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A COMPARISON OF PRESENT DAY ATCRBS PERFORMANCE WITH THAT OF THE PROPOSED ATCRBS/DABS

IIT Research Institute
Under Contract to
DEPARTMENT OF DEFENSE
Electromagnetic Compatibility Analysis Center
Annapolis, Maryland 21402

August 1976

FINAL REPORT

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16. Abstract

The Air Traffic Control Radar Beacon System (ATCRBS) is presently used by the Federal Aviation Administration for its primary air traffic control operations. The Discrete Address Beacon System (DABS) is intended to replace the ATCRBS. The DABS includes a subsystem (ATCRBS/DABS) that will permit ATCRBS-only transponders to be serviced during the transition period.

The performance of ATCRBS and ATCRBS/DABS in a 1975 and a hypothesized future ground and air environment in the vicinity of JFK Airport, New York was analyzed. Predicted performance for the transponders in the environment and for a single interrogator at JFK Airport, was provided. The impact of the discrete addressing function of the DABS on ATCRBS performance was not considered.

Transponder performance for both the ATCRBS/DABS with the future air environment and the ATCRBS/DABS with the 1975 air environment was predicted to be superior to the performance of the 1975 ATCRBS. This improvement in performance includes an increased probability of reply, decreased mean sidelobe suppression rate, and decreased mean interrogation rates, which are all a result of the reduced interrogation rates of the ATCRBS/DABS interrogators in the future ground environment.

The assumed ATCRBS/DABS interrogator at JFK Airport was evaluated in the previously mentioned environments at its lowest (97 interrogations per second) and highest (194 interrogations per second) proposed interrogation rates. The interrogator's predicted performance for the highest interrogation rate for both environments was superior to that predicted for the 1975 systems. However, the

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16. Abstract continued.

interrogator's predicted performance in both environments for the lowest interrogation rate was worse than that predicted for the 1975 ATCRBS environment. This was attributed to lower code-validation probabilities.

PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military department and other DoD components. The Center, located at North Severn, Annapolis, Maryland 21402, is under executive control of the Office of the Secretary of Defense, Director of Telecommunications and Command and Control Systems and the Chairman, Joints Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical operations function is provided through an Air Force sponsored contract with the IIT Research Institute (IITRI).

This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAI-175, as part of AF Project 649E under Contract F-19628-76-C-0017, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

To the extent possible, all abbreviations and symbols used in this report are taken from American Standard Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the United States of America Standards Institute.

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METRIC CONVERSION FACTORS

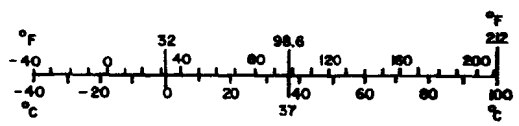
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 236, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

The mission of the Spectrum Management Staff is to assist the Department of State, Office of Telecommunications Policy, and the Federal Communications Commission in assuring the FAA's and the nation's aviation interests with sufficient protected electromagnetic telecommunications resources throughout the world to provide for the safe conduct of aeronautical flight by fostering effective and efficient use of a natural resource--the electromagnetic radio-frequency spectrum.

This objective is achieved through the following services:

- Planning and defending the acquisition and retention of sufficient radio-frequency spectrum to support the aeronautical interests of the nation, at home and abroad, and spectrum standardization for the world's aviation community.

- Providing research, analysis, engineering, and evaluation in the development of spectrum related policy, planning, standards, criteria, measurement equipment, and measurement techniques.

- Conducting electromagnetic compatibility analyses to determine intra/inter-system viability and design parameters, to assure certification of adequate spectrum to support system operational use and projected growth patterns, to defend the aeronautical services spectrum from encroachment by others, and to provide for the efficient use of the aeronautical spectrum.

- Developing automated frequency-selection computer programs/routines to provide frequency planning, frequency assignment, and spectrum analysis capabilities in the spectrum supporting the National Airspace System.

- Providing spectrum management consultation, assistance, and guidance to all aviation interests, users, and providers of equipment and services, both national and international.

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SECTION 1

INTRODUCTION

BACKGROUND

At present, the Air Traffic Control Radar Beacon System (ATCRBS) is the primary system used by the Federal Aviation Administration (FAA) for the surveillance of aircraft in the continental United States. This system employs ground-based interrogators and transponder-equipped aircraft.

In the near future (1980's and 1990's), a new system called the Discrete Address Beacon System (DABS) that has evolved from the ATCRBS will be implemented by the FAA. The DABS includes a subsystem that performs the ATCRBS ATC function (ATCRBS/DABS) which enables a DABS interrogator or transponder to communicate with an ATCRBS transponder or interrogator. This interoperability is necessary for an economical and gradual transition from ATCRBS to DABS.

The FAA needs to determine how well the ATCRBS and ATCRBS/DABS perform their ATC functions in the 1975 and predicted future aircraft and ground environments. As a result, the FAA requested that the Electromagnetic Compatibility Analysis Center (ECAC) predict the performance of the ATCRBS and ATCRBS/DABS for a 1975 and a future interrogator/transponder environment. The JFK Airport, New York Air Route Traffic Surveillance Radar site was selected for the analysis.

