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POTENTIAL INTERFERENCE OF THE DISCRETE ADDRESS BEACON SYSTEM (DABS) ON THE X AND Y MODE TACAN SYSTEM

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16. Abstract

The impact of ten proposed signal formats of the Discrete Address Beacon System (DABS) on the performance of TACAN/DME equipments was investigated. The susceptibility of the individual TACAN/DME equipments to interference from the proposed DABS emissions was determined experimentally. This information was then used to assess the interference impact of a hypothetical DABS environment on the operation of TACAN/DME systems Worst case characterizations were used in some respects. A set of frequency-distance separations was developed that would prevent DABS interference to the TACAN interrogator, and limit the generation of deadtime in the TACAN beacon.

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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 Assistant Secretary of Defense for Telecommunications 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-19628-73-C-0031, 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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SECTION 1

INTRODUCTION

BACKGROUND

The Federal Aviation Administration (FAA) has instituted a program that implements the Air Traffic Control Advisory Committee recommendations[1] for an air traffic control system that will be adequate for the 1980's and beyond. The Discrete Address Beacon System (DABS) is being developed to succeed the Air Traffic Control Radar Beacon System (ATCRBS) as the primary means of air traffic control surveillance. DABS will support higher levels of air traffic control automation than have been planned for the Automated Radar Terminal System (ARTS) and the National Airspace System (NAS), and it is capable of supporting Intermittent Positive Control (IPC) and air traffic control communications via a data link. Additionally, DABS has the potential to improve upon the aircraft-tracking capacity, azimuth resolution, and ranging accuracy of the present ATCRBS.

It has been proposed that DABS operate on the IFF frequencies of 1030 MHz and 1090 MHz. Therefore, DABS must be interoperable with the existing ATCRBS, and compatible with AIMS and TACAN/DME services. The FAA has tasked[2] the DoD Electromagnetic Compatibility Analysis Center (ECAC) to determine the EMC impact of the DABS on TACAN/DME services.

The signal structures and DABS operating characteristics considered in this analysis were provided by MIT Lincoln Laboratory, the FAA's System Engineering Contractor (SEC). ECAC initially analyzed, from an EMC standpoint, the impact of two selected DABS signal structures on TACAN X mode equipments[3]. A second task, the subject of this report, is an EMC assessment of the impact of an expanded set of DABS signal structures and operating characteristics

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[1]Report of Department of Transportation Air Traffic Control Advisory Committee, Volumes 1 and 2, December 1969.

[2]Task Assignment 16 of Interagency Agreement DOT-EA-70WAI-175.

[3]Initial Interference Assessment of the Discrete Address Beacon System (DABS) on TACAN (X Mode), March 1973 (Unpublished FAA report).

on both X and Y mode TACAN/DME equipments. The susceptibility of individual TACAN/DME equipments to DABS emissions was determined experimentally. The EMC assessment was based on the application of the experimental data to the analysis of hypothetical (but expected) DABS environments.

OBJECTIVE

The objectives of this analysis were to:

1. Determine the degree of interference to TACAN/DME systems that would result from operating DABS with its proposed signal structures.
2. Determine frequency and distance separations necessary to preclude DABS interference to TACAN/DME interrogators, and define the level of beacon interference as a function of percent count down.

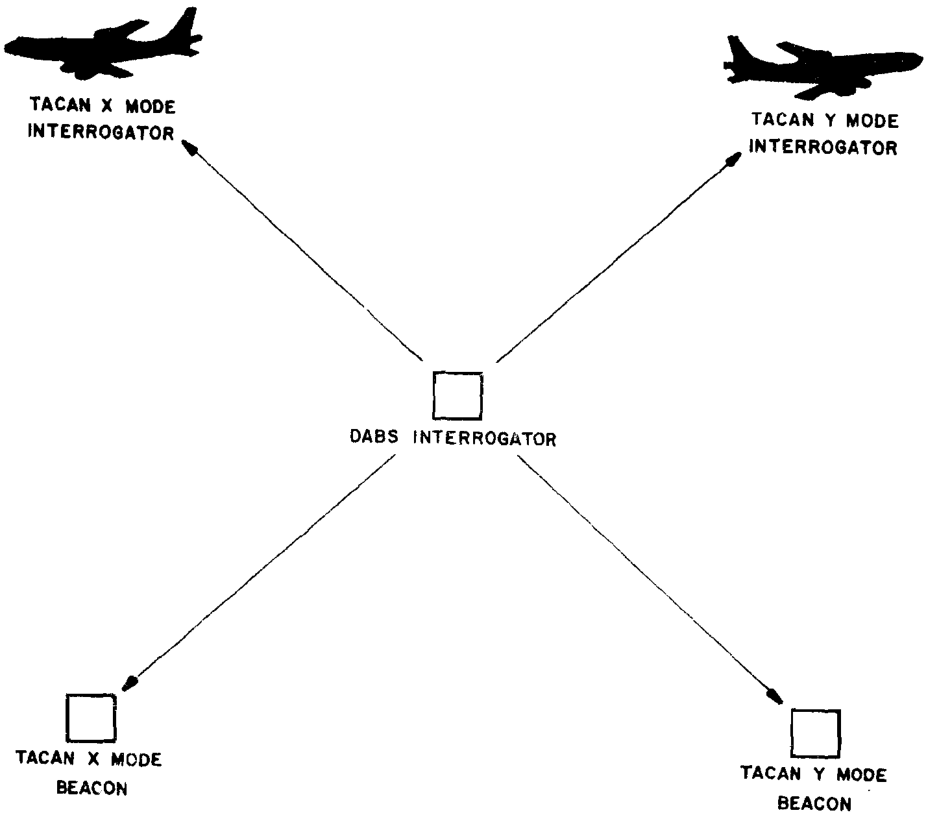
APPROACH

In order to assess the interference impact of the DABS on the TACAN/DME system, it was first necessary to determine the susceptibility of these equipments to DABS-generated interference. This was accomplished through a test program, conducted at the National Aviation Facilities Experimental Center (NAFEC) in Atlantic City, NJ. In this program the susceptibility of representative TACAN and DME equipments to each of the proposed DABS signal structures was measured. Measurements were made for the on-tune case and for various frequency differences (Δf) between the DABS emissions and the victim receiver.

The interference cases considered in this analysis are illustrated in Figures 1 and 2. In each case the potential interference source is a DABS sensor or transponder emission acting upon the receiver of a TACAN/DME beacon or interrogator.

The criteria selected for declaring degradation to the TACAN/DME interrogator were the DABS signal levels above which the interrogator, operating with a desired signal at the minimum discernible signal (MDS) level, was unable to acquire and maintain azimuth lock and range lock.

TACAN/DME beacon interference can be related to percent deadtime, where percent deadtime is defined as the percentage of time that the beacon cannot process a valid interrogation due to the presence of the interference. Thus, DABS interference would deny replies to valid interrogations. This reduction in replies could in principle result in the failure of the interrogator to acquire range lock. Any DABS-generated deadtime will add to the deadtime normally present in the beacon. The amount of internally generated deadtime is largely a function of the beacon loading. Consequently it was not possible to settle on a single



Note: On-tune interference to TACAN is possible in all cases except the TACAN X mode interrogator, where $\Delta f \geq 6$ MHz.

Figure 1. Possible interference paths for the DABS uplink signal (1030 MHz).

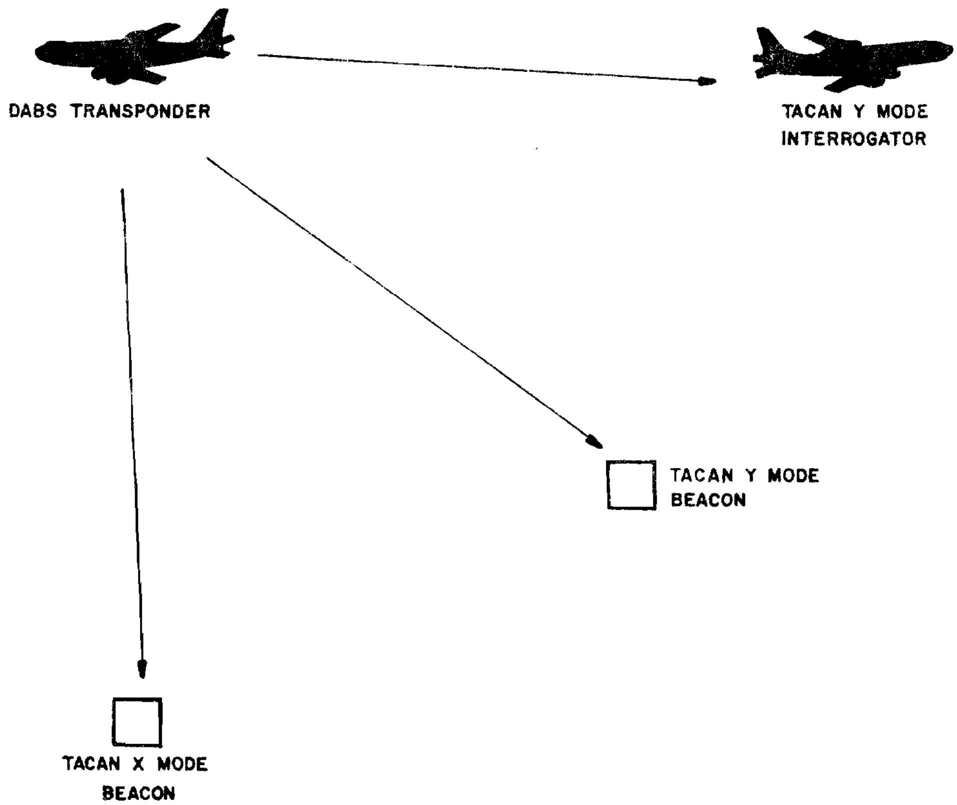


Figure 2. Possible on-tune interference paths for the DABS downlink (1090 MHz) signal.

interference level that would be applicable for all situations. Therefore, it was decided to use a family of interference levels corresponding to percent deadtime values of 0.5, 1, 2, etc., up to a maximum value of 10 percent in increments of one percent. This approach will allow those responsible for TACAN/DME system performance to make a technical judgment of the level of interference that can be tolerated without degrading the TACAN/DME system.

In the downlink analysis, the X and Y mode TACAN/DME beacon receivers and the Y mode TACAN/DME interrogators were considered as the potential victims of the DABS transponder operating on 1090 MHz. The DABS air traffic environment used in the analysis was supplied by MIT and is considered to be representative of the northeastern U. S. in the 1980 time frame. The first step in this analysis was the determination of the pulse density, i.e., the number of DABS replies per update period, that would be received by the victim receiver in the DABS environment. Plots were made of the number of pulses (DABS replies) versus their respective received power levels. This information, along with the measurement data, was used to assess the impact of the proposed formats on each potential victim. This process was repeated for various frequency separations between the victim receiver and the DABS downlink transmit frequency (1090 MHz). In this manner it was possible to determine the frequency separations required for (1) insuring that the Y mode interrogator will acquire azimuth/range lock and (2) limiting the percentage of deadtime in the X and Y mode TACAN/DME beacon to a fixed maximum value.

In the uplink analysis the X and Y mode TACAN/DME interrogator and beacon were considered to be the potential victims of the DABS sensors operating on 1030 MHz. The environment analyzed consisted of a deployment of DABS sensors (interrogators) that would provide single coverage of an aircraft operating at an altitude of 2000 feet within a 200 nmi radius of New York City. 1152 DABS-equipped aircraft were assumed to be within 200 nmi of New York, at altitudes between 1000 and 45,000 feet. First, the number and signal level of DABS interrogations that would be received by the potential victim in the DABS environment were calculated. These calculations took into consideration the DABS sensor antenna pattern and transmitter PRF. Next the pulse density information was used, along with the measurement data, to make an assessment of the impact of the proposed DABS signal formats on each potential victim. This procedure was repeated for various frequency differences between the DABS sensor and the victim receiver. In this way it was possible to determine the frequency separations, for each combination of TACAN/DME victim, DABS format and DABS PRF combination, that would either preclude interference or prevent interference from exceeding a specified level, assuming a minimum distance separation of one nautical mile. Once these frequency separations were found it was possible to generate curves showing the frequency-distance (F-D) separations required for interference-free operation of TACAN/DME equipments.

Because certain details of the DABS design were not available at the time this investigation was in progress, certain idealizations and certain worst-case assumptions were necessary. The testing of equipment was carried out using rectangular pulses with very fast rise and fall times. Free-space path loss was used in all cases. DABS ground antennas were represented by a three-level model in some cases and a four-level model in other cases. It was assumed that all DABS uplink transmissions were of a single type at one power level. Similarly, it was assumed that all DABS downlink transmissions were of a single type at one power level. Equipment availability dictated the number of TACAN/DME devices that were actually tested.

Because of these idealizations, the results should be regarded with some appreciation for the approximations involved. Although approximate, the results in this form serve the intended purpose of identifying the interference cases worth investigating further.

SECTION 2

ANALYSIS

GENERAL

With the DABS operating on 1030 and 1090 MHz there is a potential for interference to the TACAN/DME system. Specifically, the DABS use of 1030 MHz could result in interference to X and Y mode TACAN/DME beacons and interrogators, whereas the use of 1090 MHz could result in interference to the X and Y mode beacon and the Y mode interrogator.

