Frequency Guardband 
Recommendations for FAA 
Channel Assignments in the 
960-1215 MHz L-Band 

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Electromagnetic compatibility (EMC) testing has been conducted on the Federal Aviation Administration's (FAA) navigation, guidance, air traffic control, and collision avoidance systems which operate in the L-band (960-1215 megahertz (MHz)). These systems include the tactical air navigation (TACAN)/distance measuring equipment (DME), Traffic Alert and Collision Avoidance System (TCAS), the Air Traffic Control Radar Beacon System (ATCRBS), and its evolutionary replacement, Mode S. The frequency channel assignments for these systems should provide for effective operation and insure that no systems operation is impaired by electromagnetic interference. This report recommends frequency separation guardbands for the FAA to use for the channel assignments given to these systems.

To date, EMC testing has been completed on almost all of these systems. The testing has involved placing each system in the position of "victim" and determining the effects of the other systems and combinations of systems on its performance. A major objective of these tests was to determine the conditions under which these systems could operate compatibly. Specifically, this involved determining the required frequency separation, maximum system interrogation and/or reply rates, and radio frequency signal strength where applicable.
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INTRODUCTION

PURPOSE.

The purpose of this effort is to recommend frequency separation guardbands for all of the Federal Aviation Administration's (FAA) navigation, surveillance and collision avoidance systems which operate in the L-band (960-1215 megahertz (MHz)). These recommendations are based upon the results of various electromagnetic compatibility (EMC) tests that have been conducted on each individual system.

BACKGROUND.

The FAA primarily utilizes the L-band (960-1215 MHz) in the operation of various navigation, guidance, air traffic control, and collision avoidance systems. These systems include the tactical air navigation (TACAN)/distance measuring equipment (DME), Traffic Alert and Collision Avoidance System (TCAS), the Air Traffic Control Radar Beacon System (ATCRBS) and its evolutionary replacement, Mode S. The frequency channels assigned to these systems should provide for effective operation that is not impaired by electromagnetic interference.

The FAA plans to deploy the Mode S system as a replacement for the present ATCRBS. The widespread implementation of TCAS is also anticipated within the next several years. Each of these systems share the common frequencies of 1030 MHz for interrogations and 1090 MHz for responses to these interrogations.

The current frequency separation between ATCRBS transmissions and the common TACAN/DME civil/military channels and the signal processing techniques provide some degree of isolation. The Mode S system signals which use long interrogation and reply signals, phase shift keying modulation techniques, and high chip transmission rates, were used to test their effect on TACAN/DME operation as well as the effect of the additional TCAS 1030 MHz pulses on TACAN/DME.

To date, EMC testing has been completed on almost all of these systems. This testing has involved placing each system in the position of "victim" and determining the effects of the other systems and combinations of systems on its performance. A major objective of these tests was to determine the conditions under which these systems could operate compatibly. Specifically, this involved determining the required frequency separation, maximum system interrogation and/or reply rates, and radio frequency (RF) signal strength where applicable.

GENERAL CRITERIA AND EVALUATION APPROACH.

Establishing frequency separation criteria involves determining maximum tolerable levels of system performance degradation. Systems with performance characteristics that are critical to the safe operation of aircraft were not permitted any degradation of performance. These systems include TCAS, ATCRBS, and Mode S. A slight degradation in performance of the TACAN and DME ground systems was permitted to conserve spectrum. The limiting criterion for airborne TACAN/DME interrogators was a 3-decibel (dB) decrease in Acquisition Stable Operating Point (ASOP). For TACAN/DME ground beacon transponders, the limiting criterion was not more than 1 dB loss in receiver sensitivity and not less than 70 percent reply efficiency in the presence of undesired signals.
ATCRBS GENERAL DESCRIPTION.