OBJECTIVE

The objective of this analysis was to compare the predicted system performance of the ATCRBS with that of the ATCRBS/DABS for a 1975 and a future interrogator and transponder environment.

APPROACH

The ATCRBS-IFF-MARK XII-System Performance Prediction Model[1] (AIMS PPM) was used in making performance predictions for the ATCRBS and ATCRBS/DABS operations. These predictions were made for four different interrogator/transponder environments consisting of the various combinations of 1975 and future interrogators and transponders.

To perform the analysis, the AIMS PPM requires several different inputs. Among these inputs are the characteristics of the various transponders and interrogators that make up the environment. The characteristics of transponders for the 1975 and future aircraft environments are listed in TABLE 1. All transponders were of the ATCRBS type. The interrogator of interest (I_o) characteristics are listed in TABLE 2 for the 1975 and future interrogator environments.

TABLE 1

CHARACTERISTICS OF 1975 AND FUTURE TRANSPONDERS

Sensitivity	-74 dBm
Power	57 dBm
Antenna Gain	measured Boeing 727 pattern
Reply Rate Limit (RRL)	1200 replies/s
Sidelobe Suppression Limit (SSL)	5000 suppressions/s
Transmitter Duty Cycle Limit (TDL)	18,000 pulses/s
Modes	3/A,C
Line Loss	3 dB

[1]Sutton, S. and Ehler, W., "Application of Markov Chain Theory of the Modeling of IFF/SSR Systems," *AGARD Conference Proceedings, No. 159*, NATO, November 1975.

TABLE 2

CHARACTERISTICS OF PRESENT ATCRBS I_o AND PROPOSED ATCRBS/DABS I_o AT JFK TERMINAL RADAR SITE

	Present ATCRBS	ATCRBS/DABS
LATITUDE	40° 38' 10" N	40° 38' 10" N
LONGITUDE	73° 46' 02" W	73° 46' 02" W
ELEVATION	28 feet	28 feet
POWER	0.1 kW	0.1 kW
SENSITIVITY	-84 dBm	-84 dBm
MAINBEAM GAIN[a]	21 dBi	21 dBi
MAINBEAM WIDTH	4°	4°
SIDELOBE GAIN[a]	-7 dBi	-7 dBi
SIDELOBE WIDTH	56°	56°
BACKLOBE GAIN[a]	-19 dBi	-19 dBi
BACKLOBE WIDTH	300°	300°
MODE INTERLACE	3/A, 3/A, C	3/A, C
SCAN RATE	15 RPM	15 RPM
INTERROGATION RATE	391 Interrogations/s	97 Interrogations/s @ 4 I/BW[b] 194 Interrogations/s @ 8 I/BW[b]
SLS TYPE	Improved	Improved
RECEIVER SLS	No	Yes
OMNI Antenna	FA-8044	FA-8044
LINE LOSS	4 dB	4 dB
BEACON ANTENNA	FA-8043	Sum-difference type

[a] 3-level representation of horizontal antenna patterns used for PPM simulation.

[b] I/BW = interrogations per 3-dB beamwidth.

Other major inputs to the AIMS PPM are the 1975 and future aircraft deployments. The 1975 aircraft environment was obtained from target reports that were generated by the Common Digitizer at the JFK Enroute Radar in New York. For the future aircraft environment, a worst-case assumption was made that there would be twice as many beacon-equipped aircraft in the future as there were around JFK Airport, New York in 1975.

The 1975 interrogator environment used in the analysis consisted of all interrogators within a 500-statute-mile radius of JFK Airport. The I_o of this environment was the JFK ATCRBS interrogator. This interrogator environment was taken from an FAA deployment in ECAC's IFF master files.

The predicted future interrogator environment again consisted of all interrogators within a 500-statute-mile radius of the I_o at JFK. The I_o in this environment was one of the ATCRBS/DABS type. All FAA interrogator sites in the environment were assumed to be equipped with the ATCRBS/DABS interrogators. These future beacons differed from the 1975 type in the interrogation rate, SLS capability, and processor operation.

There were four transponder performance predictions provided by the AIMS PPM that were of importance to this study. These predictions were: the probability of reply to all modes, Mark X sidelobe suppression rate, Mode 3/A interrogation rate, and Mode C interrogation rate. The minimum, maximum, and mean of these predictions were calculated.

Interrogator performance predictions that were calculated are: the probability of target detection, the probability of code validation for Mode 3/A, and the probability of code validation for Mode C. These predictions were calculated by using the AIMS PPM in conjunction with two other prediction models that simulate the target-detection and code-validation processors of the ATCRBS and the ATCRBS/DABS.

SECTION 2

SYSTEM DESCRIPTIONS

ATCRBS DESCRIPTION

The ATCRBS provides range, bearing, altitude, and identity information on all transponder-equipped aircraft that are able to properly receive and reply to interrogations of the ground-based interrogator/receiver.