TACAN/DME SYSTEM

The TACAN/DME system provides an aircraft pilot with slant range and bearing (TACAN only) to a selected ground beacon. The aircraft determines its distance to a beacon by interrogating it and timing the reply. Bearing is derived by analog techniques.

Two modes of operation are available for TACAN/DME use: the X mode and the Y mode. The X mode uses the entire TACAN/DME band (962 to 1213 MHz). In the Y mode, only the 1025 to 1150 MHz band is used.

In both the X and the Y modes, the basic channeling increment is 1 MHz. The channels are paired so that the aircraft and the selected ground beacon transmit on frequencies separated by 63 MHz.

The channel pairings for the X and the Y mode TACAN/DME are shown in Figure 3. In the X mode the beacon transmits in either the 962-1024 MHz or the 1151-1213 MHz band and the aircraft transmits in the 1025-1150 MHz band. If the aircraft is on channel 1X, it transmits on 1025 MHz and receives on 962 MHz. The corresponding beacon on channel 1X transmits on 962 MHz and receives on 1025 MHz. If the aircraft is on channel 64X, it transmits on 1088 MHz and receives on 1151 MHz. The corresponding beacon on channel 64X transmits on 1151 MHz and receives on 1088 MHz. In the Y mode, both the aircraft and the beacon transmit in the 1025-1150 MHz band. If the aircraft is on 1Y, it transmits on 1025 MHz and receives on 1088 MHz. The corresponding beacon on 1Y transmits on 1088 MHz and receives on 1025 MHz. If the aircraft is on channel 64Y, it transmits on 1088 MHz and receives on 1025 MHz. Its corresponding beacon on channel 64Y transmits on 1025 MHz and receives on 1088 MHz.

DABS CHARACTERISTICS

The DABS surveillance system may be thought of as a modified ATCRBS. It is a network of sensors, each measuring range and azimuth

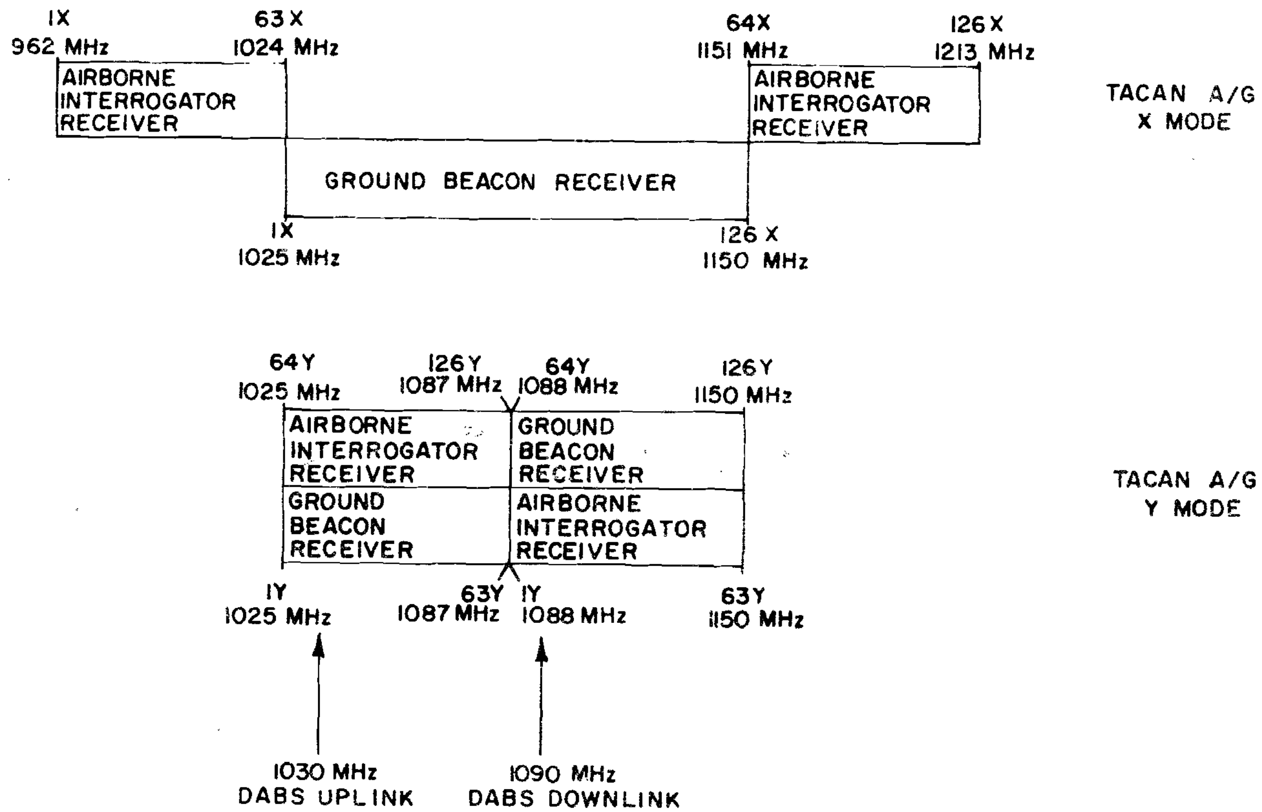


Figure 3. TACAN/DME X and Y mode receiver frequency pairing.

of aircraft within its coverage limits, and obtaining aircraft identity and altitude from coded replies. The chief difference between ATCRBS and DABS is that each DABS interrogation is addressed to a specific aircraft rather than to all aircraft simultaneously. Each aircraft recognizes and replies only to its own discrete address. The system schedules interrogations in such a way as to prevent garbling of the replies. Provisions have been made to add new aircraft to the discrete address roll call.

Since aircraft are addressed individually in DABS, the surveillance system automatically provides a natural vehicle for a data-link, between the ground sensor and the aircraft, that can be used for air traffic control purposes, including Intermittent Positive Control. The DABS design will accommodate this double function through the selection of an appropriate modulation format and coding techniques.

The pertinent DABS operating characteristics and signal formats used in this analysis were supplied by the system engineering contractor. Five candidate signal formats were proposed for use in the DABS uplink signal. An uplink preamble, consisting of three 0.8 μs pulses, is common to all five. These three pulses occur at 0, 2, and 3.5 μs, respectively, after the start of a DABS uplink interrogation. The message portion starts at the 5 μs point in the interrogation. Shown in TABLE 1 are the five message formats considered in this analysis. The DABS uplink operating characteristics considered are shown in TABLE 2. As indicated, two different sets of operating characteristics were considered, one set for formats 1, 2, 3 and 4 and another set for format 5.

For the DABS downlink, five candidate signal formats were proposed by MIT. The five formats had a common preamble consisting of three 1-μs pulses. These pulses occurred at the 0, 2, and 4 μs points in the DABS downlink reply. The downlink reply message starts at the 6-μs point. TABLE 3 contains the pertinent parameters of the five proposed message formats. A description of the downlink operating characteristics is contained in TABLE 4.

TACAN/DME INTERROGATOR INTERFERENCE

In the presence of an interfering signal, degradation of interrogator performance can take several different forms. For example, if the potential victim is a TACAN interrogator, the possible forms of performance degradation are:

a. inability to acquire azimuth lock.
b. presentation of erroneous bearing information.
c. inability to maintain a bearing indication, i.e., azimuth breaklock.

TABLE 1

DABS UPLINK MESSAGE FORMATS

DABS Uplink Format	Data Rate (Mb/s)	Message Length (μs)	Modulation
1	2.0	50	Pulse Amplitude Modulation, RZ
2	2.0	30	Pulse Amplitude Modulation, RZ
3	4.0	25	Pulse Amplitude Modulation, NRZ
4	4.0	25	Differential Phase Shift Keying
5	3.2	32	Differential Phase Shift Keying

RZ - Return to Zero
NRZ - Non-Return to Zero

TABLE 2

DABS UPLINK OPERATING CHARACTERISTICS

A. UPLINK FORMATS 1, 2, 3, and 4

Transmit Frequency - 1030 MHz
Interrogation Rate - 300, 500, or 1000 pulses/s.
Transmitter power (excluding antenna gain) - 1 kW (+60 dBm)
Interrogator scan rate - 15/min (4 s per scan)
Average number of hits/aircraft/scan = 3

ANTENNA PATTERN

Mainbeam Gain (3 dB width)	+23.5 dBi (3.2°)
Sidelobe Gain (width)	- 6.5 dBi (36°)
	-12.5 dBi (144°)
Backlobe Gain (width)	-17.5 dBi (144°)
	-22.5 dBi (32.8°)

B. UPLINK FORMAT 5

Transmit Frequency - 1030 MHz
Interrogation rate - 300 or 500/s
Transmitter power (excluding antenna gain) - 250W (+54 dBm)
Interrogator scan rate - 15/min (4 s/scan)
Average number of hits/aircraft/scan = 1.5

ANTENNA PATTERN

Mainbeam Gain (3 dB width)	+28 dBi [4° (ground to air)]
	+22 dBi [4° (ground to ground)]
Sidelobe Gain (width)	- 5 dBi (23°)
Backlobe Gain (width)	-11 dBi [189° (remaining 144° of backlobes to have infinite attenuation]

TABLE 3

DABS DOWNLINK MESSAGE FORMATS

DABS Downlink Format	Data Rate (Mb/s)	Message Length μs	Modulation
6	1	80	Pulse Amplitude Modulation, NRZ
7	1	40	Pulse Amplitude Modulation, NRZ
8	2	80	Pulse Amplitude Modulation, NRZ
9	2	40	Pulse Amplitude Modulation, NRZ
10	3.2	40	Pulse Amplitude Modulation, NRZ

RZ - Return to Zero
NRZ - Non-Return to Zero

TABLE 4

DABS DOWNLINK OPERATING CHARACTERISTICS

Transmit Frequency	-	1090 MHz
Transmitter Power	-	250W (+54 dBm)
Antenna Gain	-	0 dBi
Coverage	-	1, 2, or 3 sensors/target (Formats 6, 7, 8, 9). 2 sensors/target (Format 10)

d. inability to acquire range lock.

e. presentation of erroneous range information.

f. inability to maintain a range indication, i.e., range breaklock.

For the DME interrogator, the forms of performance degradation are the same as d., e., and f. for the TACAN interrogator.

In the test program, it was determined that the TACAN interrogator function most susceptible to interference was the ability to acquire azimuth lock. That is, for a given set of test conditions, acquisition of azimuth lock was precluded at an interference signal level which was lower than that at which the other forms of performance degradation occurred. For the DME interrogator, the most susceptible function proved to be the ability to acquire range lock. Shown in TABLE 5 are some of the measured interference power levels at which azimuth lock and breaklock occurred in the TACAN interrogator, and range lock occurred in the DME interrogator (complete data set contained in APPENDIX A). Based on these tests, an interference condition was said to exist when, as a result of the presence of the DABS emissions, the TACAN/DME interrogator failed to acquire azimuth/range lock when receiving a desired signal at the MDS level.

The interference mechanism associated with the inability of the interrogators to acquire azimuth/range lock is the reduction in receiver gain due to the presence of an interfering pulse train (AGC capture). The interfering signal was decoded by the interrogator and processed by the automatic gain control (AGC) circuitry along with the desired signal. One purpose of the AGC is to maintain a constant signal level in the interrogator receiver, i.e., at the detector output. The effect of these decoded interference signals on the AGC is similar to that which occurs when there is an increase in desired signal level. That is, the AGC reduces the gain of the receiver in an attempt to maintain some predetermined detector output. When this occurs, the corresponding reduction in desired signal level results in the loss of amplitude modulation and reference-burst information needed for azimuth determination. The fact that AGC capture is the interference mechanism was verified experimentally by observing that acquisition of azimuth lock and azimuth breaklock were accompanied by changes in the AGC voltage.

The interrogator AGC voltage is a function of the average received power. The implication of this is that there should be some correlation between the interference average power and break lock/acquire lock levels. TABLE 6 is a tabulation of the average interference power levels corresponding to azimuth acquire lock and break

TABLE 5

MAXIMUM DABS SIGNAL LEVELS ABOVE WHICH A TACAN/DME INTERROGATOR CANNOT ACQUIRE AZIMUTH/RANGE LOCK, AND THE DABS SIGNAL LEVELS AT WHICH AZIMUTH BREAKLOCK OCCURRED IN THE TACAN INTERROGATOR

DABS PRF (PPS)	DABS Signal Level Above Which the TACAN Will Not Acquire Azimuth Lock (dBm)	DABS Signal Level For Azimuth Breaklock (dBm)	DABS Signal Level Above Which the TACAN/DME Will Not Acquire Range Lock (dBm)
1.6K	-74.5	-71.5	-72.0
1.0K	-74.0	-71.0	-66.0
800	-72.0	-70.0	-66.0
600	-71.0	-69.0	-64.0
500	-70.0	-68.0	-62.0
400	-69.0	-67.0	-62.0
200	-59.0	-57.0	> -36.0

Notes: DABS signal format #4 was used.
DABS signal frequency same as victim receiver frequency (worst-case situation).
TACAN victim: ARN/21C, desired signal level = -85 dBm.
DME victim: Collins DME 860E-2, desired signal level = -86 dBm.
(Desired signal levels for victim equipments represent worst-case conditions.)