The ATCRBS is a cooperative system which consists of a ground-based rotating directional antenna, interrogator/receiver, signal processing equipment, and active aircraft transponders. In operation, an interrogation pulse-group transmitted from the directional antenna triggers each airborne transponder located in the main beam of the antenna as it rotates or scans by the aircraft. Measurement of the signal round-trip transmit time (the interrogation and reply) determines the range (rho); and the mean direction of the interrogator antenna during aircraft replies determines the azimuth (theta) of the replying aircraft.

The ground-based interrogations are precisely controlled RF pulse groups (code trains) transmitted by the ground equipment (on 1030 MHz) to interrogate all aircraft within the area of coverage. Upon interrogation, the aircraft transponder transmits a coded reply on a different frequency (1090 MHz). This reply contains the aircraft identity selected by the pilot or, when the aircraft is properly equipped, the aircraft altitude. The ground-based equipment decodes the information to obtain the aircraft range, azimuth, identity, and altitude. Discrete aircraft emergency codes are also provided in the ATCRBS.

Processing the signals received by ATCRBS interrogators is commonly done by the Sensor Receiver and Processor (SRAP) and the Automated Radar Terminal Systems (ARTS) IIIA computer system. The SRAP is a digital processor which utilizes airborne transponder replies passed from the ATCRBS receiver in digital form. ATCRBS replies are decoded into altitude (mode C) and identity (mode 3A) and tagged with range and azimuth values at the time of decoding. The SRAP compiles a target report based on several corresponding replies from the same aircraft. Report level information is then passed on to the ARTS IIIA terminal air traffic control computer system which, through special purpose software, drives the display screens used by air traffic controllers. The ARTS IIIA system derives beacon target "blip scan ratio" information based on scan-to-scan target detection of aircraft.

MODE S GENERAL DESCRIPTION.

Mode S is a discrete addressing air traffic surveillance system that provides improved surveillance data and an integral ground-air-ground digital communications data link. Mode S is compatible with the present ATCRBS.

Uplink interrogations are on a frequency of 1030 MHz. The interrogations are two basic types consisting of (1) the present pulse-amplitude modulation (PAM) mode 3 and mode C ATCRBS waveforms with the addition of a P4 pulse after the normal P3 pulse (ATCRBS/Mode S all-call), and (2) a discrete interrogation consisting of PAM (P1 and P2) pulses followed by a data field of 16.25 or 30.25 microseconds (usec). The information in the data field is modulated at a 4-megabit pulse-per-second data rate using differential phase-shift keying (DPSK).
Downlink replies are at 1090 MHz. The replies are either the present PAM ATCRBS reply waveforms or the Mode S waveforms. The ATCRBS replies are the normal 12-bit reply field; the Mode S replies consist of a PAM 4-pulse preamble, followed by a data field of 56 or 112 µsec. The data in the data field are in the pulse position modulation (PPM) format at a 1-megabit-per-second data rate.

TCAS GENERAL DESCRIPTION.

The TCAS is an airborne collision avoidance system which operates in both the ATCRBS and Mode S mode.

This system transmits on 1030 MHz and has the two basic types of interrogations: (1) the present PAM mode C ATCRBS waveform with the additional P4 pulse after the normal P3 pulse, and (2) an (Mode S type) interrogation consisting of PAM (Pi and P2) pulses followed by a data field of 15 or 29 µsec time duration. The information in the data field is DPSK modulated at a 4-megabit pulse-per-second data rate.

Replies are received at 1090 MHz. The replies are the present PAM ATCRBS reply waveforms and the discrete address waveforms. The ATCRBS replies are the normal 12-bit reply field. Mode S replies consist of a PAM 4-pulse preamble followed by a data field of 56 or 112 µsec. The information in the data field is pulse position modulated at a 1-megabit-per-second data rate.

TACAN/DME SYSTEM OVERVIEW.