A block diagram of a typical ATCRBS is shown in Figure 1. The ATCRBS antennas are usually mounted on the same pedestal as the antenna of the primary radar. As the primary (and ATCRBS) antennas are scanning through an azimuth of 360°, the ATCRBS interrogator is transmitting a series of time-coded pulses at a frequency of 1030 MHz. These time-coded pulses define different interrogation or transponder-reply modes. These modes are transmitted in a repetitive sequence (mode interlace). An interrogation rate that is less than or equal to 450 interrogations per second (I/s) is used by all ATCRBS interrogators. Figure 2 depicts the different interrogation modes used in civil ATC. Modes 3/A and C are used exclusively by the FAA for its ATC operations. The time spacing between the first pulse and the last pulse defines the different transponder reply modes.

The transponder responding to a valid mode 3/A or mode C interrogation will transmit, at a frequency of 1090 MHz, a 14-bit code containing identification or altitude information respectively. The altitude or identification information in the coded pulse train is used in generating target reports in the ARTS III (Automated Radar Terminal System).

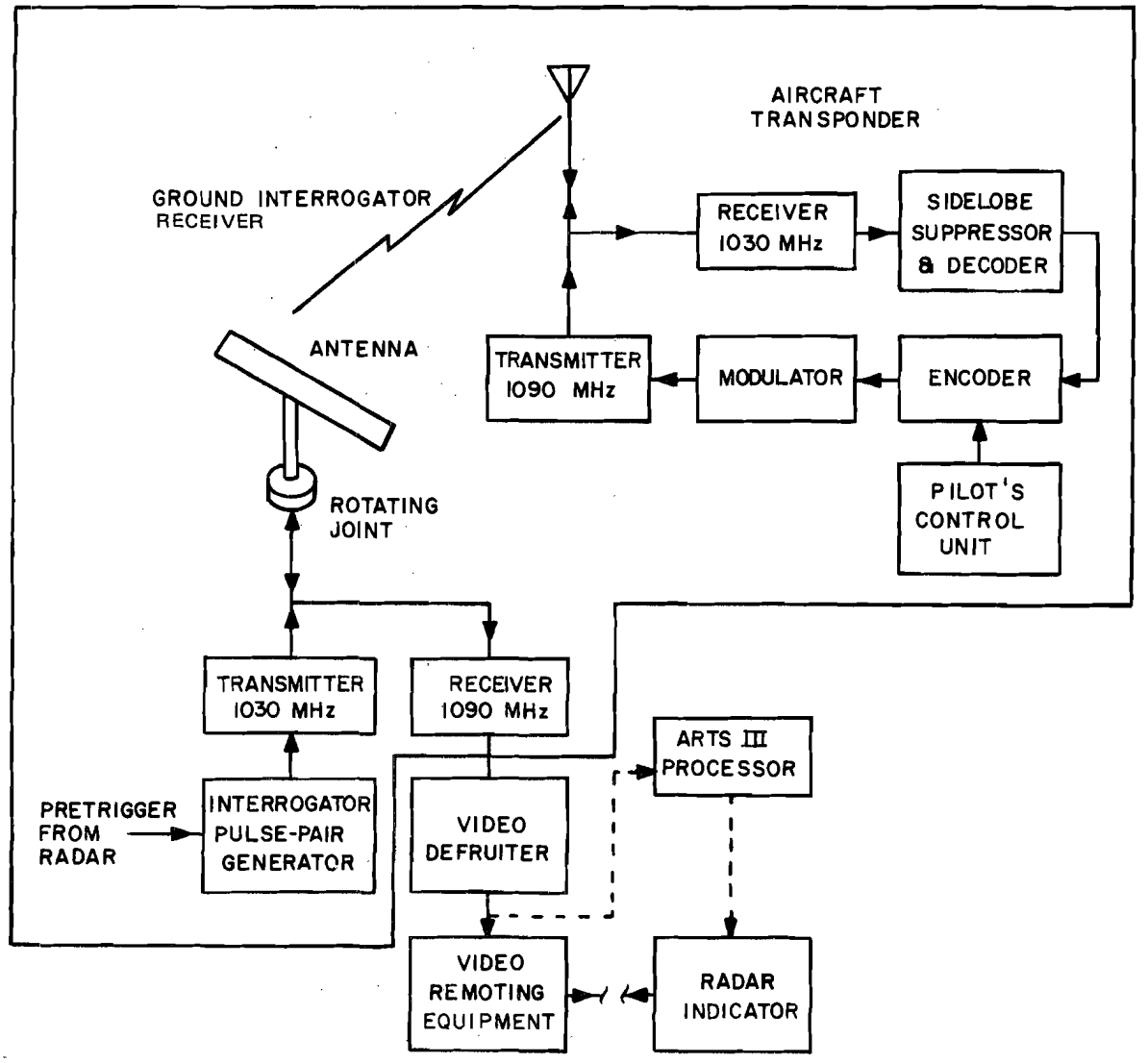


Figure 1. ATCRBS block diagram.