TABLE 6

AVERAGE ON-TUNE INTERFERENCE POWER FOR AZIMUTH ACQUIRE LOCK AND BREAKLOCK FOR THE TACAN X MODE INTERROGATOR

DABS PRF (PPS)	Average Interference Power (dBm)							
	Format # 1		Format # 2		Format # 3		Format # 4	
	Acquire Lock	Break Lock	Acquire Lock	Break Lock	Acquire Lock	Break Lock	Acquire Lock	Break Lock
1.6K	-91	-88	-91	-89	-99	-96	-89	-87
1.0K	-91	-89	-92	-90	-99	-96	-89	-87
800	-92	-89	-92	-90	-99	-96	-89	-87
600	-92	-89	-92	-90	-99	-96	-89	-86
500	-92	-89	-92	-90	-98	-96	-89	-86
400	-91	-89	-91	-89	-97	-94	-88	-86
300	-90	-88	-91	-89	-97	-94	-88	-85
200	-86	-84	-88	-85	-96	-93	-86	-83
150	-83	-81	-86	-84	-95	-92	-72	-69

Note: TACAN signal level represents worst-case condition.

lock in the TACAN interrogator for various DABS PRF's and formats. The average interference power is obtained from the measured peak power by reducing the peak power by a duty factor, defined as the product of PRF and pulse width, expressed in decibels. It is evident from TABLES 6 and 7 that, for a range of PRFs, there exists a correlation between the average interference power and azimuth acquire and breaklock levels in the TACAN interrogator. Thus by computing the average power of the interfering signal or signals it is possible to predict the occurrence of lock or break-lock.

A further examination of the data in TABLES 6 and 7, and the original test data in APPENDIX A, indicates that this average power concept is only valid for PRF's above a certain point. This is attributed to saturation or limiting effects in the receiver. For any given AGC setting there is a limited range of signal levels which the receiver will process linearly. Any signals which exceed the upper limit of this range will saturate the receiver, with the result that the detector output for that signal remains constant for further increases in signal level. This means that any received DABS signals having a peak power equal to or greater than the saturation level will have the same effect on the interrogator as a signal at the saturation level. The saturation levels for each of the proposed DABS signal structures were determined experimentally.

TABLE 8 contains the saturation levels and the acquire lock average power levels that were used in this analysis. The values shown are for the TACAN interrogator, since this particular piece of equipment is the most susceptible to interference. Hence, any criterion that precludes interference to the TACAN interrogator would adequately protect the other equipments.

The interrogator off-frequency rejection to the various DABS formats was determined experimentally. The term "off frequency rejection" is defined as the difference in DABS signal levels, in dB, between an on-tune signal and an off-tune signal of the same PRF, that result in the same interference effect, e.g., azimuth breaklock. It was determined that the interference mechanism was the same for off-tuned interfering signals as it was for on-tune interfering signals. In both cases, an interference condition existed because the interference controlled the receiver AGC action. The off-frequency rejection curves used in the analysis are presented in APPENDIX A.

Once the saturation level, acquire lock average interference power level, and off-frequency rejection had been determined for a signal structure, the following procedure was used to assess the impact of an environment of interfering signal sources on the

TABLE 7

AVERAGE ON-TUNE INTERFERENCE POWER FOR AZIMUTH ACQUIRE LOCK AND BREAKLOCK FOR THE TACAN Y MODE INTERROGATOR

DABS PRF (PPS)	Average Interference Power (dBm)							
	Format # 1		Format # 2		Format # 3		Format # 4	
	Acquire Lock	Break Lock	Acquire Lock	Break Lock	Acquire Lock	Break Lock	Acquire Lock	Break Lock
1.6K	-91	-89	-88	-86	-86	-82	-80	-77
1.0K	-93	-91	-88	-86	-86	-84	-79	-77
800	-92	-90	-89	-86	-86	-83	-78	-76
600	-91	-89	-88	-86	-86	-84	-78	-76
500	-91	-88	-88	-86	-85	-83	-78	-76
400	-90	-87	-88	-86	-84	-82	-78	-76
300	-89	-86	-88	-85	-84	-82	-77	-75
200	-87	-83	-86	-84	-82	-80	-74	-72
150	-83	-80	-85	-78	-81	-76	-73	-67

Note: TACAN signal level represents worst-case condition.

TABLE 8

SATURATION LEVELS (PEAK POWER) AND ACQUIRE LOCK AVERAGE POWER LEVELS FOR THE TACAN INTERROGATOR

DABS Format	X Mode Interrogator		Y Mode Interrogator	
	Saturation Level (dBm)	Acquire Lock Average Power Level (dBm)	Saturation Level (dBm)	Acquire Lock Average Power Level (dBm)
1	-69	-92	-69	-91
2	-69	-92	-65	-88.5
3	-69	-98	-61	-86
4	-68	-89	-55	-78
5[a]	-70	-91	-67	-89
6	N.A.[b]	N.A.	-70	-94
7	N.A.	N.A.	-70	-95
8	N.A.	N.A.	-71	-92
9	N.A.	N.A.	-71	-93
10	N.A.	N.A.	-70	-98

[a]No raw data was available for Format #5; the indicated levels are extrapolated.

[b]Not applicable.

interrogator. First, the received signal level from each source was computed. Next, any frequency difference between the victim and interference sources was accounted for by reducing the received signal levels by the appropriate off-frequency rejection. This, in effect, converts the received signal to an equivalent on-tune signal. All of the equivalent on-tune signals having a level greater than the saturation level were placed at the saturation level. Finally, an average interference power level was summed from a tabulation of the interfering signal levels. This computed value of average interfering signal power was then compared to the threshold value for acquisition of azimuth lock. If the computed value exceeded the threshold level, an interference condition was assumed to exist. A sample calculation using the method described above is shown on page 36.

TACAN/DME BEACON INTERFERENCE

The question of what constitutes degradation of beacon performance is not clearly defined. No well-defined degradation level exists, similar to acquire lock in the interrogator, which can be adapted to assess the impact of the DABS on beacon performance. However, it is possible to discuss the interference effect of the DABS signal on the TACAN/DME beacon. As will be shown, the interference effect of the DABS is similar to the self interference that is inherent in the beacon.

The normal beacon output consists of 3600 TACAN pulse pairs, of which 900 are azimuth reference bursts and 2700 are divided between squitter (noise-generated pulses) and replies to interrogations. The beacon restricts the time interval between any two of the 2700 pulse pairs to a minimum of 60 microseconds. Once the beacon replies to a noise input or valid interrogation there will be no further replies for at least 60 μs. This is because, when either a noise signal or a valid interrogation is decoded by the receiver, the decoder is disabled for the next 60 μs while the signal is further processed and a reply is eventually transmitted. Hence there is a deadtime associated with each decoding cycle, during which the receiver will not decode and process another interrogation, valid or otherwise.

As the beacon traffic increases (i.e., as the number of aircraft being serviced by the beacon increases) two effects are noted. First, the number of squitter output pulse pairs is reduced and, second, as a result of the deadtime, the probability of reply to a valid interrogation is reduced. The designed upper bound on the reply percentage is that, under conditons of 100 percent loading, the beacon will reply to a minimum of 70 percent of the valid interrogations[4]. The overall effect

[4]MIL-STD-291B, Standard Tactical Air Navigation (TACAN) Signal.

of this inherent self-interference, i.e., the reduction in replies because of deadtime, is to reduce the probability that an interrogator will maintain or acquire range lock.

The effect of an interference signal on the beacon is to further increase the amount of beacon deadtime. Depending on the structure of the interfering signal, there are two mechanisms by which deadtime can be generated. If the interference signal structure is not decoded in the beacon, a variable deadtime, dependent on the interference signal level, will be generated as a result of the activation of the beacon's echo suppression circuitry. If the interfering signal is decoded by the beacon, the resulting deadtime will be similar to that generated by a valid interrogation. When the interfering signal is decoded, a fixed amount of deadtime is generated over each of several levels of signal strength, whereas, for non-decoding interference signals, the resulting deadtime varies continuously with the interference signal level. The more severe case is that in which the interference is decoded by the beacon. The deadtime associated with an interference signal that decodes will be constant and at a maximum value for a wide range of interference signal levels. For a non-decoding signal, deadtime will be less than this maximum value for the same range of signal levels.

The question of how much interference-generated deadtime can be tolerated is not readily answered. It was not possible to establish any fixed percentage of deadtime as a degradation criterion, because not enough is known about beacon loading or the impact of additional deadtime on the ability of the interrogator to acquire or maintain range lock. Hence no attempt was made in this analysis to assess the degree of degradation to beacon performance that would result from the presence of DABS emissions. It was possible, however, to determine the percentage of deadtime that would result for various combinations of DABS signal structure, operating characteristics, and frequency/distance separations.

During the test program, it was found that all of the proposed DABS signal structures except Format 4 were decoded by both the X and Y mode beacons. The one exception was the case in which the victim was a Y mode beacon. The deadtime associated with each DABS signal structure was determined experimentally, in the presence of a desired signal at the MDS level.

Figure 4 shows the deadtime generated in the RTB-2 X mode beacon by DABS downlink format number seven. As indicated, deadtime was a function of the interference signal level, even when the interference was decoded by the beacon. The deadtime associated with interfering signals at the levels in Region I was the result of the detected interference pulses having an advantage over a detected desired signal at

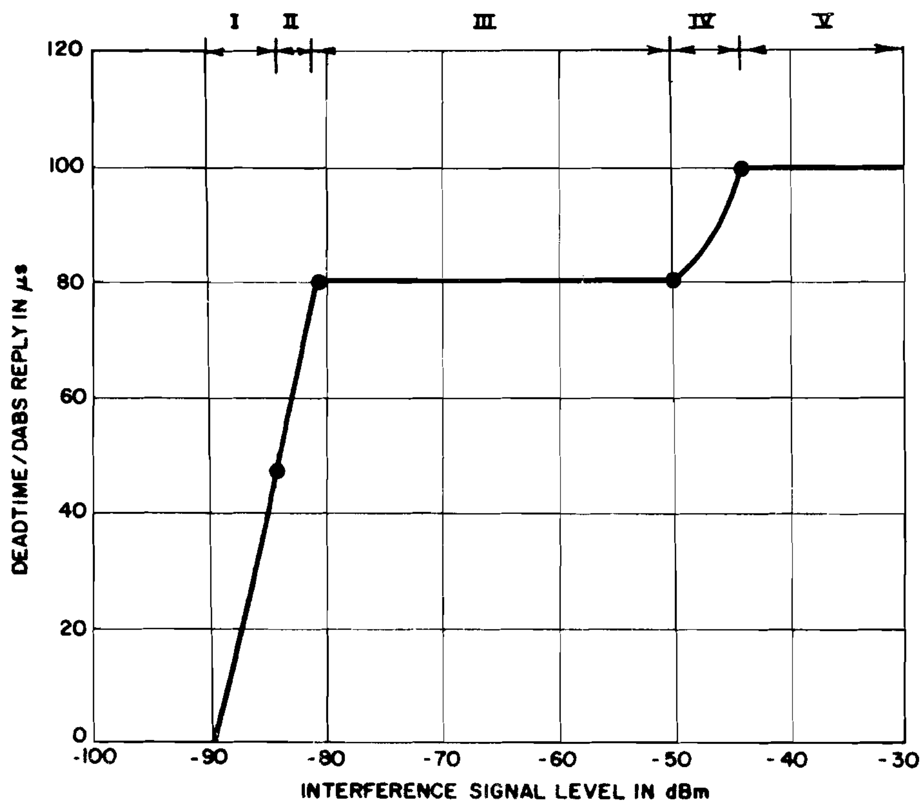


Figure 4. RTB-2 X mode deadtime for DABS downlink format 7.

the MDS level. That is, the interference effectively masked the desired signal. As the interference signal level was increased (Region II) decodes began to appear at the decoder output, accompanied by the 60 μs decoder inhibit gate. The deadtimes shown for this region are approximate average values. Averaging was necessary in order to account for the fact that the interfering signal in this region did not always decode. If the interference signal level was in Region III, the deadtime was solely a function of the resulting decode. For an interference signal in Region IV, the deadtime was determined by the echo suppression. For sufficiently large interference signals, the deadtime generated through echo suppression exceeded that resulting from the decode. Further increases in the interfering signal level (Region V) resulted in a constant deadtime. This is attributed to the fact that the deadtime generated via echo suppression had obtained its maximum value. Curves similar to Figure 4 were generated for each proposed DABS format and potential TACAN/DME beacon victim.

The beacon off-frequency rejection of the DABS signal was based on the percentage of reduction in the replies to valid interrogations as described in APPENDIX A. It was experimentally determined that, when the DABS signal was off-tuned from the beacon receiver frequency, the interference mechanism was the same as for an on-tune DABS signal. Beacon deadtime was generated because the DABS signal either was decoded or activated the beacon echo suppression. Hence, using the measured off-frequency rejection, an off-tuned DABS signal of a particular level can be related to an effective on-tune signal.

The following procedure was used to determine the percentage of deadtime resulting from the presence of the DABS signal. First, the received signal level from each DABS source was determined. Next, each interference pulse was equated to an equivalent on-tune pulse by making use of the off-frequency rejection characteristics of the TACAN beacon receiver. Then, with the aid of the appropriate deadtime curve, the deadtime resulting from these signals was computed. Finally, the average percentage of deadtime per second was computed. A sample calculation is shown on page 29.