The DME system, operating in the 960-1215 MHz band, is used in determining the slant range between an aircraft and a known ground location. In the United States, the DME is usually integrated with the very high frequency (VHF) omnidirectional radio range (VOR) in a VOR/DME installation or VOR/TACAN (VORTAC) installation. The VOR is a system operating on 50 kilohertz (kHz) channels in the 108-117.95 MHz band to provide aircraft with the bearing information to a known ground location. TACAN is a United States and North Atlantic Treaty Organization (NATO) military navigation system that incorporates the international DME function with a bearing determination system. It also operates in the 960-1215 MHz band.

The TACAN/DME operation requires an interrogator in the aircraft and a transponder (beacon) on the ground. The TACAN interrogator calculates a bearing and a range based on reference signals transmitted by the ground station. The DME interrogator calculates only the slant range to the ground station. Slant range is obtained by interrogating the ground transponder which receives and decodes each interrogation (a pulse pair with proper spacing) and then transmits a reply (also a pulse pair with proper spacing). The interrogator receives the reply and determines the distance, based on the time between transmission of the interrogation and the reception of the reply (minus the transponder's fixed time delay).

TACAN/DME CHANNEL ASSIGNMENTS. Frequencies assigned at 1 MHz increments in the 960-1215 MHz band are used in airborne interrogators and ground transponder equipments of the TACAN/DME systems. TACAN and DME frequencies are designated on aeronautical charts by channel numbers 1-126. TACAN channels are paired with VOR or instrument landing system (ILS) localizer frequencies in the 108-118 MHz band.
TACAN channels 17-59 and 70-126 are designated for use in the NAS. Most of these TACAN channels are used by the FAA to provide air navigation services. TACAN channels 1-16 and 60-69 are designated for the military services and are not used by civil aviation.

TACAN channels designated X-mode use a pulse pair spacing of 12 μsec for both the ground-to-air (G/A) and the air-to-ground (A/G) frequencies. TACAN channels designated Y-mode use a G/A pulse pair spacing of 30 μsec and an A/G pulse pair spacing of 36 μsec. Channels are assigned to the military and civil user with the corresponding G/A and A/G frequencies along with the corresponding VORTAC/ILS VHF pairs.

The closest A/G assigned frequency to the 1090 MHz frequency of the ATCRBS/Mode S downlink signals is, in fact, 1090 MHz. Military TACAN channels 66X and 66Y are assigned an A/G frequency of 1090 MHz (64X = 1088 MHz, 65X = 1089 MHz, 66X = 1090 MHz, etc.); thus, a ground TACAN transponder assigned to operate on 66X or 66Y would have its receiver tuned to 1090 MHz.

The closest civil A/G frequency to 1090 MHz is 1094 MHz. Thus, a ground TACAN transponder assigned to operate on channel 70X or 70Y would have its receiver tuned to 1094 MHz.

The closest A/G assigned frequency to the 1030 MHz frequency of the Mode S/TCAS waveforms signals is, in fact, 1030 MHz. A military TACAN assigned to channel 6X or 6Y would have its receiver tuned to 1030 MHz.

The closest civil A/G frequency to 1030 MHz is 1041 MHz. A ground TACAN transponder assigned to operate on channel 17X or 17Y would have its receiver tuned to 1041 MHz.

**SPECIAL TEST EQUIPMENT**

Several simulators were used to simulate the RF environment of undesired signals to which each of the victim systems were subjected. One simulator was built to simulate 1030 MHz signals; a second simulator was built to simulate 1090 MHz signals. A third unit, the Mobile Transponder Performance Analyzer (MTPA), was constructed specifically to perform tests on ATCRBS and Mode S transponders. A fourth unit, the Aircraft Reply and Interference Environment Simulator (ARIES), was used to simulate an environment for Mode S testing. Each simulator was designed and built at the FAA Technical Center.