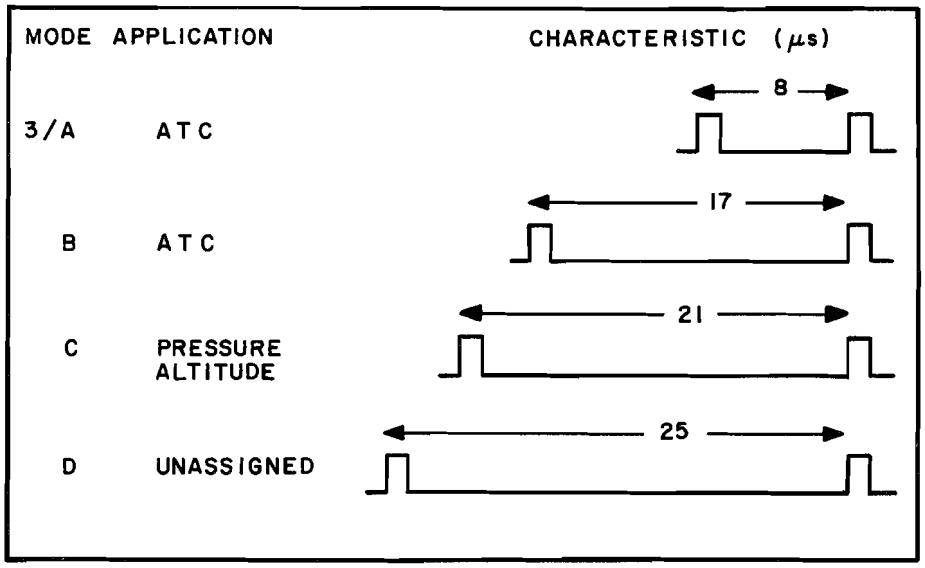


Figure 2. ATCRBS interrogation-mode pulse timing.

ATCRBS/DABS SYSTEM DESCRIPTION

The Discrete Address Beacon System (DABS) is an ATC system that is being implemented by the FAA to eventually replace the ATCRBS. A gradual, extended transition from ATCRBS to all-DABS is planned, because of the large number of ATCRBS equipments presently in use. Designed into DABS so that DABS interrogators and transponders can interface with ATCRBS transponders and interrogators is a feature called ATCRBS/DABS which consists of the elements of the DABS that perform the ATCRBS function. The overall operation of the ATCRBS/DABS is practically the same as the ATCRBS and most of the characteristics of the ATCRBS discussed in the previous system description apply to ATCRBS/DABS. However, a few major operational differences between the ATCRBS and ATCRBS/DABS exist.

The ATCRBS/DABS uses a slightly different signal format for its interrogations than does the ATCRBS. The signal format used (shown

in Figure 3) is known as the ATCRBS/DABS All-Call Interrogation which is used by DABS for the surveillance of ATCRBS-equipped aircraft. The ATCRBS transponder will recognize an ATCRBS/DABS All-Call Interrogation as a valid mode 3/A or mode C interrogation originating from the main-beam of the sum pattern of the DABS sum-difference antenna. Pulse P_2 in Figure 3 is an interrogator sidelobe suppression pulse. Pulse P_4 is ignored by the ATCRBS transponder. The DABS transponder, however recognizes its presence as indicating that the interrogation is an All-Call, and it responds with a DABS All-Call reply.

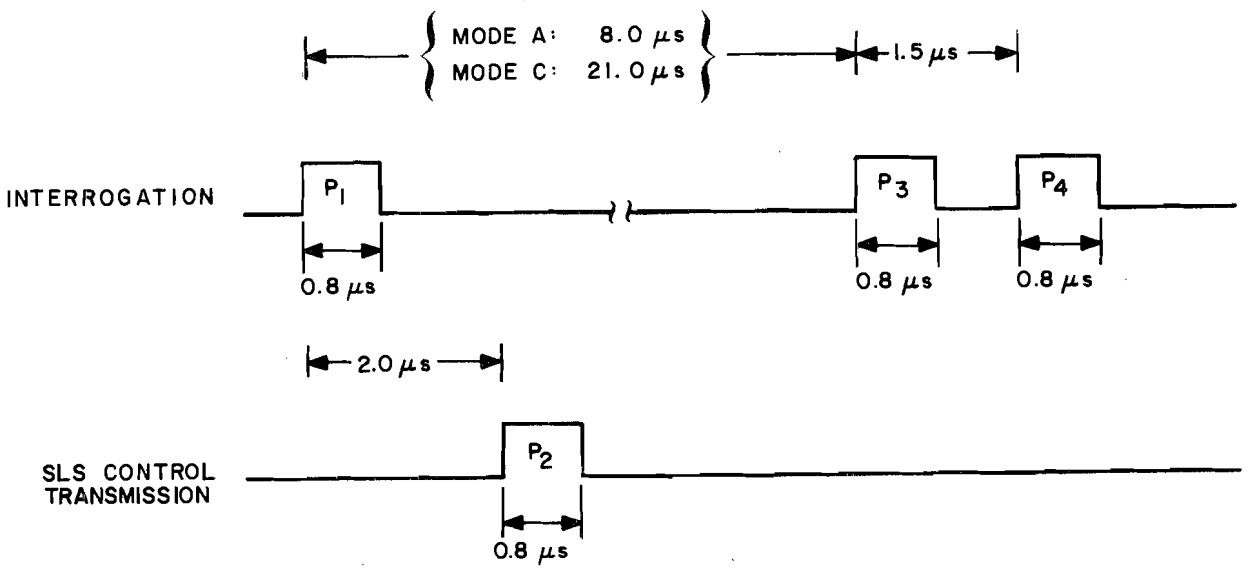
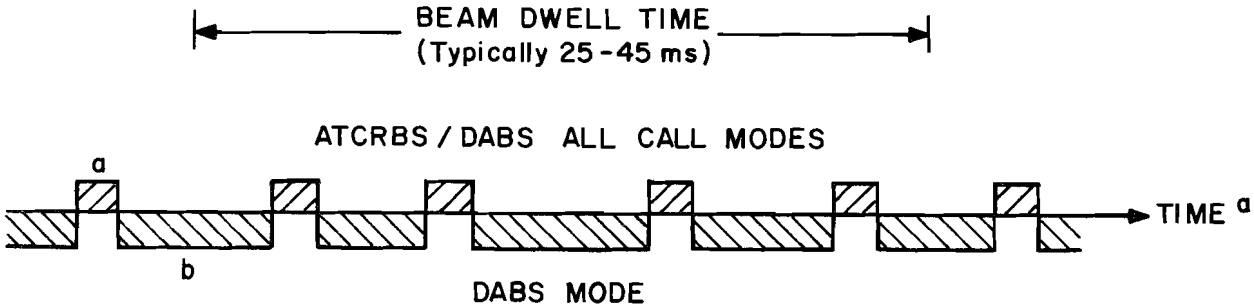