DOWNLINK ANALYSIS

In the downlink analysis the potential victims were assumed to be the X and Y mode beacons and the Y mode interrogator. The TACAN equipments were subjected to a hypothetical deployment of DABS-equipped aircraft, as specified by the System Engineering Contractor. It is considered to be representative of the environment which will exist in the northeastern U. S. in the 1980 time period. 1152 aircraft, ranging in altitude between 1000 and 45,000 feet, were deployed within a 200 nmi. radius of New York City. For the purpose of this analysis, the victim beacon was located at JFK Airport and the victim interrogator was located at 10,000 feet above JFK. These particular victim locations were selected because they represent worst case locations within the environment analyzed. TABLES 9 and 10 show the number of DABS-equipped aircraft that would be received by the beacon and interrogator victims at each signal level.

By processing this environment in conjunction with the DABS operating characteristics and measurement results, it was possible to make an assessment of the effect of the proposed DABS formats on the TACAN/DME beacon and interrogator. Specifically, frequency separations were calculated that would prevent interference to the interrogator and that would prevent beacon deadtime from exceeding a specified percentage per second.

<u>Sample Beacon Calculation</u>

To illustrate the procedure used to calculate the interference effect of DABS on the TACAN X mode beacon, consider the following assumptions:

Victim	- X mode TACAN Beacon (RTB-2) Receiver
DABS Signal	- Downlink format number 7
Coverage	- Triple coverage (each aircraft is interrogated by three DABS sensors)
Interrogations/Sensor	- Three (each aircraft is interrogated three times per scan by each DABS sensor)
Update Time	- Four seconds (an aircraft is illuminated by each sensor once every four seconds)
Transponder Transmit Frequency	- 1090 MHz

First the total deadtime is computed for the environment of DABS transponders. This computation treats each aircraft as the source of a single DABS reply once every update period. The total deadtime for these conditions is the sum of the deadtimes caused by each contributor. The deadtime corresponding to the received signal level from each contributor is found from Figure 4. The average per-second deadtime can then be found from the following:

$$\text{Per Second Deadtime} = \frac{(X)(\text{Interrogations/Sensor})(\text{Sensors/Aircraft})}{4}$$

TABLE 9

RECEIVED DABS SIGNAL LEVEL AT TACAN/DME BEACON VICTIM LOCATED AT JFK

Received Signal Level (dBm)[a]	Number of DABS-Equipped A/C	Received Signal Level (dBm)[a]	Number of DABS-Equipped A/C
-42	1	-73	53
-45	1	-74	47
-49	2	-75	55
-53	1	-76	54
-54	2	-77	58
-55	2	-78	80
-56	4	-79	68
-57	3	-80	46
-58	3	-81	53
-59	6	-82	42
-60	4	-83	36
-61	3	-84	44
-62	12	-85	31
-63	9	-86	19
-64	11	-87	23
-65	12	-88	26
-66	29	-89	23
-67	31	-90	7
-68	21	-91	12
-69	38	-92	20
-70	26	-93	5
-71	36	-94	8
-72	49	-95	5

[a]Signal level of -70 dBm represents the range from -69.5 to -70.5 dBm, etc.

TABLE 10

RECEIVED DABS SIGNAL LEVEL AT TACAN/DME INTERROGATOR VICTIM LOCATED 10K FT ABOVE JFK

Received Signal Level (dBm)[a]	Number of DABS-Equipped A/C	Received Signal Level (dBm)[a]	Number of DABS-Equipped A/C
-47	2	-75	76
-52	4	-76	63
-54	3	-77	72
-55	1	-78	60
-56	4	-79	54
-57	1	-80	63
-58	1	-81	67
-59	5	-82	50
-60	4	-83	54
-61	7	-84	49
-62	4	-85	33
-63	6	-86	37
-64	4	-87	21
-65	8	-88	23
-66	12	-89	19
-67	22	-90	15
-68	25	-91	11
-69	29	-92	8
-70	28	-93	11
-71	21	-94	6
-72	59	-95	4
-73	45	-96	4
-74	53	-97	3

[a]Signal level of -70 dBm represents the range from -69.5 to -70.5 dBm, etc.

where:

$$X = \text{Total deadtime} = \sum_{i=1}^{N} \Delta T_i(P_r)$$

ΔT_i = Deadtime per aircraft

i = Number of aircraft

P_r = Received power

For this example, this reduces to:

$$\text{Per Second Deadtime} = \frac{(X)(3)(3)}{4} \; (\mu s/s)$$

The beacon's off-frequency rejection of the DABS signal can be found in TABLE 11. For example, for a frequency difference of 2 MHz, the off-frequency rejection of the beacon is 24 dB. The 29 contributors that would produce a -66 dBm signal at the beacon if they were co-channel (TABLE 9) would now have an effective on-tune signal level of -90 dBm. Once the environment is processed to account for the frequency difference, the procedure for finding the resulting deadtime is the same as that outlined for the co-channel case.

TABLE 12 contains the computed values of percent deadtime for the set of conditions considered in this example. These results are based on the assumption that the transmit frequency of the DABS transponders is 1090 MHz. The results can be extended to account for variations in transponder transmitter frequency. This has been done for the following distribution of transponder frequencies:

PROB(Tx Freq. = 1090 MHz) = .3058
PROB(Tx Freq. = 1089 MHz) = .2222
PROB(Tx Freq. = 1091 MHz) = .2222
PROB(Tx Freq. = 1088 MHz) = .1111
PROB(Tx Freq. = 1092 MHz) = .1111
PROB(Tx Freq. = 1087 MHz) = .0138
PROB(Tx Freq. = 1093 MHz) = .0138

TABLE 13 lists the percentage of deadtime for this distribution.

Interrogator Calculations

The procedure used to determine the impact of the downlink formats on the interrogator is the same as the uplink analysis. The results of the downlink analysis can be found in APPENDIX B.

TABLE 11

TACAN X MODE BEACON OFF-FREQUENCY REJECTION OF DABS DOWNLINK FORMAT 9

Δf [a] (MHz)	Off-Frequency Rejection (dB) [b]
1	13.0
2	21.0
3	24.5
4	26.0
5	27.0
6	27.5
7	28.0
8	29.0
9	30.0
10	31.5

[a] Δf is frequency difference between beacon receiver and 1090 MHz.

[b] This data assumes rectangular DABS pulses.

TABLE 12

PERCENT DEADTIME IN AN X MODE TACAN BEACON RESULTING FROM DABS DOWNLINK FORMAT 9 (DABS TRANSPONDER TRANSMITTER FREQ. = 1090 MHz)

Δf [a] (MHz)	Percent Deadtime [b]
0	17.8
1	8.41
2	2.94
3	1.31
4	.829
5	.561
6	.457
7	.367
8	.303
9	.241
10	.187

[a] Δf is frequency difference between TACAN receiver and 1090 MHz.

[b] This data assumes worst case TACAN signal level.

TABLE 13

PERCENT DEADTIME IN AN X MODE TACAN BEACON RESULTING FROM DABS DOWNLINK FORMAT 9 (DABS TRANSPONDER TRANSMITTER FREQ. = 1090 ± 3 MHz)

Δf [a] (MHz)	Percent Deadtime [b]
0	9.86
1	8.31
2	5.25
3	2.48
4	1.16
5	.689
6	.493
7	.384
8	.309
9	.247
10	.194

[a] Δf is frequency difference between TACAN receiver and 1090 MHz.

[b] This data assumes worst-case TACAN signal level.

UPLINK ANALYSIS

For this part of the analysis, both X and Y mode TACAN beacons and interrogators were the potential victims. The DABS environment was generated by replacing present ATCRBS interrogators with DABS interrogators and deploying additional DABS interrogators to provide no-hole DABS coverage 2000 feet above ground for the northeastern United States. The victim TACAN interrogator was located 6000 feet above the DABS antenna at JFK. The victim TACAN/DME beacon was located at the JFK VORTAC, which is assumed to be 1.7 nmi. from the DABS interrogator. The received DABS signal level at each potential victim was computed. For these computations the PRF of the sensor and its antenna pattern were considered. TABLE 14 lists the number of pulses at each of several signal levels, as received by the TACAN/DME beacon in a four second period, assuming a DABS PRF of 1000 interrogations per second.

TACAN/DME Beacon Assessment

The procedure used to determine the impact of the DABS uplink emissions on the beacon is the same as that described in the downlink analysis. Preliminary calculations of this type indicate that, in the interesting cases, the large majority of detectable DABS signals come from a single DABS interrogator. Accordingly, the remainder of the calculations apply to the case of a single DABS interrogator. The percentages of beacon deadtime resulting from the DABS emissions, for various frequency differences between the beacon receiver and the DABS uplink transmitter, are shown in TABLE 15.

Once the frequency separation is found that corresponds to a specific percent beacon deadtime, it is possible to determine the frequency-distance separations that would be required to maintain that percent deadtime. This amounts to finding the frequency-distance separations that result in the same attenuation of the DABS emissions as obtained for the minimum distance separation and frequency separation which resulted in that percent deadtime. For example, for the conditions described in TABLE 15 a two percent beacon deadtime will occur at the minimum distance separation of 1.7 nmi (path loss = 103 dB), if there is a frequency separation between the beacon receiver and the DABS interrogator of 24 MHz. This 24 MHz frequency separation corresponds to a 34 dB off-frequency rejection of this particular DABS signal. Hence for the condition being considered, a two percent beacon deadtime will occur if there is a 137 dB attenuation of the DABS emissions. The frequency-distance separations shown in TABLE 16 are those for which the sum of the path loss and beacon off-frequency rejection is 137 dB. Therefore, for these frequency-distance separations, the beacon will experience a two percent deadtime as a result of the presence of the DABS signal.

TABLE 14

PULSE DENSITY AT VICTIM TACAN/DME BEACON IN A FOUR-SECOND SCAN OF THE DABS ANTENNA

Number of DABS Interrogations	Received Signal Level (dBm)
11	-19
119	-49
178	-54
178	-59
114	-64

Note: PRF of DABS Interrogator = 300/s Beacon receiver freq. = 1030 MHz. (Assumes worst case condition for TACAN signal level.)

TABLE 15

DEADTIME PER SECOND IN TACAN X MODE BEACON RESULTING FROM DABS UPLINK EMISSIONS

Δf Between DABS Sensor And TACAN/DME Beacon (MHz)	Resulting Percent Deadtime Per Second (%)
0	2.6
10	2.4
15	2.2
16	2.0
17	1.8
18	1.6
19	1.5
22	1.0
24	0.6
27	0.3
31	0.2

Note: Distance separation between DABS interrogator and victim beacon = 1.7 nmi, DABS Signal Format Number 4, DABS PRF = 300/s. (Assumes worst-case condition for TACAN signal level.)

TABLE 16

FREQUENCY-DISTANCE SEPARATIONS REQUIRED BETWEEN DABS INTERROGATOR AND VICTIM TACAN BEACON FOR A 2% BEACON DEADTIME. DABS SIGNAL FORMAT NUMBER 4, DABS PRF = 300/s

Δf (MHz)	Distance Separations (nmi)
0	37.0
2	18.5
4	8.5
6	5.3
8	4.2
10	3.0
12	2.4
14	2.0
16	1.7

Note: Calculations based on worst-case condition for TACAN signal level.

Sample Interrogator Calculation

The procedures used to assess the impact of the DABS uplink signal on the TACAN interrogator, and to determine the frequency-distance separations required for non-interference, are illustrated below. For this example the following conditions are assumed:

Victim - TACAN X Mode Interrogator
DABS Signal - Uplink Format Number 4
DABS PRF - 300/s
Distance between DABS and victim - 1 nmi.

The number of DABS interrogations for a four second scan of the DABS antenna, as a function of signal level at the victim interrogator, is shown in TABLE 17. The received signal levels shown require adjustment to account for the 6 MHz difference between the DABS uplink frequency (1030 MHz) and the closest X mode interrogator receive frequency (1024 MHz). This is accomplished by reducing the received signal levels by the measured off-frequency rejection (TABLE 18) of the X mode interrogator. This converts the received off-tuned signal to an equivalent on-tune signal. The following procedure was then used to determine if the interrogator would acquire azimuth lock in the presence of the DABS emissions. First, equivalent on-tune DABS signals having a level equal to or greater than the saturation level were placed at the saturation level. For this example, there were 2028 DABS interrogations per 4-second interval at or above the -68 dBm saturation level. Next, the total received interference power was computed. This was accomplished by summing the average powers of all the interference signals. This computed value of total received interference power is that which would be received in a 4-second scan of the DABS antenna. The average interference power is obtained by reducing this value, if expressed in dBm, by 6 dB. For this example, the average interference power was found to be -85.8 dBm. This computed value of average interference power is then compared to the threshold value for acquiring azimuth lock (-89 dBm). For the case being discussed it is obvious that an interference condition exists, i.e., the interrogator will not acquire azimuth lock. This procedure was then repeated for successively greater frequency separations until the Δfs were found that resulted in an average interference power at least 1 dB below the degradation level. TABLE 19 contains the calculated values of average interference power versus Δf for this example. For the conditions assumed, a frequency separation of 12 MHz would be required to prevent interference to the TACAN X mode interrogator.