**1030 MHz ENVIRONMENT SIMULATOR.**

FAA systems which transmit on 1030 MHz include airborne TCAS, ATCRBS ground beacons, and Mode S Sensors. The 1030 MHz simulator generates RF signals which represent the output of the Los Angeles Basin Model of air traffic in the year 2000. Specifically, the simulator generates waveforms from two Mode S sensors, one ATCRBS ground beacon, and 83 TCAS equipped aircraft.
1090 MHz FRUIT GENERATOR.

Airborne replies of the ATCRBS and Mode S systems are transmitted on 1090 MHz. Unsolicited, nonsynchronous airborne replies (per second) to Mode S and ATCRBS ground interrogations are referred to as "fruit." The fruit generator used in these EMC tests is capable of generating fruit reply rates of up to 80k for ATCRBS and 1k for Mode S. Most of the EMC tests performed involved subjecting the victim system to many different fruit rates.

MOBILE TRANSPONDER PERFORMANCE ANALYZER.

The MTPA was designed to conduct performance tests on ATCRBS and Mode S transponders. It is a sophisticated, self-contained computer-controlled system which can perform over 40 different tests and performance measures.

AIRCRAFT REPLY AND INTERFERENCE ENVIRONMENT SIMULATOR.

The ARIES is a comprehensive automatic test system designed to test the performance of Mode S sensors. It injects selectable Mode S and ATCRBS targets, along with fruit, if desired, into the sensor's monopulse antenna lines. It calculates and applies the appropriate monopulse number for each target reply, as would be done if received by the sensor's external antenna system.

TEST RESULTS

VICTIM: TCAS.

The TCAS EMC testing was conducted by MIT Lincoln Labs on a TCAS unit equipped with an omnidirectional antenna. The data results of these tests are contained in the Lincoln Labs report PM 84-33, Effect of Interference on the Performance of a Minimum TCAS II, by R.G. Sandholm, September 1985.

Figure 10 of report PM 84-33 contains performance curves of the TCAS unit when subjected to undesired TACAN/DME signals. The data curves show that the TACAN/DME signals should be tuned at least 12 MHz away to insure that TCAS performance is not degraded.

VICTIM: ATCRBS.

EDO AIRE AIRBORNE TRANSпонDER. An Edo Aire ATCRBS transponder was tested using the MTPA and TACAN/DME signals. The test used to best characterize the performance of an ATCRBS transponder was the Dynamic Range Test. During this test, the transponder was interrogated from about -90 to about -25 dBm. Several interrogations were performed for each RF level, and the MTPA recorded the number of transponder replies provided as the RF level of the interrogations was increased. The MTPA then provided a plot of transponder reply efficiency versus interrogation power.

A TACAN/DME RF level of -50 dBm and squitter rate of 2700 pulse-pairs-per-second (ppps) was used in determining how far away in frequency the TACAN/DME signal had to be tuned so as not to degrade the performance of the Edo Aire.
The data show that TACAN/DME signals of -50 dBm/2700 squitter need to be tuned at least 3 MHz away from the 1030 receive frequency of the transponder. The data have not been formally published in a report but are on file at the Technical Center and can be examined upon request.

**ATCBI-5 Ground Beacon (SRAP/ARTS IIIA).** The criteria used to judge the results of TACAN/DME interference on the air traffic control beacon interrogator (ATCBI-5) ground beacon focused on the beacon's ability to correctly detect targets, referred to as "blip scan ratio." The desired signal consisted of 16 ATCRBS equipped aircraft positioned in a ring, equally spaced in azimuth, all at equal range, and all having the same altitude (mode C) code and identification (mode 3A) code. The RF level of the desired targets was set to be just strong enough for the system to achieve at least 90 percent correct recognition. Along with the TACAN/DME and desired signals, an environment consisting of 18k ATCRBS fruit and 52 Mode S fruit (as seen by the main beam of the ATCBI-5) was injected into the system.