Figure 3. ATCRBS/DABS All-Call interrogation.

While an ATCRBS interrogator is continuously transmitting interrogations and receiving transponder replies, the ATCRBS/DABS and DABS interrogations and replies are received at different times. This is known as ATCRBS/DABS time sharing of the radio frequency channel (see Figure 4). For a fixed amount of time, ATCRBS/DABS All-Call interrogations are transmitted and DABS All-Call and ATCRBS mode 3/A and mode C replies are received. When the system is in the DABS mode, only DABS interrogations can be transmitted.

The ATCRBS/DABS uses a lower interrogation rate than the ATCRBS. An interrogation rate of 391 interrogations per second (I/s) is used by the ATCRBS I_o while the ATCRBS/DABS will use an interrogation rate that provides from 4 to 8 interrogations per mainbeam target sweep (97 to 194 I/s respectively).



[a]ATCRBS round-trip time to maximum range (i.e., 741.6 μs for 60 nmi).

[b]DABS allocated time (nominally 4-8 ms).

Figure 4. ATCRBS/DABS time sharing of the RF channel.

The ATCRBS uses a sliding-window technique to determine azimuth while the ATCRBS/DABS uses the monopulse method. The monopulse method of determining target azimuth requires only one reply pulse. The strengths of the reply signal received via the sum and difference channels of the receiver are compared and a monopulse estimate is obtained. This technique permits a lower interrogation rate than the ATCRBS.

The ATCRBS/DABS interrogator was assumed to operate without a defruiter. The signal amplitudes received on the sum and difference antenna patterns are compared and through the use of special signal processing techniques (receiver sidelobe suppression), sidelobe fruit are eliminated.

SECTION 3

ANALYSIS

THE 1975 AIR AND GROUND ATCRBS ENVIRONMENTS

The 1975 transponder environment was obtained from target reports generated by the Common Digitizer at the Enroute Radar in New York City. Each of the 150 transponder-equipped aircraft in the environment was identified by its latitude, longitude, and altitude. The 1975 interrogator environment comprises all interrogators that operate at least eight hours per day and are within 500 statute miles of the designated interrogator of interest (I_o) at JFK Airport, New York. It contained 163 ATCRBS terminal and enroute interrogators. The operating characteristics of each of the interrogators used in the analysis were obtained from ECAC's IFF Master file.

The AIMS model was used to obtain performance predictions for the 1975 ATCRBS environment. The results of these performance predictions are listed in TABLE 3.

A graph of fruit rate versus bearing angle is shown in Figure 5. This graph represents the maximum value of fruit per second for various antenna bearing angles. The highest fruit rate (2500 fruit per second) occurs at a bearing angle of approximately 226°.

Probability of target detection for the ARTS III processor is the probability that the I_o will receive at least 7 replies per 18 interrogations and is a function of the probability of reply, and the probabilities of mode 3/A and mode C code validation are the probabilities that two consecutive non-garbled mode 3/A or mode C codes are received respectively. These probabilities are both functions of the probability of reply and the fruit rate.

TABLE 3

ATCRBS PERFORMANCE PREDICTIONS

	Transponder Performance Prediction												Interrogator Performance Prediction					
	Probability of Reply			Sidelobe Suppression Rate			Interrogation Rate						Target Detection		Code Validation			
							Mode 3/A			Mode C					Mode 3A		Mode C	
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Min	Max	Min	Max
1975 (ATCRBS) ground environment; 1975 aircraft population	.93	.99	.97	0	1557	408	41	680	233	4	43	21	1.0	1.0	.99	1.0	.92	.99
Future (ATCRBS/DABS) ground environment; Future aircraft population																		
8 Interrogation/Beamwidth	.97	1.0	.99	0	574	146	31	569	191	1	21	10	1.0	1.0	.99	1.0	.98	1.0
4 Interrogation/Beamwidth	.97	1.0	.99										1.0	1.0	.79	.99	.79	.99
1975 (ATCRBS) ground environment; Future aircraft population	.93	1.0	.97										1.0	1.0	.99	1.0	.92	.99
Future (ATCRBS/DABS) ground environment; 1975 aircraft population																		
8 Interrogation/Beamwidth	.97	1.0	.99	0	534	141	31	569	185	1	21	9	1.0	1.0	.99	1.0	.99	1.0
4 Interrogation/Beamwidth	.97	1.0	.99										1.0	1.0	.86	.99	.85	.99