The frequency-distance separations that will preclude interrogator interference can be determined once the frequency separation has been found that results in non-interference at the minimum distance separation. The technique used to generate this F-D information is the same as that

TABLE 17

THE NUMBER OF DABS INTERROGATIONS AT VICTIM TACAN INTERROGATOR IN A FOUR SECOND SCAN OF THE DABS ANTENNA (DABS PRF = 300/s)

Number of DABS Interrogations	Received Signal Level (dBm)
11	14
119	-44
178	-49
478	-54
114	-59

Notes: Distance = 1 nmi.
Includes effect of one DABS interrogator
Assumes worst-case conditions for TACAN signal level.

TABLE 18

TACAN X MODE INTERROGATOR OFF FREQUENCY REJECTION OF DABS UPLINK FORMAT NUMBER 4

Δf (MHz)	Off-Frequency Rejection (dB)
6	17
7	18
8	19
9	20
10	21
11	22
12	23
13	24

(Assumes worst-case conditions for TACAN signal level.)

TABLE 19

RECEIVED AVERAGE INTERFERENCE POWER LEVEL AT AN X MODE TACAN INTERROGATOR

Δf (MHz)	Average Interference Power Level (dBm)
6	-91.0
7	-91.5
8	-91.8
9	-92.2
10	-93.0
11	93.5
12	-94.4
13	95.0

Notes: Distance Separation = 1 nmi.
DABS Uplink format number 4
DABS PRF = 300/s
Acquire lock degradation level = -89 dBm

described earlier in the section dealing with the TACAN/DME beacon.

APPENDIX B contains the complete results of the uplink analysis. These results are presented in the form of graphs showing the F-D separations that will (a) prevent interference to the TACAN interrogator (prevent azimuth lock) and (b) keep the percentage of deadtime in the TACAN/DME beacon below a fixed value.

SECTION 3

CONCLUSIONS

Interference to the TACAN/DME system from the Discrete Address Beacon System can be controlled through observance of the frequency-distance separations specified in this report. Application of these frequency-distance separations will allow the TACAN/DME interrogator to acquire azimuth/range lock in the presence of the DABS emissions, and will limit the beacon deadtime resulting from the DABS emissions to acceptable values.

APPENDIX A

TEST RESULTS

INTRODUCTION

The purpose of this appendix is to document the results of experimental tests to determine the susceptibility of TACAN/DME equipment to interference from the DABS, operating on the ATCRBS frequencies of 1030 MHz and 1090 MHz. Three main areas were investigated: the effects of DABS emissions on TACAN/DME beacon receivers, the effects of DABS emissions on TACAN/DME interrogator receivers, and the off-frequency rejection of these receivers to DABS signals.

Ten DABS signal formats (five uplink and five downlink) were simulated using the DABS signal simulator developed by the Systems Engineering Contractor. The simulator permits controlled variations in signal format, frequency, message length and, through the use of variable attenuator, power level. The following receivers were tested as potential victims:

1. Butler DME-100 beacon
2. RTB-2 TACAN beacon
3. AN/ARN-21C TACAN interrogator (2)
4. AN/ARN-21B TACAN interrogator
5. Collins 860E-2 DME interrogator

BEACON TESTS

To determine the effects of DABS interference on TACAN and DME beacons, a known level of interference was introduced into the receiver of a loaded beacon and the resulting degradation to the beacon was measured. The actual equipment configuration used in this test is illustrated in Figure A-1. The beacon, a Butler DME-100 X mode, contained internal test circuitry which enabled the simulation of actual operating conditions, including provision for controlling the number of interrogations coming into the beacon and the desired signal level. With these controls set to produce approximately 2000 interrogations per second and a reply rate of 70%, the DABS signal was added to the simulated environment. For each DABS format, a PRF was selected and the beacon reply count was recorded as the DABS power level was varied. This procedure was repeated for each of several PRF's of interest. Each reply count was then expressed as a percentage of the count when no DABS interference was present, and these percentages were plotted as a function of interference signal

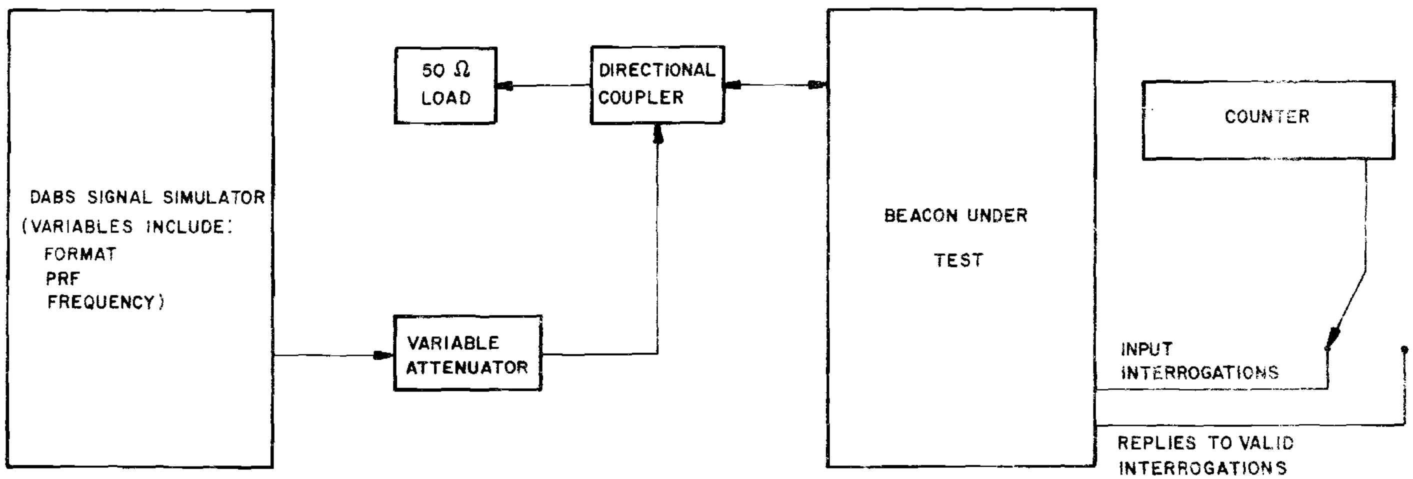


Figure A-1. Beacon test set-up.

level. An example of reply counts and percentage replies for one uplink DABS format (2MB, PAM RZ, 50 μs) is shown in TABLE A-1. Figure A-2 is a graph of these results. Graphs of similar results for each of the other DABS formats are shown in Figures A-3 through A-10.

The Butler DME-100 was modified for Y mode operation and the test procedure was repeated. These results are contained in Figures A-11 through A-19.

The same test was then performed using an RTB-2 X mode TACAN beacon as the victim. A similar set of data was taken; however, for this equipment, only X mode operation was tested. Figures A-20 through A-28 contain these results.

Off-Frequency Rejection Data

Using the same test configuration as previously described, off-frequency rejection data for the DME beacon was obtained in the following manner. With no DABS interference present and the beacon set up for the same reply rate as before, the number of replies from the beacon was counted and recorded. An on-tune signal (PRF = 3200) was then introduced and its level was varied until a reply count of approximately 70% of the no interference count was observed. This signal level, and the resulting reply count, were recorded. The interference signal was then reduced in steps of 2 dB and the corresponding reply counts were recorded as a function of signal level. The DABS signal simulator was then tuned to a frequency 1 MHz below the beacon receiver frequency. For this frequency difference, and a range of other frequency differences, the procedure was repeated, producing the data in TABLE A-2. In each case, the DABS signal simulator was off-tuned to produce the desired frequency differential (Δf). The reply counts in each case were converted to percentages of the count when no DABS interference was present, and plotted as a function of interference signal level (Figure A-29). From the graph so obtained, values of "off-frequency rejection" (the difference in signal levels, between the on-tune interference and the off-frequency interference, needed to produce an equal reply percentage in each case) were measured and recorded for values of "percentage replies" equal to 90, 85, 80, 75, and 70 percent. The values of OFR from each percentage level were averaged for each Δf, as in TABLE A-3, and plotted, as in Figure A-30. For each DABS format, this procedure was repeated and an off-frequency rejection curve was generated. The resulting curves are shown in Figures A-31 through A-34.

The off-frequency rejection curves for the TACAN beacon were obtained in a manner very similar to that used with the DME beacon.

TABLE A-1

PERCENT REPLIES VERSUS INTERFERENCE SIGNAL LEVEL AND PRF

Signal Structure: Uplink, 2 MB, PAM, RZ, 50μs
Interference Freq = Receive Freq = 1051 MHz
Guard Between Blocks/Transmission = 99μs
No. of Desired Interrogations: 2000/s
No Replies (No Interference): 1437 (avg)
Victim: X Mode DME Beacon

Interference Signal Level (dBm)	PRF = 4800		PRF = 3200		PRF = 2000		PRF = 1600		PRF = 1200		PRF = 800		PRF = 400	
	Reply Count	% Replies	Reply Count	% Replies	Reply Count	% Replies	Reply Count	% Replies	Reply Count	% Replies	Reply Count	% Replies	Reply Count	% Replies
-90	1489	99.5	1487	100	1436	96.5	1408	100	1417	99.8	1430	100	1420	100
-85	1474	98.5	1471	98.9	1430	96.1	1392	99.2	1409	99.2	1399	97.9	1411	100
-80	1423	95.1	1439	96.7	1408	94.6	1380	98.4	1400	98.6	1405	98.2	1395	99.3
-78	1386	92.6	1416	95.2	1395	93.8	1386	98.5	1403	98.8	1402	98.1	1369	97.4
-76	1352	90.3	1398	94.0	1366	91.8	1355	96.6	1400	98.6	1385	96.9	1362	96.9
-74	1277	85.3	1327	89.2	1335	89.7	1353	96.5	1373	96.7	1381	96.7	1367	97.3
-72	1180	78.8	1244	83.6	1291	86.8	1290	92.0	1347	94.9	1355	94.8	1362	96.9
-70	1053	70.3	1156	77.7	1226	82.4	1228	87.5	1278	90.0	1321	92.5	1327	94.4
-68	906	60.5	1030	69.2	1121	75.3	1138	81.2	1221	86.0	1294	90.6	1295	92.2
-65	693	46.3	792	53.2	963	64.7	1007	71.8	1093	77.0	1202	84.1	1271	90.4
-60	234	15.6	506	34.0	814	54.7	889	63.4	1010	71.1	1161	81.3	1216	86.5
-55	108	7.2	502	33.7	792	53.2	853	60.8	962	67.7	1102	77.1	1192	84.8
-50	94	6.2	511	34.3	817	54.9	869	61.9	978	68.9	1120	78.4	1226	87.2
-40	163	10.8	530	35.6	815	54.8	919	65.5	1032	72.7	1134	79.4	1241	88.3
-30	239	15.9	507	34.0	793	53.5	892	63.6	1007	70.9	1136	79.5	1265	90.0
No Interference	1496	-	1487	-	1421	-	1402	-	1419	-	1428	-	1404	-

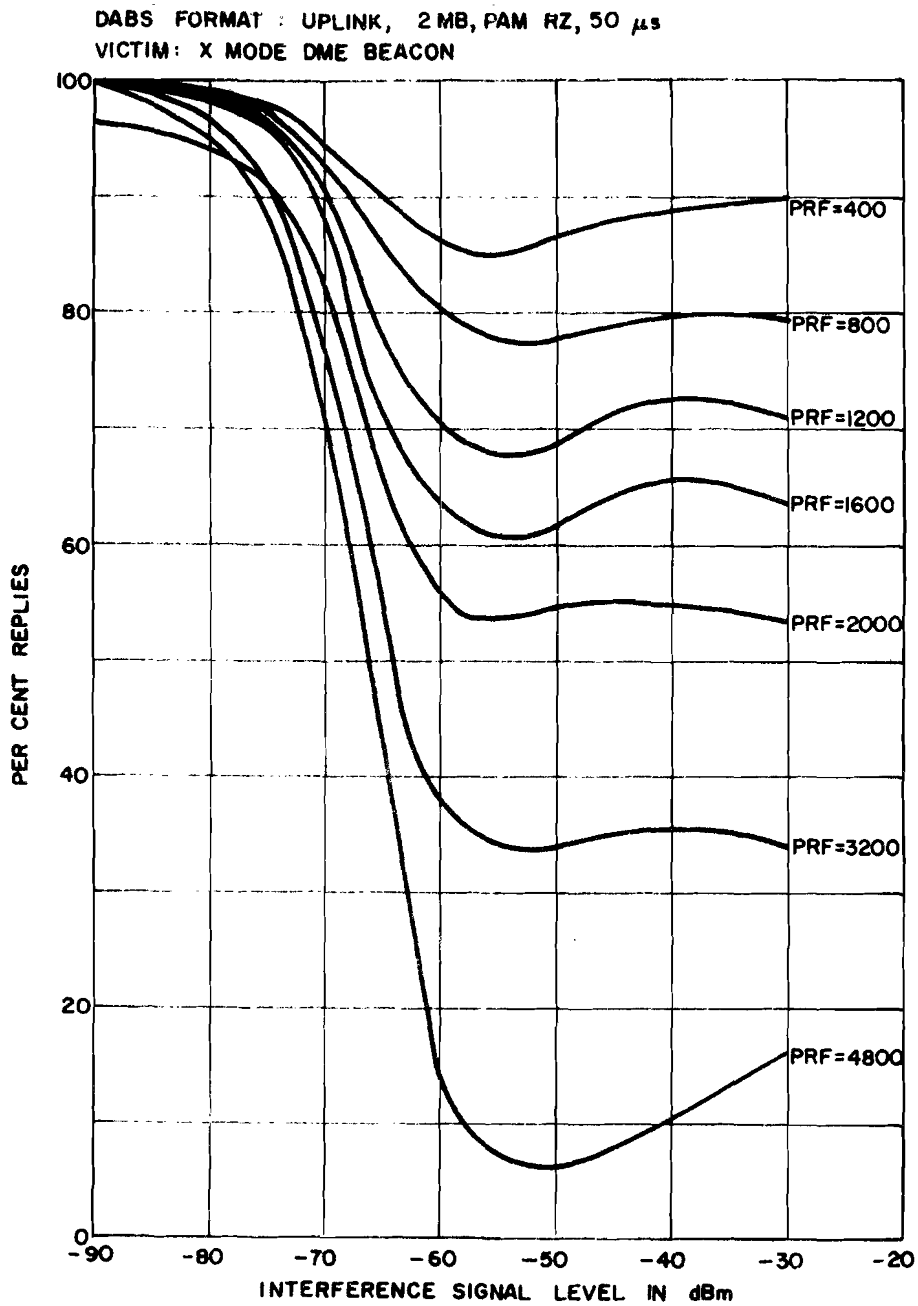


Figure A-2. Percent replies vs interference signal level and PRF.