The TACAN/DME signals were injected into the main beam of the ATCBI-5 at RF along with the environment and desired signals. Tests were performed with the TACAN/DME tuned to 1090 MHz (delta F=0) and the delta F increased until no effect was noticed on blip scan ratio. A reasonable estimate which represented a TACAN/DME ground beacon located approximately 1 mile away from an ATCBI-5 was a squitter rate of 2k ppps and an RF level of -30 dBm. The guardband recommendation was based on the data results of the TACAN/DME signal source in this configuration.

Examination of the data showed that a recovery of the blip scan ratio did not occur until the TACAN/DME signals were tuned at least 9 MHz away from the ATCBI-5 receive frequency of 1090 MHz. The data have not been published, but are on file at the Technical Center and can be examined upon request.

**VICTIM: MODE S.**

**TRU-2 AIRBORNE TRANSPONDER.** Data to be collected at the FAA Technical Center using the MTPA.

**MODE S SENSOR ENGINEERING MODEL.** Data to be collected at the FAA Technical Center using the ARIES simulator.

**VICTIM: TACAN.**

Collins AN/ARN-118 Airborne Interrogator. The performance measure used to evaluate the performance of the ARN-118 airborne interrogator was "delta ASOP." The ASOP is the lowest RF level reply (from a ground transponder) an airborne interrogator can acquire and lock onto. A change in ASOP will occur when undesired signals are injected into the interrogator, thus requiring a stronger desired signal in order to acquire and lock onto it. A 3-dB delta ASOP was determined to be the maximum performance degradation allowed.

Tests on the ARN-118 when subjected to undesired signals from the 1030 MHz environment simulator provided data which indicated that the ARN-118 interrogator receiver should be tuned at least 3 MHz away from 1030 MHz. This frequency separation was required to meet the criterion of no more than 3 dB delta ASOP degradation. The test data can be found in DOT/FAA/CT-TN83/02, Mode S/TCAS to TACAN/DME Uplink Compatibility Tests, by G. Hartranft, July 1983.
When undesired 1090 MHz signals consisting of 40k of ATCRBS and 200 Mode S fruit were injected into the ARN-1l8, the test data showed that the ARN-1l8 receiver should be tuned at least 2 MHz away from 1090 MHz. At delta F=2 MHz, ASOP degradation did not exceed the 3 dB criterion limitation. The test data can be found in a report by G. Hartranft and H. Postel, ATCRBS/Mode S to TACAN/DME Downlink Compatibility Tests, 1982.

SECOND GENERATION VORTAC (SGV). Beacon reply efficiency was used as a criterion for determining performance of the SGV. Reply efficiency equal to or greater than 70 percent at the desired signal RF level (which determined receiver sensitivity) was required. All undesired signals were injected directly into the receiver antenna port.

Results from data taken when the SGV receiver was subjected to signals from the 1030 MHz environment simulator indicate that the SGV receiver needs to be tuned at least 3 MHz away from 1030 MHz to maintain normal operational performance.

When the 1090 MHz fruit source was used as an undesired signal source, the data results show that Mode S fruit of 1k affects beacon reply efficiency if the SGV receiver is tuned within 3 MHz of 1090 MHz. The ATCRBS fruit of 40k noticeably affected reply efficiency of the beacon unless the SGV receiver was tuned at least 6 MHz away from 1090 MHz.

Results from both of these tests can be found in DOT/FAA/CT-TN87/15, Electromagnetic Compatibility Tests of 1030/1090 MHz Waveform Environment to the Second Generation VORTAC, by R. Yost, September 1987.

VICTIM: DME/N.

KING KDM 7000 AIRBORNE INTERROGATOR. Representative of DME units installed in commercial aircraft, the KDM 7000 is also used in FAA flight inspection aircraft for checking the navigation suitability of the FAA VORTAC system. The KDM 7000 was recently modified by its manufacturer and a service bulletin requiring modification of existing units was issued to all present owners. This modification will increase the KDM 7000's immunity to undesired signal interference. Evaluation of data collected in the past on unmodified units will not correctly characterize the performance of modified or new KDM 7000. Therefore, new test data should be collected on a modified unit. As per agreement between the Spectrum Engineering Division (FAA Headquarters) and Spectrum Engineering Branch (FAA Technical Center), the KDM 7000's currently in inventory will be modified by the manufacturer and tested at the Technical Center.