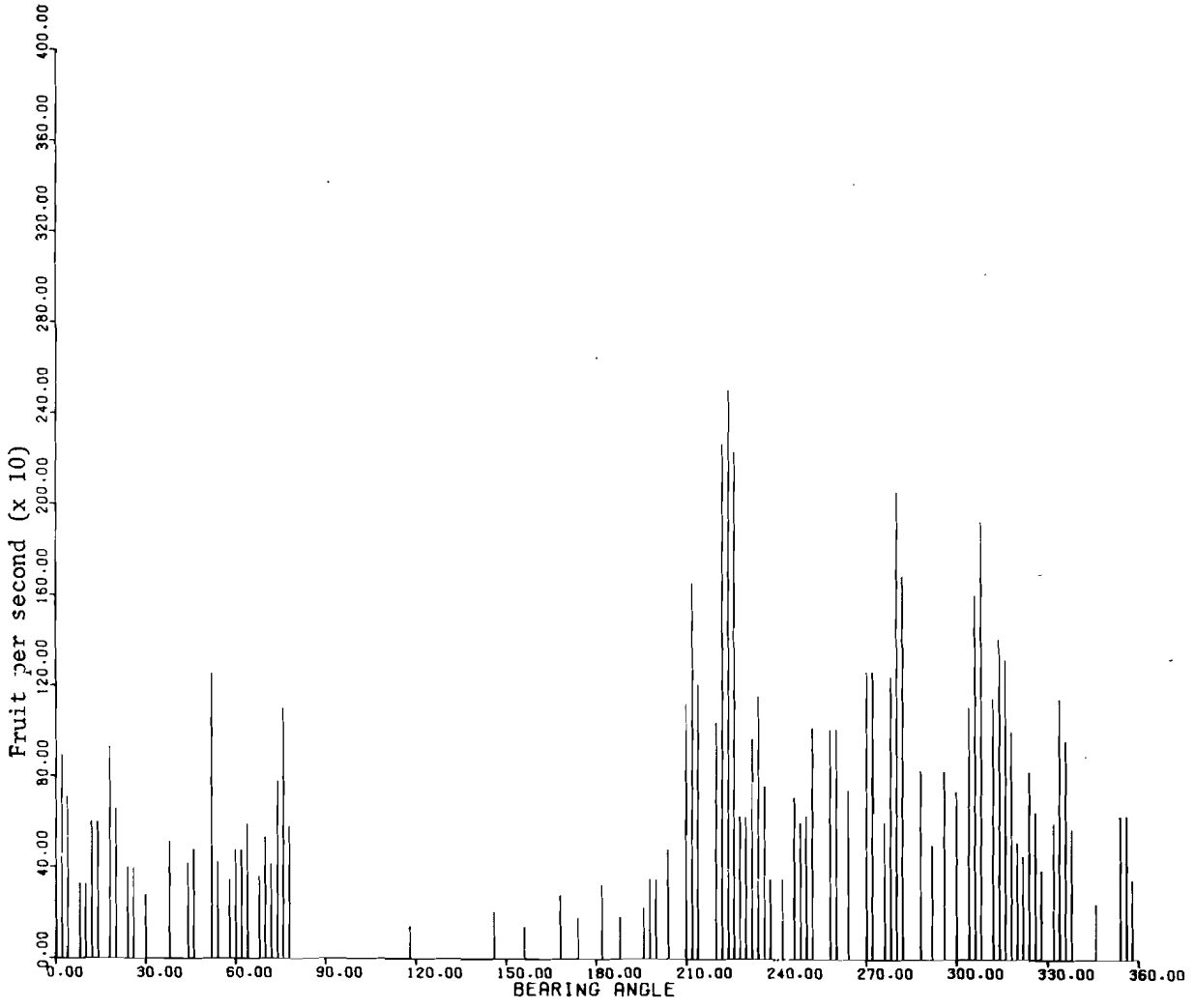


Figure 5. Maximum fruit at I_o as a function of bearing angle for the 1975 ATCRBS environment.

THE FUTURE AIR AND GROUND ENVIRONMENTS

For this analysis, the future transponder environment was assumed to contain twice the number of aircraft as the 1975 environment. To construct this environment, an additional beacon-equipped aircraft was located in altitude 2000 feet above each of the 150 beacon-equipped aircraft of the 1975 air environment. The interrogator environment is an approximation of the ground environment that is expected to exist around JFK Airport, New York in the future and differed from the 1975 environment since all FAA interrogators were of the ATCRBS/DABS type. This type of interrogator has different characteristics and uses a different processing system than does the ATCRBS. The operating characteristics of the various interrogators that make up this enviornment were obtained from a deployment in ECAC's IFF Master File.