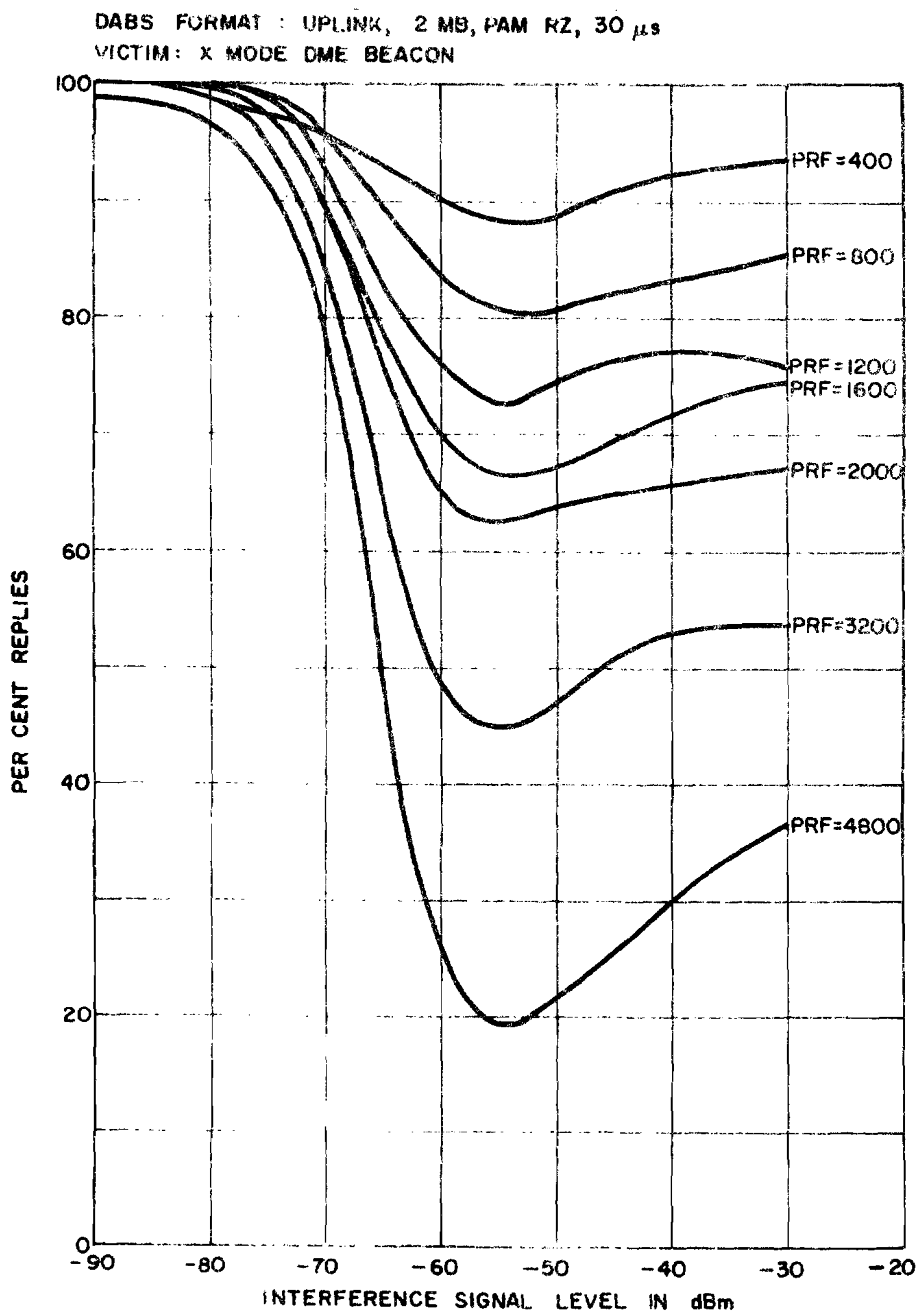


Figure A-3. Percent replies vs interference signal level and PRF.

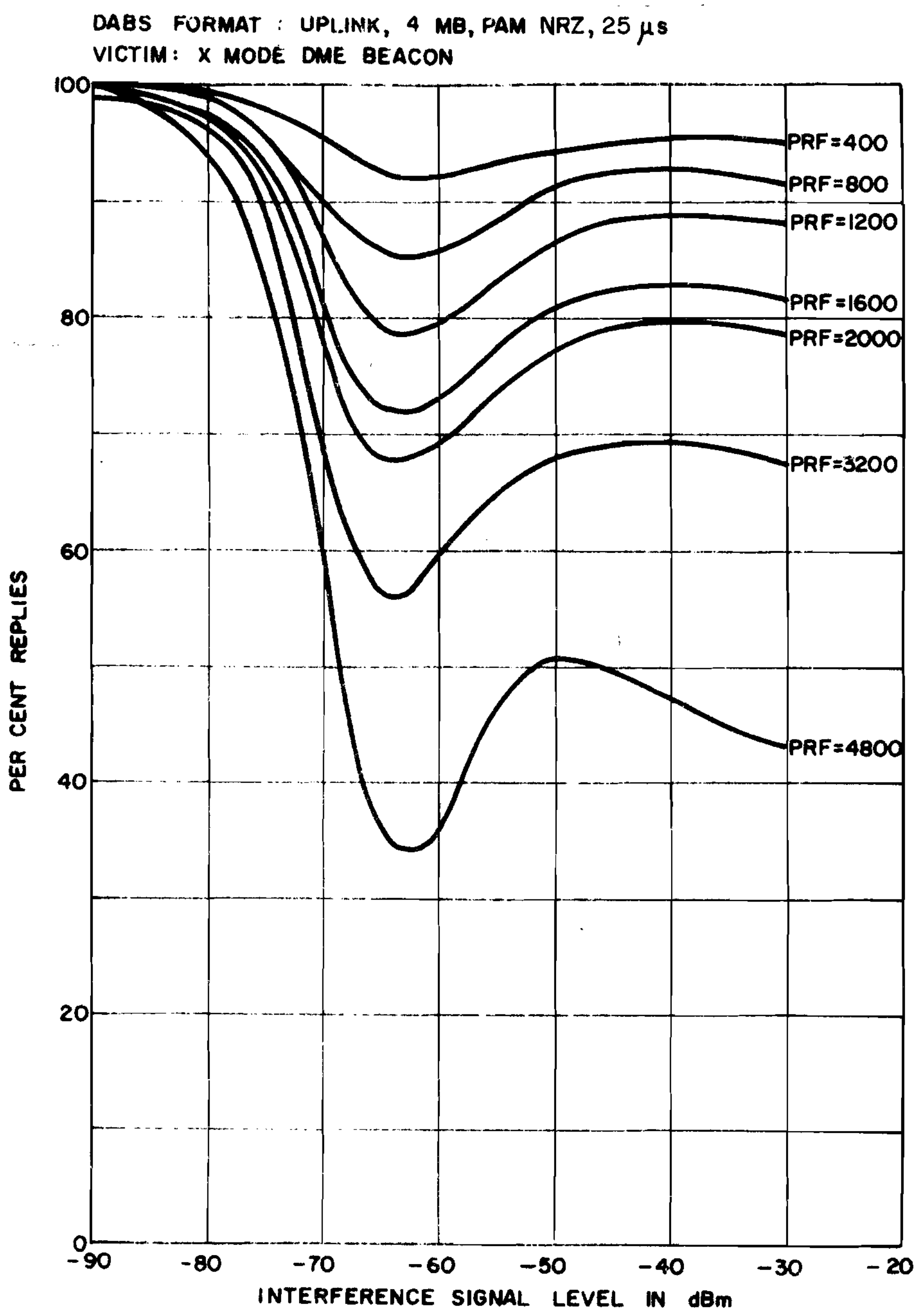


Figure A-4. Percent replies vs interference signal level and PRF.

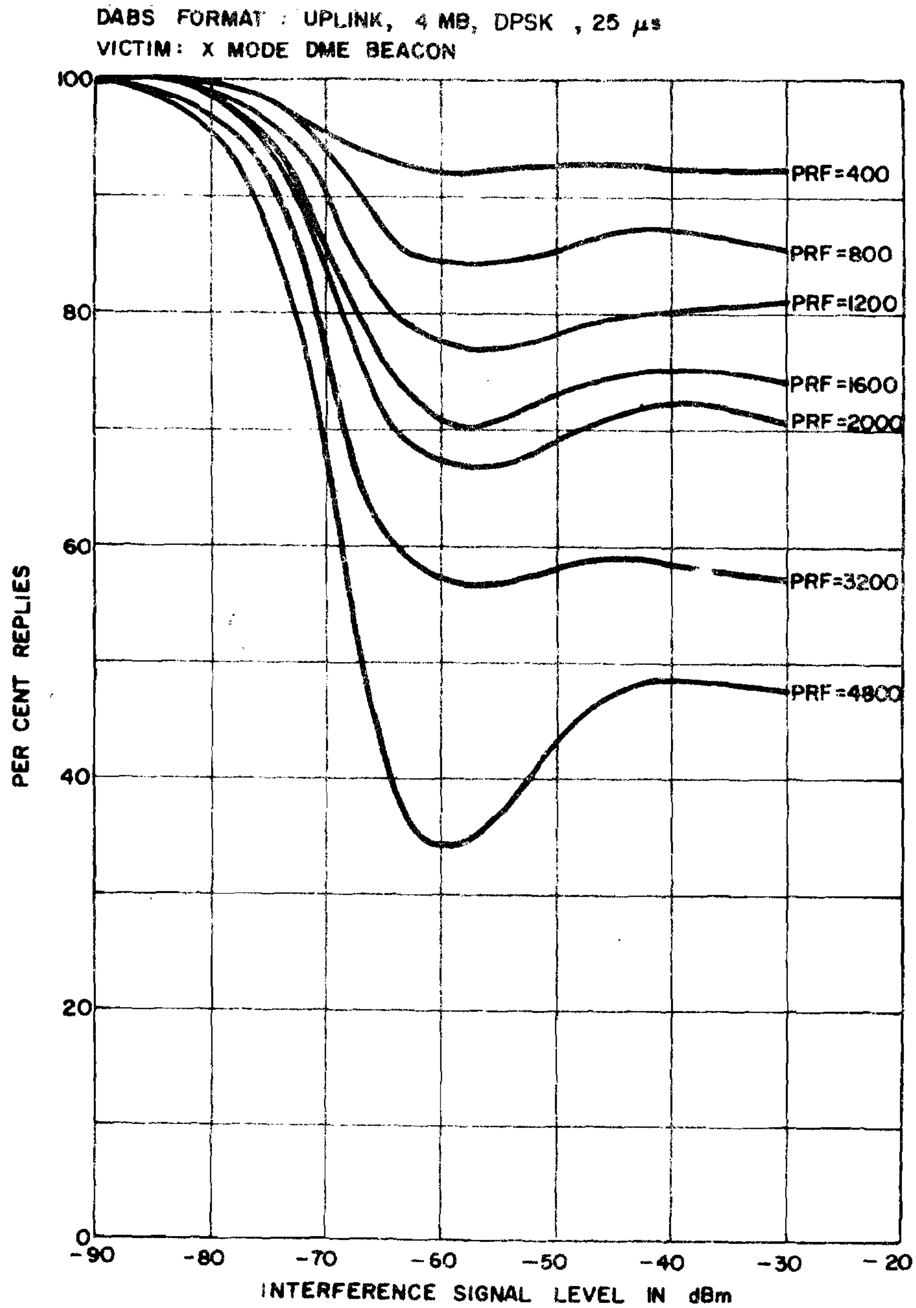


Figure A-5. Percent replies vs interference signal level and PRF.