Data that have been collected on unmodified KDM 7000 interrogators should be given consideration in determining frequency guardbands in order for units still in use and not yet modified to be operated properly. It is reasonable to expect the modification of the entire KDM 7000 inventory to take place gradually; thus for the near future, there will be a mixture of modified and unmodified units.

A loss of ASOP of not more than 3 dB was used as a criterion to judge the performance of DME interrogators.
Using 40k ATCRBS and 200 Mode S fruit at 1090 MHz, an unmodified KDM 7000 was tested. ASOP degradation of not greater than 3 dB was found to occur at delta F=7 MHz. Therefore, a guardband of at least 7 MHz away from 1090 MHz should be used in considering the receiver frequency to which an unmodified KDM 7000 should be tuned. This information can be found in DOT/FAA/CT-TN84/09, An Evaluation of the Performance of an Air Carrier Type DME Interrogator In the Presence of Electromagnetic Interference from ATCRBS/TCAS/Mode S 1090 MHz Transmissions, by W. Barto and H. Morgan, April 1984.

ASOP data were collected on an unmodified KDM 7000 when using 1030 MHz ATCRBS/Mode S/TCAS transmissions as undesired signals. The data results show that the (unmodified) KDM 7000 receiver had to be tuned at least 4 MHz away from 1030 MHz in order not to degrade ASOP by more than 3 dB. These data can be found in DOT/FAA/CT-TN83/02, Mode S/TCAS to TACAN/DME Uplink Compatibility Tests, by G. Hartranft, July 1983.

KING KN 65 DME INTERROGATOR. The King KN 65 DME interrogator is representative of DME units marketed for the general aviation user.

The ASOP data collected when 1030 MHz waveforms were injected into the interrogator indicate that ASOP signal levels decreased by 1 dB at delta F=1 MHz. Since the test data passes the criteria set forth, there is no guardband requirement for 1030 MHz waveforms for this unit. The data used for this evaluation are also contained in DOT/FAA/CT-TN83/02.

The KN 65 was tested with 40k ATCRBS and 1k Mode S fruit, at 1090 MHz, as the undesired signals. ASOP data were collected for delta F=2 and delta F=3 MHz. No data were collected when the frequency separation (delta F) was greater than 3 MHz. The data show that at delta F=3 MHz, the ASOP degradation was 5 dB, which is in excess of the 3 dB limiting criterion. These data can also be found in the Hartranft and Postel report.

Since not enough data are available on the KN 65, additional testing (using 1090 MHz undesired signals) is recommended to determine exactly what frequency separation should be considered for this unit.

CARDION™ BEACON TRANSPONDER. The Cardion DME ground beacon transponder was tested at the FAA Technical Center. Beacon reply efficiency, as was considered for the SGV TACAN, is the best measure of system performance. A loss of system sensitivity of not greater than 1 dB while maintaining a reply efficiency of equal to or greater than 70 percent was used as the criterion for performance judgment. Undesired signals were injected into the receiver antenna port.

When the 1030 MHz environment simulator was used as an undesired signal source, the data showed that the Cardion DME should have its receiver tuned at least 2 MHz away from 1030 MHz in order to maintain normal system reply efficiency.

If 40k of ATCRBS fruit and 200 Mode S fruit at 1090 MHz were injected into the Cardion DME, the test data showed that the beacon's receiver should be tuned at least 8 MHz away from 1090 MHz.