The AIMS model was used to obtain predictions for the future environment. The results of these performance predictions are listed in TABLE 3.

Probability of target detection for the ATCRBS/DABS processor is the probability that at least three replies are received during a main-beam sweep of the target, and the probabilities of mode 3/A and mode C code validation are the probabilities that two consecutive non-garbled mode 3A or mode C codes are received respectively. These probabilities are both functions of the probability of reply and the fruit rate. A target detection criterion of 3 was used because it was assumed that a criterion of 2 would result in an excess of false alarm.

The performance of the I_o was evaluated at two different interrogation rates, 97 and 194 interrogations per second which correspond to 4 and 8 interrogations per beamwidth. For the case of the I_o using 4 interrogations per beamwidth, values for the probability of target

detection were the same as in the 1975 environment, while the probabilities of mode 3/A and mode C code validation either remained the same or decreased. This reduction in performance was due to the lower interrogation rate of 4 interrogations per beamwidth.

For the case of the I_o using an interrogation rate of 8 interrogations per beamwidth, a significant improvement in performance over that of the future environment at 4 interrogations per beamwidth was noted; probabilities of target detection remained at unity while all of the code validation probabilities were increased. Comparing the performance shown by analysis of the future environment for the case of the I_o using an interrogation rate of 8 interrogations per beamwidth to the interrogator performance of the 1975 environment, an improvement in performance can be seen.

FUTURE AIR AND 1975 GROUND ENVIRONMENT

The AIMS model was used to obtain performance predictions for the future air and 1975 ground environment. The results of these performance predictions are listed in TABLE 3.

Target detection and code validation probabilities remained the same as those obtained for the 1975 environment although the number of beacon-equipped aircraft was doubled.

A graph of fruit rate versus bearing angle is shown in Figure 6. This graph represents the maximum value of fruit per second for various antenna bearing angles. The highest fruit rate (5100 fruit per second) occurs at a bearing angle of 224°.

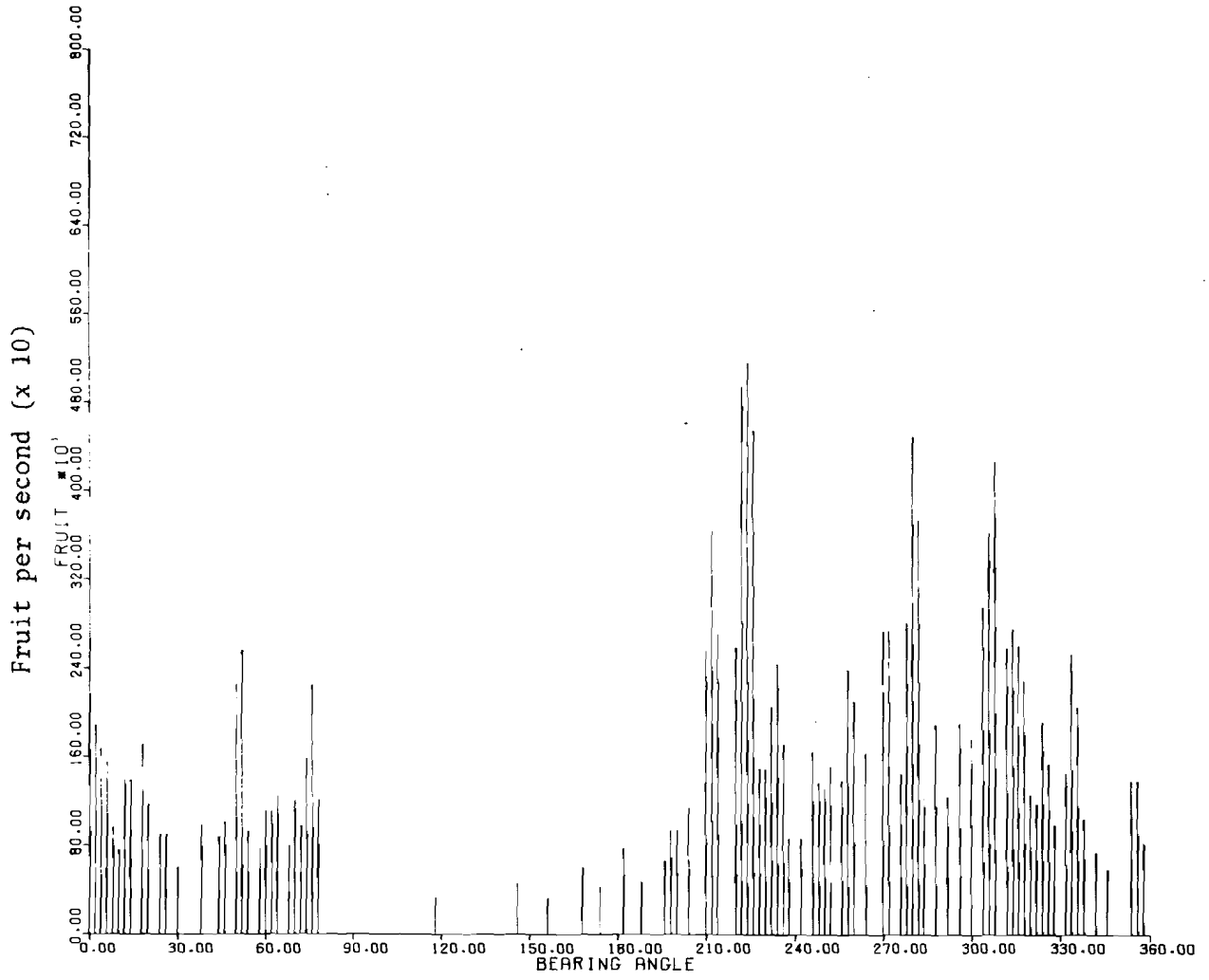


Figure 6. Maximum fruit at I_o as a function of bearing angle for future air and 1975 ground environments.

