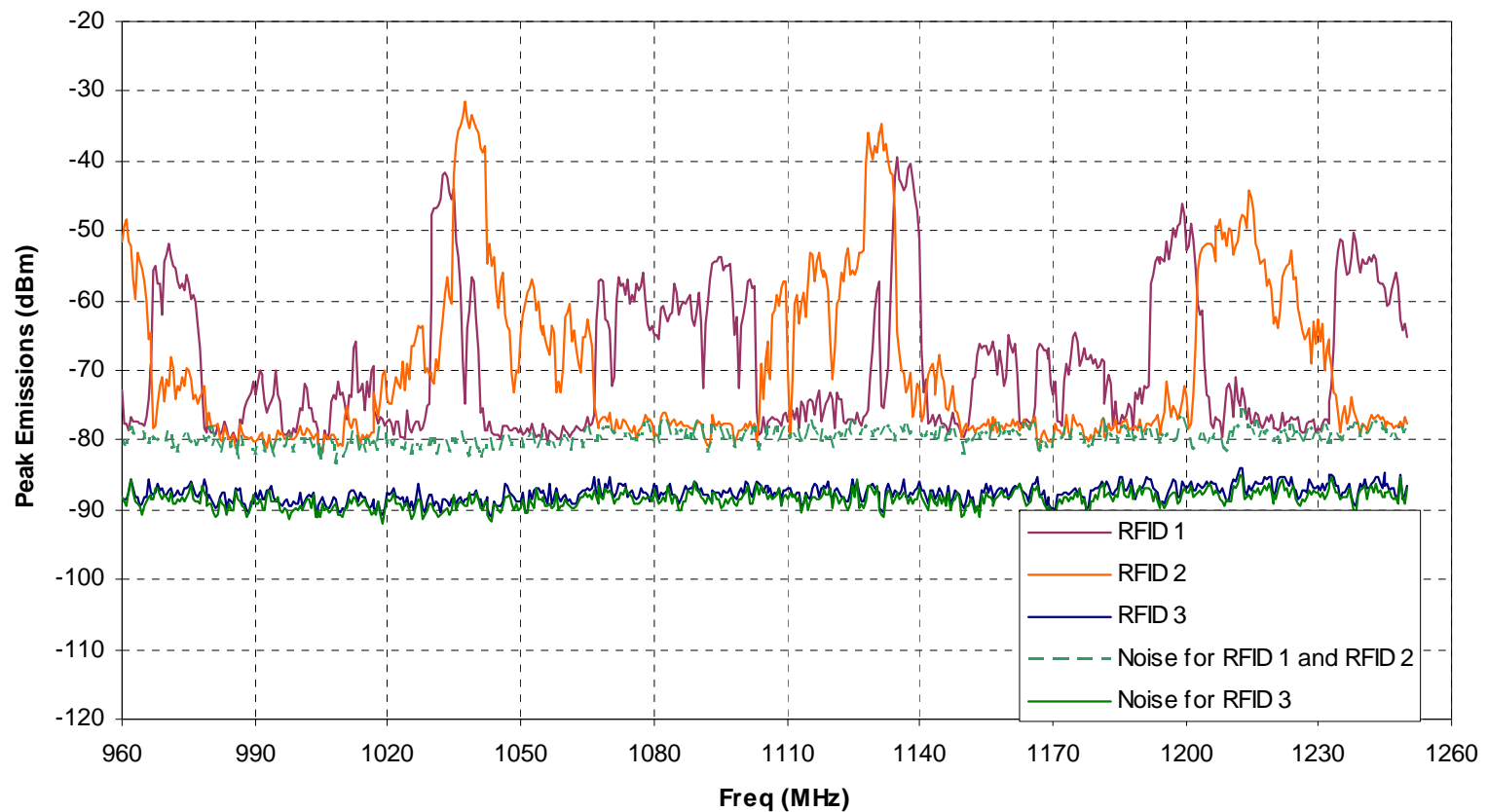
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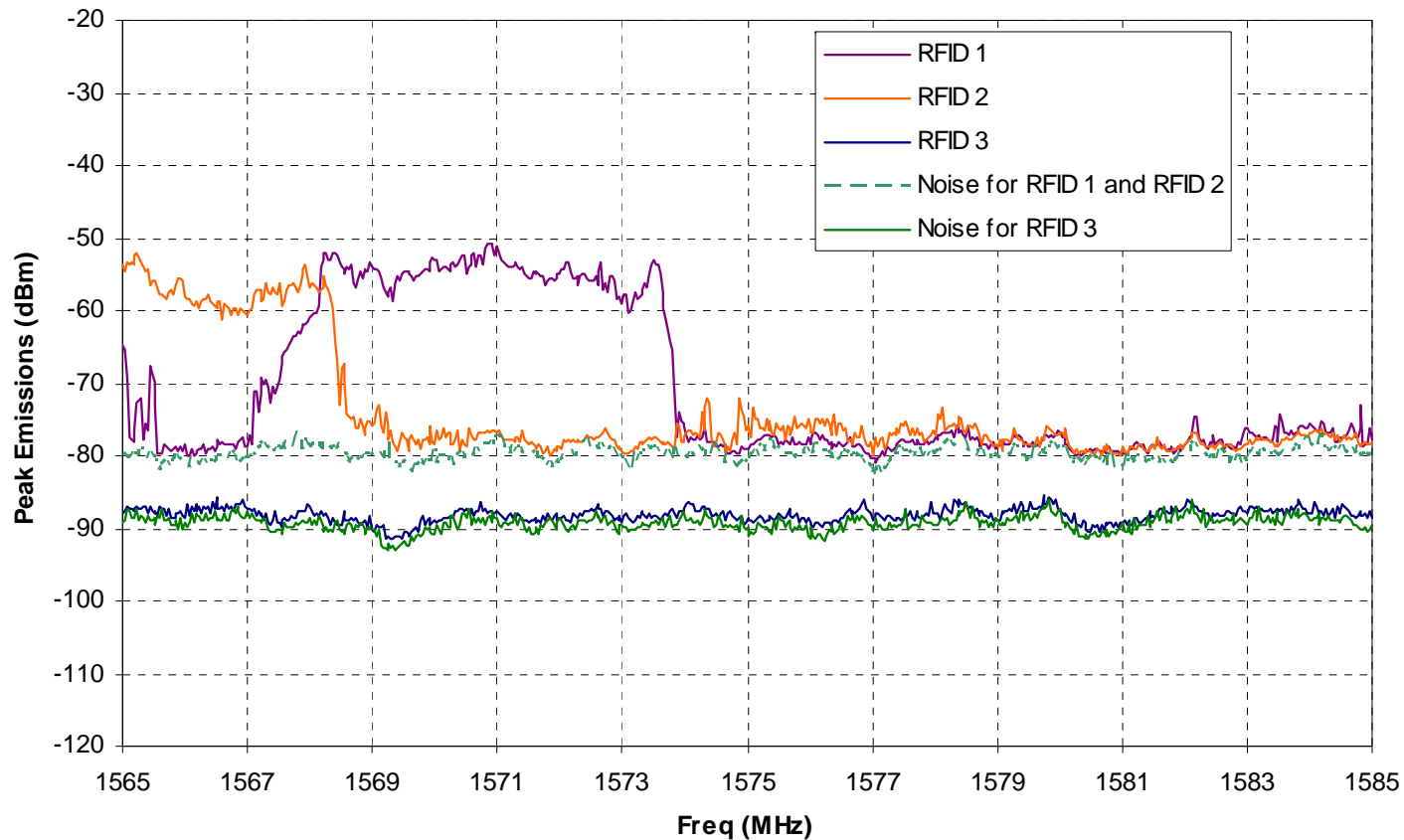
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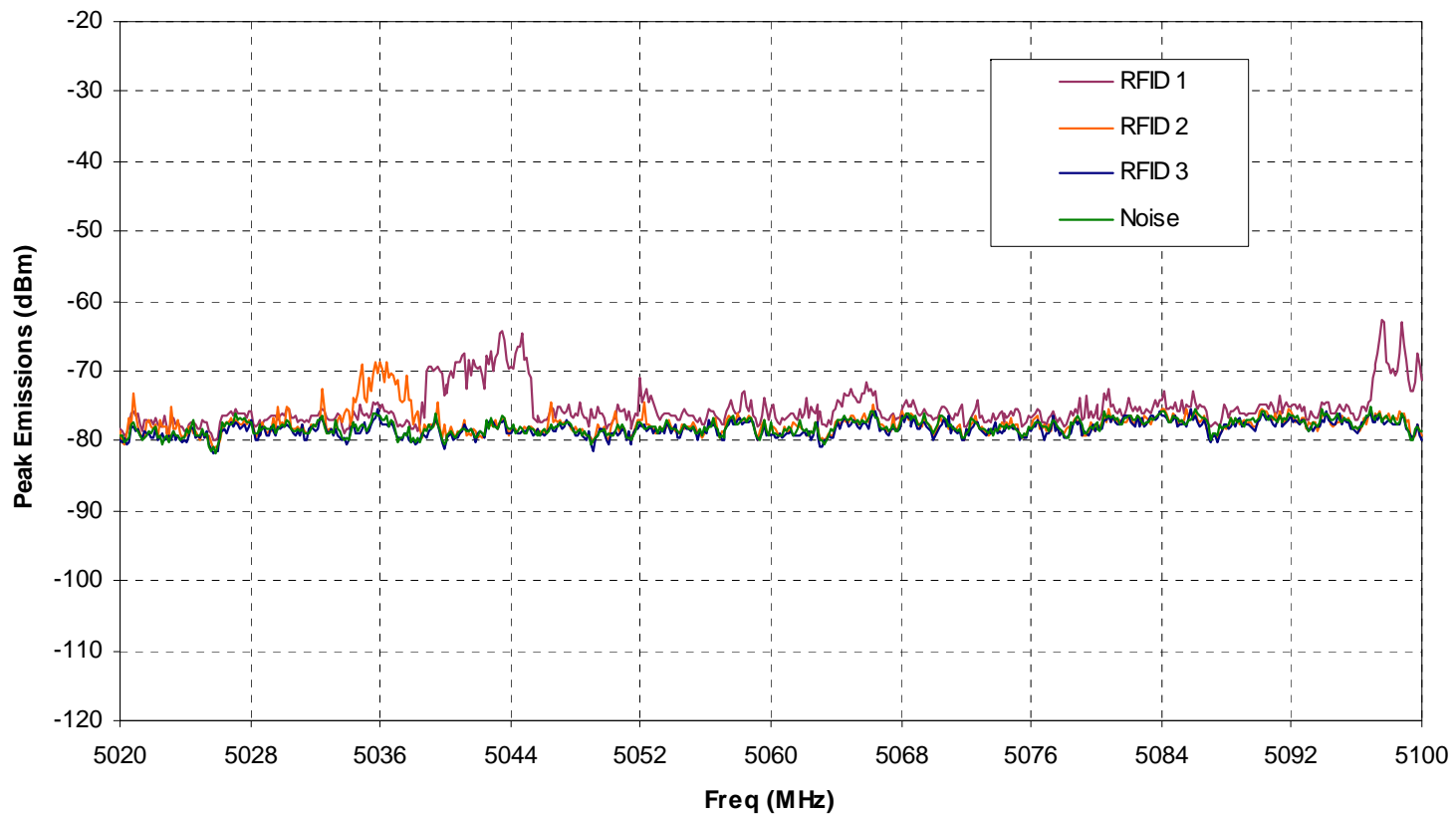
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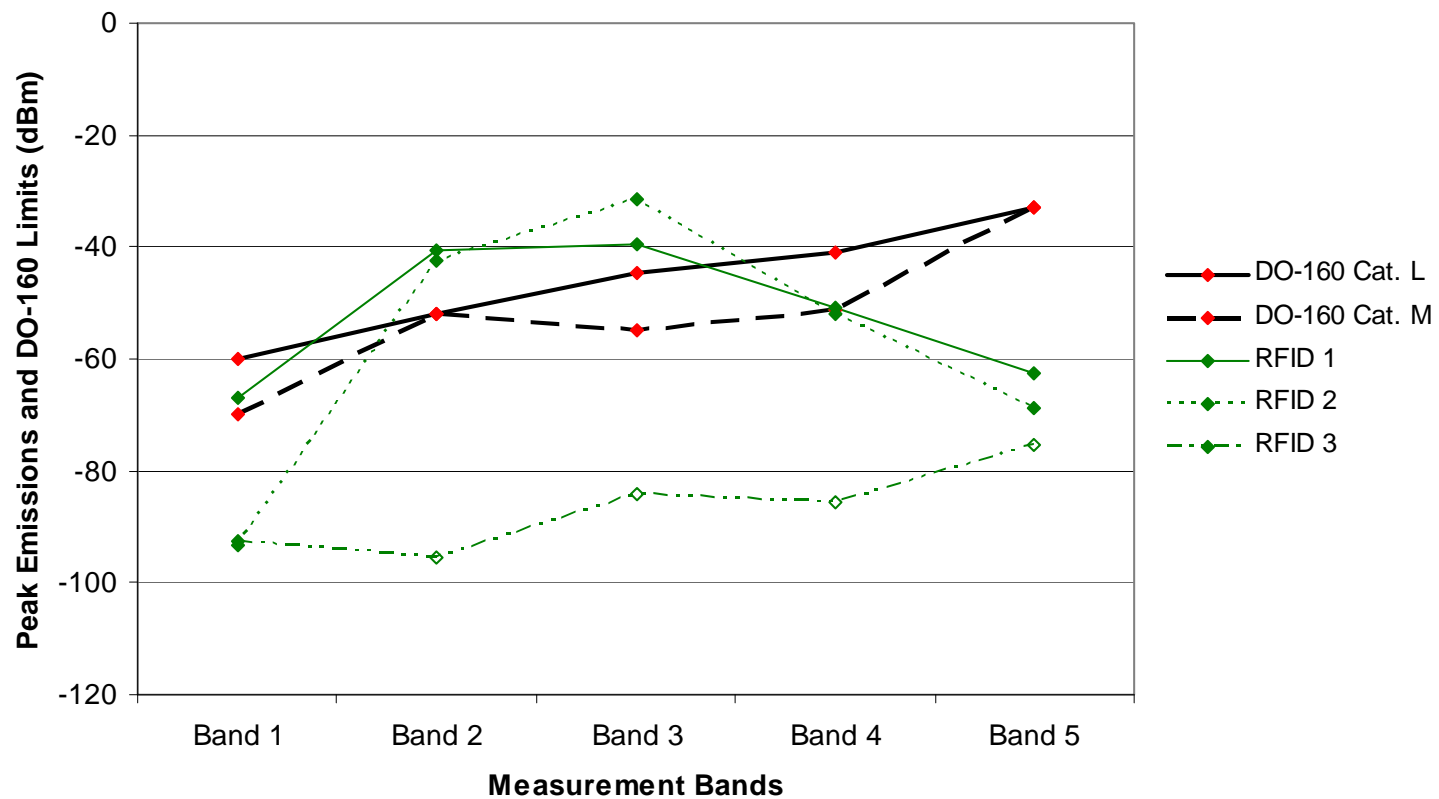
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Examples of DO-160 RF Radiated Emissions Test Results–Active RFID

- **The spurious emissions of RFID 1 and RFID 2 exceeded the Category L, or M limits of Section 21 of RTCA/DO-160F in Band 2 and Band 3.**
 - The RF emissions radiated test results showed that RFID 1 and RFID 2 test units were found to be noncompliant with the RF radiated emissions tests specified in RTCA/DO-160F.
- **The RF emissions radiated test results also showed that RFID 3 test unit was found to be compliant with the RF radiated emissions tests specified in RTCA/DO-160F.**
- **The results of the RTCA/DO-160F RF emissions tests may be used to select frequencies or systems to be monitored during the aircraft EMC ground test. In a recent NASA study (T. X. Nguyen, John J. Mielnik, “Radio Frequency Compatibility of an RFID Tag on Glideslope Navigation Receivers”, NASA/TP-2006-214295, October 2007), a similar approach was taken to evaluate EMC between an active RFID device and an aircraft glideslope (GS) radio receiver.**
 - The RFID device chosen was previously shown to have significant spurious emission level that exceeded the RTCA/DO-160F radiated emission limit in the GS band.

Thank you for your attention

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