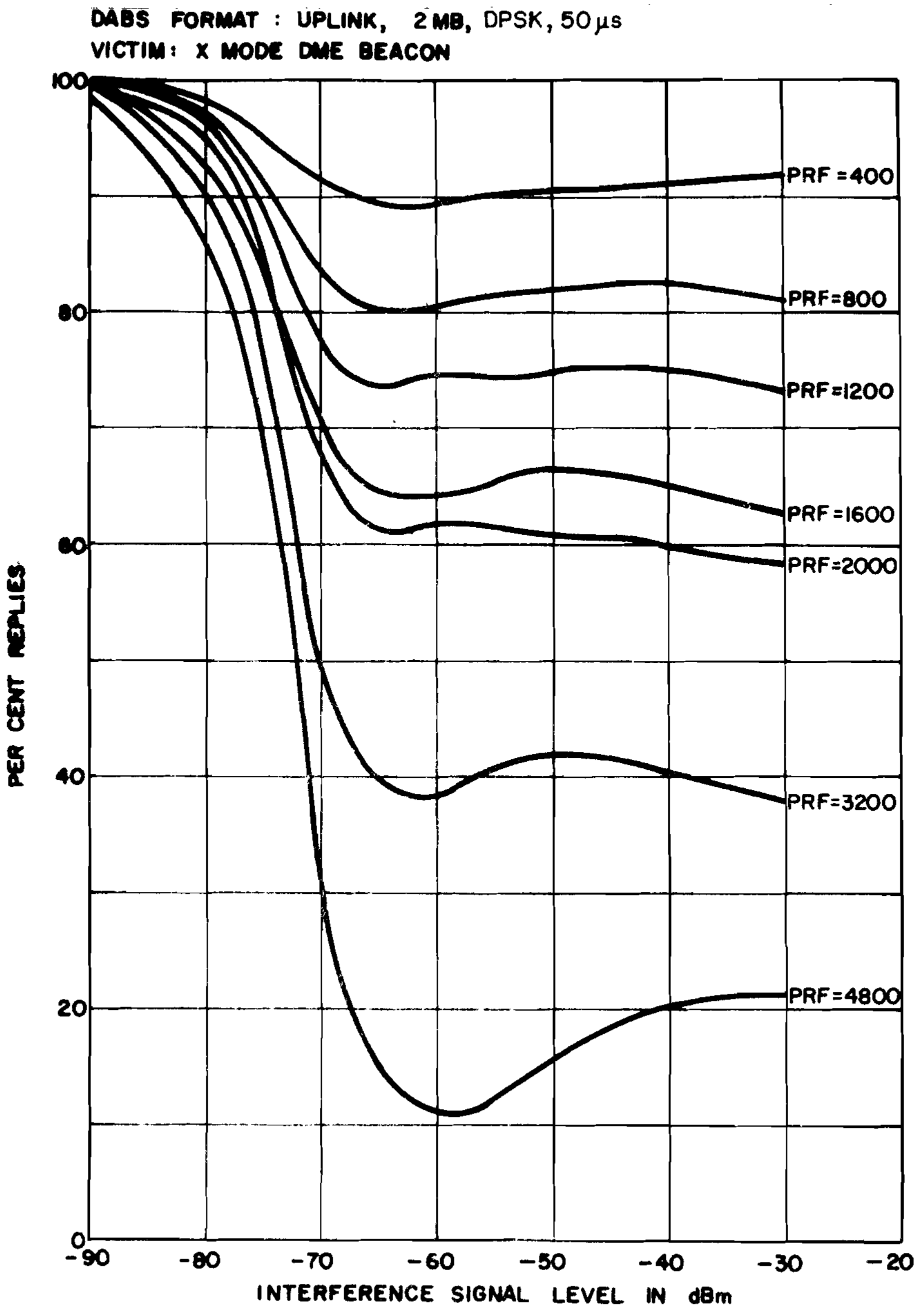


Figure A-6. Percent replies vs interference signal level and PRF.

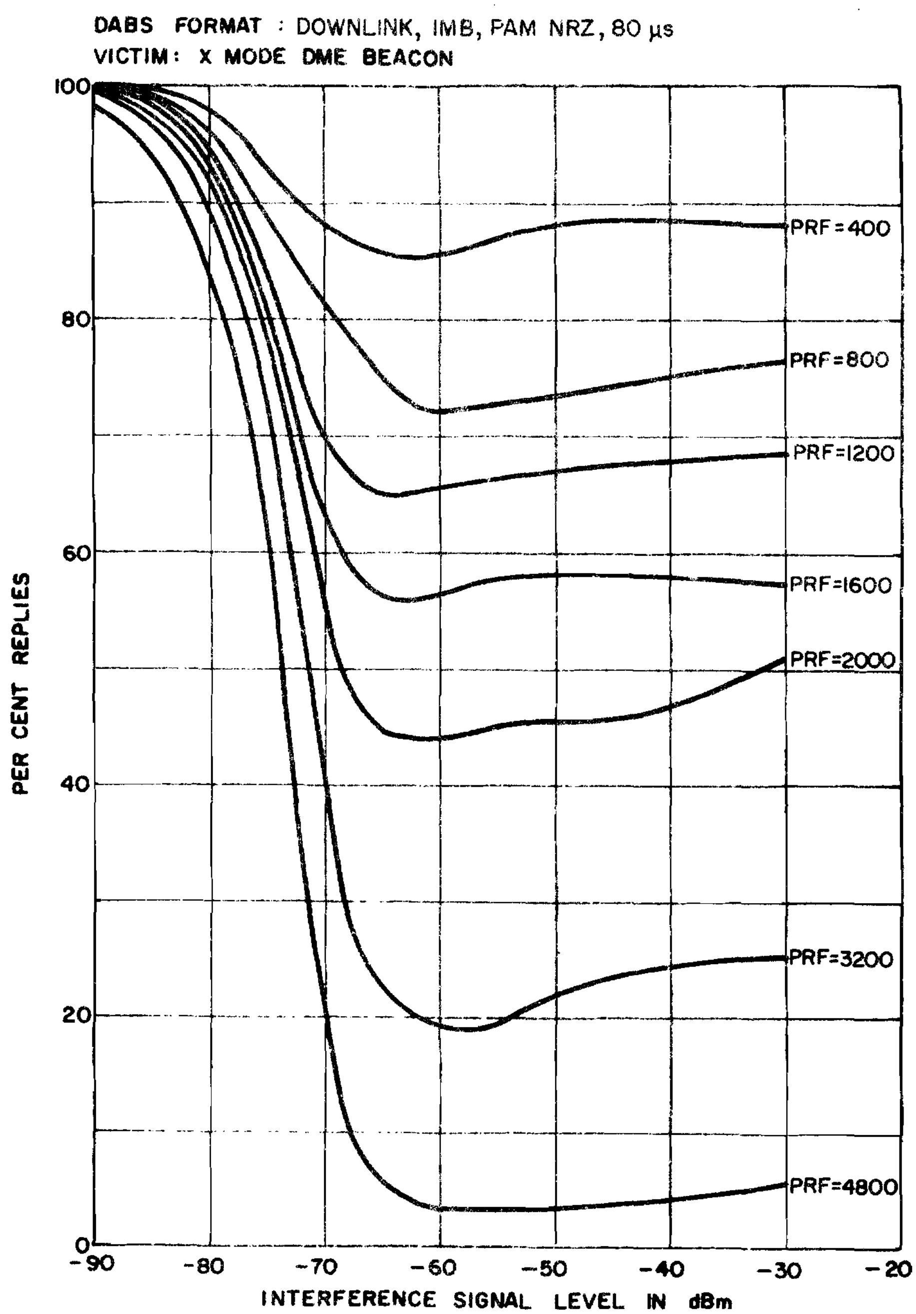


Figure A-7. Percent replies vs interference signal level and PRF.

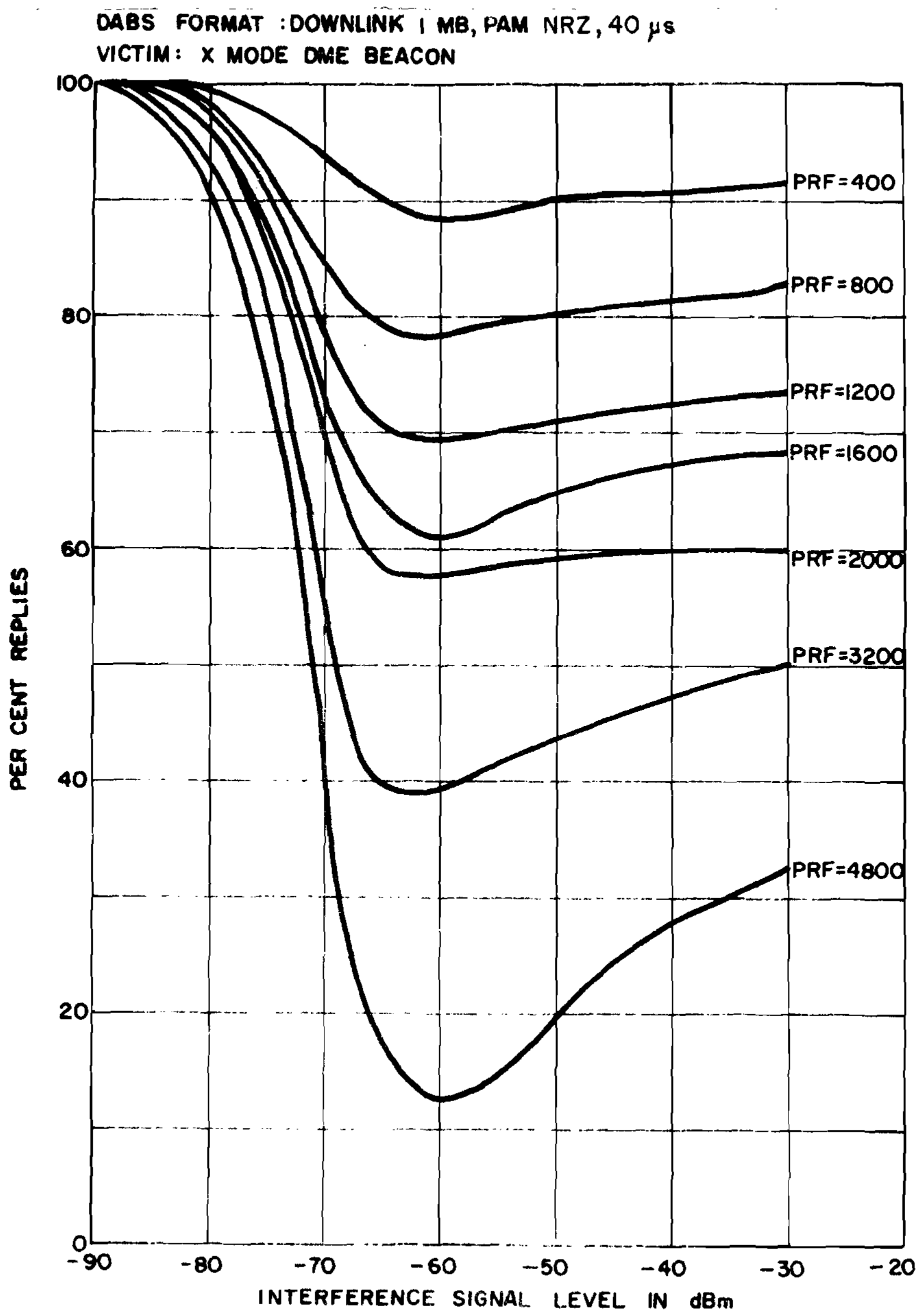


Figure A-8. Percent replies vs interference signal level and PRF.

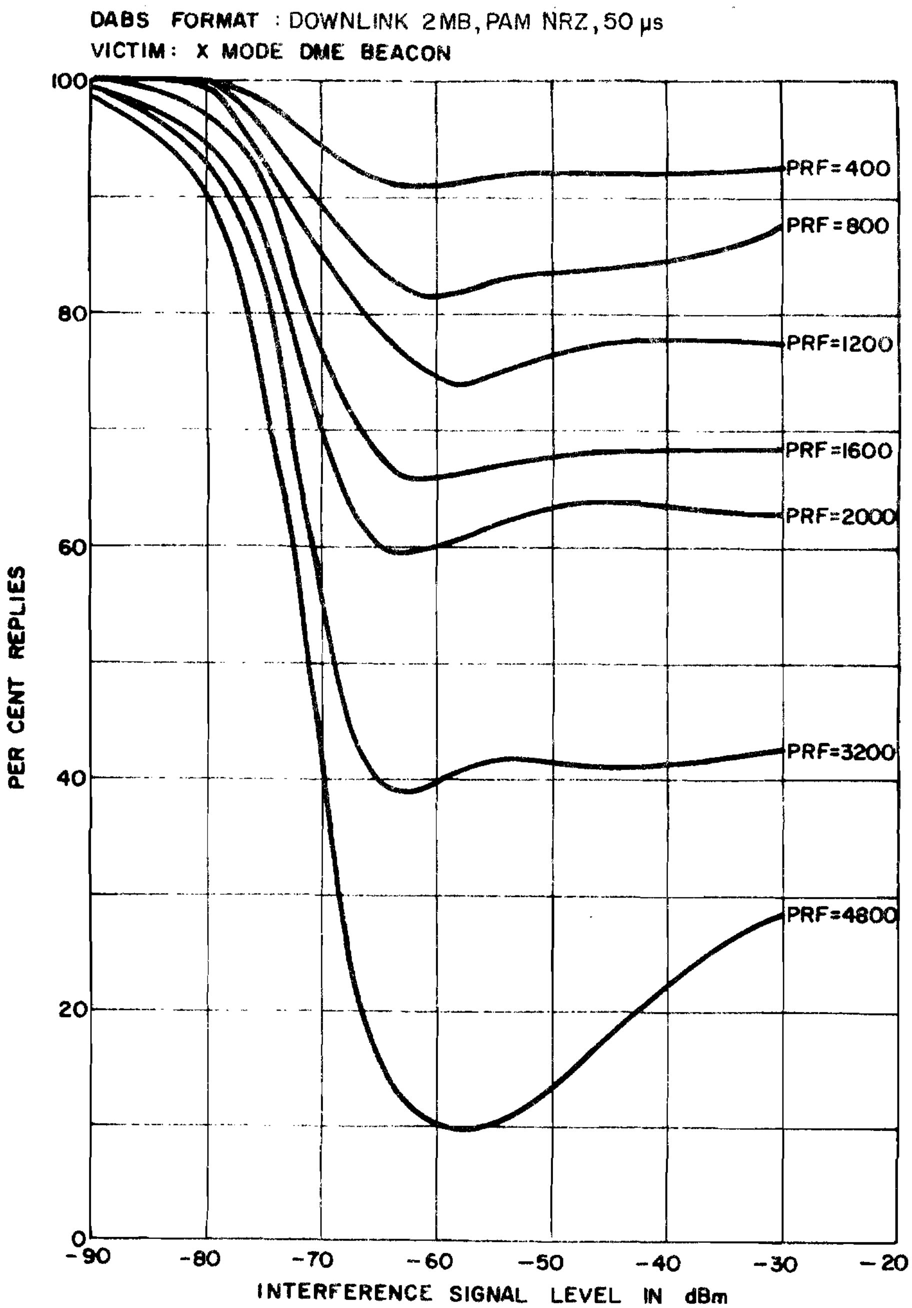


Figure A-9. Percent replies vs interference signal level and PRF.