The data used to evaluate the guardband required for the Cardion Beacon for both 1030 and 1090 MHz environments are contained in report DOT/FAA/CT-TN86/60, Electromagnetic Compatibility Tests of ATCRBS/TCAS/Mode S to Cardion Distance Measuring Equipment Beacon, by W. Bell and E. Lind, March 1987.
A summary of the frequency guardband recommendations for each L-band system is shown in table 1.

**TABLE 1. GUARDBANDS NEEDED FOR FAA CHANNEL ASSIGNMENTS**

<table>
<thead>
<tr>
<th>Interference Source</th>
<th>Victim</th>
<th>TACAN/DME</th>
<th>1030 MHz Environment</th>
<th>1090 MHz Environment</th>
</tr>
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<tbody>
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<td>DME</td>
<td>A</td>
<td>King KN 7000 data to be collected</td>
<td>F=4 MHz</td>
<td>F=7 MHz</td>
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<td></td>
<td>G</td>
<td>Cardion™</td>
<td>F=2 MHz</td>
<td>F=8 MHz</td>
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<td>TCAS</td>
<td>A</td>
<td>Omnidirectional Antenna</td>
<td>F=12 MHz</td>
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<td>ATCRBS</td>
<td>A</td>
<td>EDO AIRE</td>
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<td>F=3 MHz</td>
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<tr>
<td></td>
<td>G</td>
<td>ATCBI-5</td>
<td>F=9 MHz</td>
<td>F=9 MHz</td>
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<td></td>
<td>G</td>
<td>SGV</td>
<td>F=3 MHz</td>
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</tr>
<tr>
<td>Mode S</td>
<td>G</td>
<td>FAA Technical Center Sensor Data to be collected</td>
<td>F=3 MHz</td>
<td>F=6 MHz</td>
</tr>
</tbody>
</table>

**NOTE:** A = Airborne Unit  G = Ground Unit
The recommendations are listed below:

DISTANCE MEASURING EQUIPMENT.

1. Distance measuring equipment (DME) airborne interrogator receivers should be tuned at least 4 MHz away from 1030 MHz.

2. DME airborne interrogator receivers should be tuned at least 7 MHz away from 1090 MHz.

3. The Cardion™ DME Beacon receiver should be tuned at least 2 MHz away from 1030 MHz.

4. The Cardion DME Beacon receiver should be tuned at least 8 MHz away from 1090 MHz.

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM.

1. The tactical air navigation (TACAN)/DME transmissions should be separated by 12 MHz from the 1090 MHz receiver of omnidirectional Traffic Alert and Collision Avoidance System (TCAS) II.

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM.

1. The TACAN/DME transmissions should be separated by 3 MHz from the 1030 MHz receiver of Air Traffic Control Radar Beacon System (ATCRBS) airborne transponders.

2. TACAN/DME transmissions should be separated by greater than 9 MHz from the 1030 MHz receiver of ATCRBS ground interrogators.

TACTICAL AIR NAVIGATION.

1. TACAN airborne interrogator receivers should be tuned at least 3 MHz away from 1030 MHz.

2. TACAN airborne interrogator receivers should be tuned at least 2 MHz away from 1090 MHz.

3. TACAN beacon transponder receivers should be tuned at least 3 MHz away from 1030 MHz.

4. TACAN beacon transponder receivers should be tuned at least 6 MHz away from 1090 MHz.
FURTHER TESTING.

Further testing is recommended on the King KN 65 DME interrogator using 1090 MHz waveforms as undesired signals.

Testing of the Mode S sensor should be performed to determine the effects of TACAN/DME on its performance.

The TRU-2 Mode S airborne transponder should be tested on the Mobile Transponder Performance Analyzer (MTPA) to determine the effects of TACAN/DME on its performance.

CRITERIA.

The Federal Aviation Administration (FAA) should develop performance criteria for all its systems to be used as a guideline for electromagnetic compatibility (EMC) testing. These criteria could be used for both civil and military applications and would give test engineers better guidance in designing system performance tests.