1975 AIR AND FUTURE GROUND ENVIRONMENT

The AIMS model was used to obtain performance predictions for the 1975 air and the future ground environment. The results of these performance predictions are listed in TABLE 3.

The performance of the I_o was evaluated at two different interrogation rates, 97 and 194 interrogations per second which correspond to 4 and 8 interrogations per beamwidth. For the case of the I_o using 4 interrogations per beamwidth, values for probability of target detection were the same as in the 1975 environment analysis while the probabilities of mode 3/A and mode C code validation either remained the same or decreased. This reduced performance is due to the lower interrogation rate of 4 interrogations per beamwidth.

For the case of the I_o using an interrogation rate of 8 interrogations per beamwidth, a significant improvement in performance over that achieved for the I_o using 4 interrogations per beamwidth was noted; mode 3/A and mode C code validation probabilities were all increased. An improvement in interrogator performance over the 1975 environment was noted for the case of I_o using the higher interrogation rate.

SECTION 4
RESULTS AND CONCLUSIONS

SUMMARY OF RESULTS

TABLES 4 and 5 summarize the transponder and I_o performance predictions for the analyses considered in this report.

CONCLUSIONS

1. The predicted transponder and ATCRBS/DABS interrogator-of-interest performance in a future ground and air environment indicates an improvement in interrogator performance over the 1975 ATCRBS performance assuming eight mainbeam interrogations of the aircraft per scan (a rate of 194 interrogations per second). This performance was reflected by the probability of target detection and code validation.

2. With only four interrogations per mainbeam sweep (a rate of 97 interrogations per second), the future ATCRBS/DABS predicted interrogator performance was worse than the predicted 1975 ATCRBS performance since an insufficient number of replies was available for reliable code validation.

3. The predicted performance of the ATCRBS/DABS interrogator in a 1975 air environment also indicated that the use of the lower interrogation rate (4 interrogations per beamwidth) results in interrogator performance inferior to baseline (1975 ATCRBS) performance.

4. Predicted transponder performance for the future ground and air environment was improved over the 1975 predicted transponder performance. This was due to introduction of ATCRBS/DABS interrogators with lower interrogation rates into the environment.

TABLE 4

TRANSPONDER PERFORMANCE PREDICTIONS

Condition	Probability of Reply to all Modes			Mark X Sidelobe Suppression Rate (suppressions/s)			Mode 3/A Interrogation Rate (I/s)			Mode C Interrogation Rate (I/s)		
	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.	Mean
A - ATCRBS I_o 1975 Interrogator Environment 1975 Aircraft Deployment	.93	.99	.97	0	1557	408	41	680	233	4	43	21
B - ATCRBS/DABS I_o Future Interrogator Environment Future Aircraft Deployment	.97	1	.99	0	574	146	31	569	191	1	21	10
C - ATCRBS I_o 1975 Interrogator Environment Future Aircraft Deployment	.93	.99	.97	0	1573	431	41	686	242	4	45	22
D - ATCRBS/DABS I_o Future Interrogator Environment 1975 Aircraft Deployment	.97	1	.99	0	534	141	31	569	185	1	21	9

TABLE 5

PERFORMANCE PREDICTION SUMMARY

Condition	Probability of Reply		Probability of Target Detection		Probability of Mode 3 Code Validation[a]		Probability of Mode C Code Validation[a]	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
A - ATCRBS I_o								
1975 Interrogator Environment 1975 Aircraft Deployment	.93	.99	1.0	1.0	.99 (2230)	1.0 (179)	.92 (2230)	.99 (179)
B - ATCRBS/DABS I_o								
Future Interrogator Environment Future Aircraft Deployment 4 I/BW	.97	1.0	1.0	1.0	.79 (1865)	.99 (84)	.79 (1865)	.99 (84)
8 I/BW	.97	1.0	1.0	1.0	.99 (1865)	1.0 (85)	.98 (1865)	1.0 (84)
C - ATCRBS I_o								
1975 Interrogator Environment Future Aircraft Deployment	.93	1.0	1.0	1.0	.99 (4543)	1.0 (420)	.92 (2579)	.99 (420)
D - ATCRBS/DABS I_o								
Future Interrogator Environment 1975 Aircraft Deployment 4 I/BW	.97	1.0	1.0	1.0	.86 (944)	.99 (33)	.85 (944)	.99 (33)
8 I/BW	.97	1.0	1.0	1.0	.99 (944)	1.0 (33)	.99 (944)	1.0 (33)

[a]Numbers in parentheses are fruit per second.