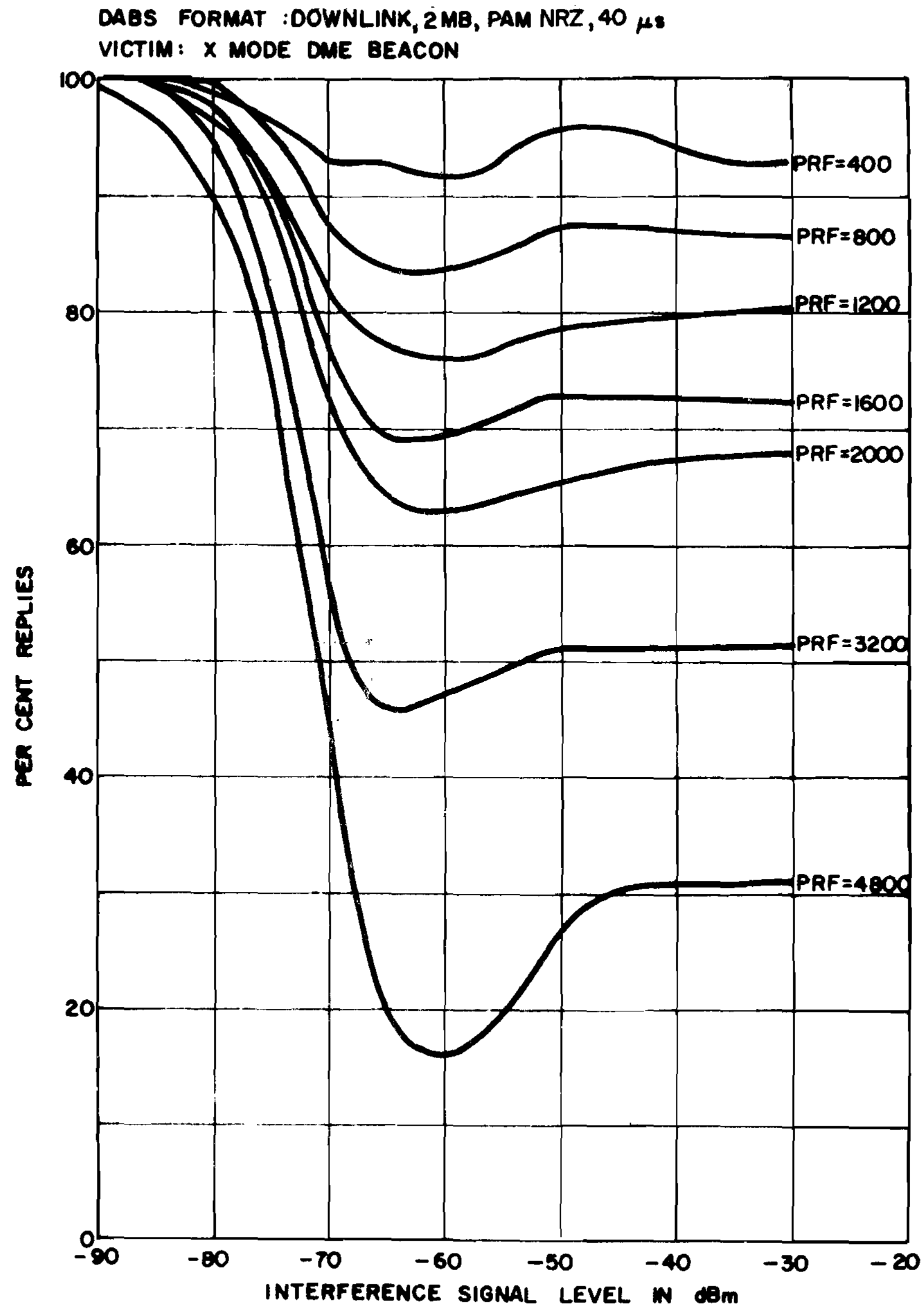


Figure A-10. Percent replies vs interference signal level and PRF.

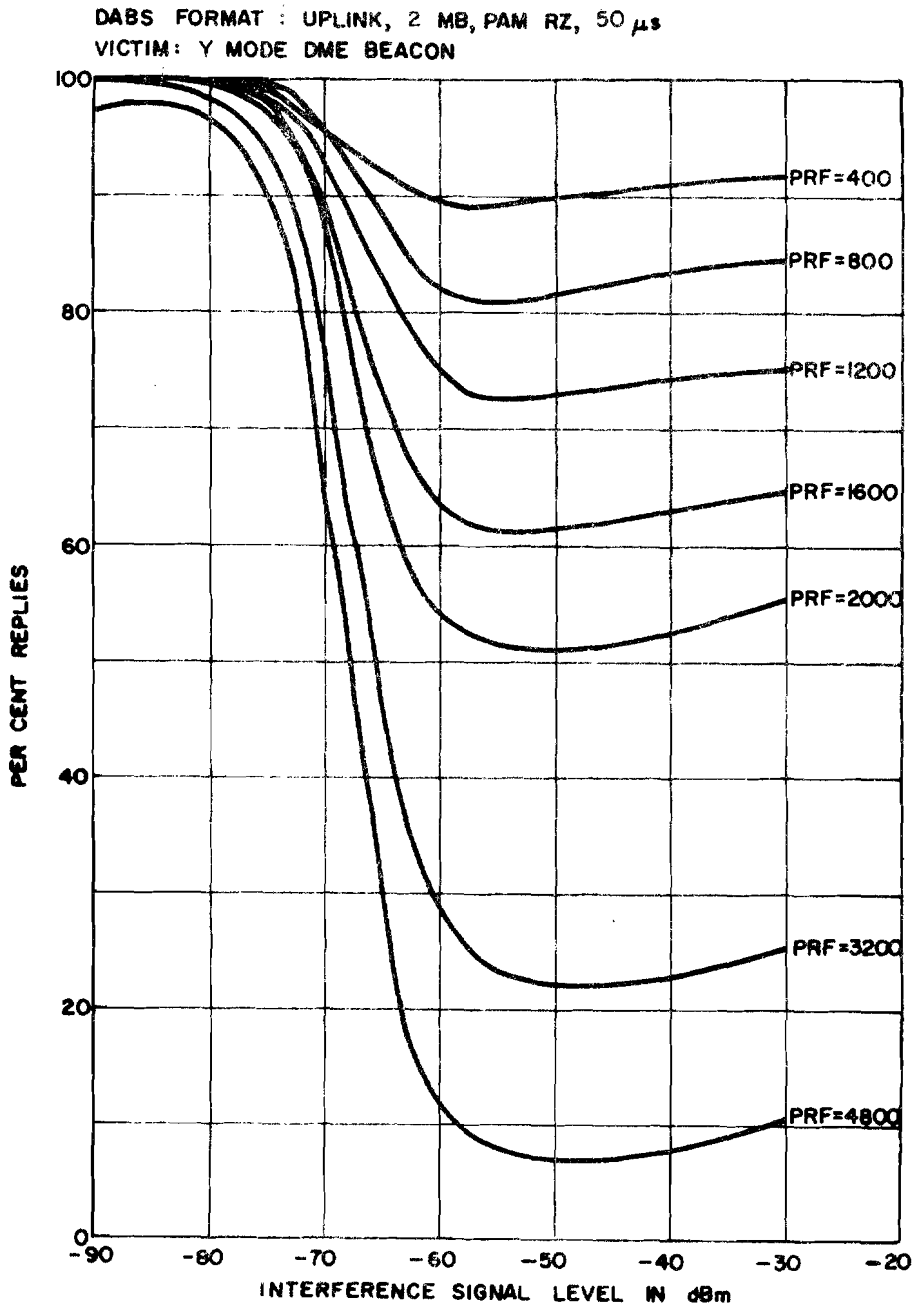


Figure A-11. Percent replies vs interference signal level and PRF.

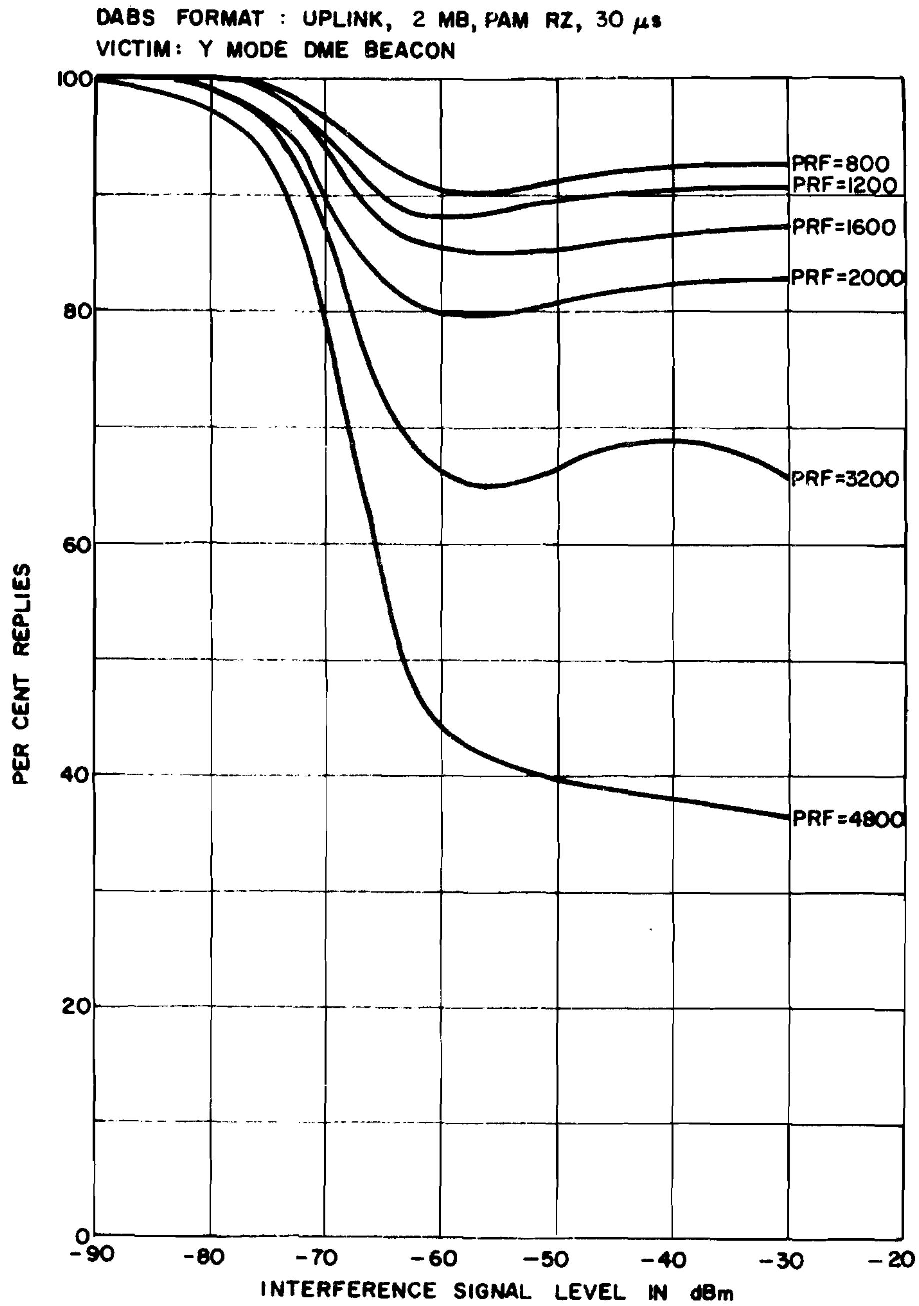


Figure A-12. Percent replies vs interference signal level and PRF.

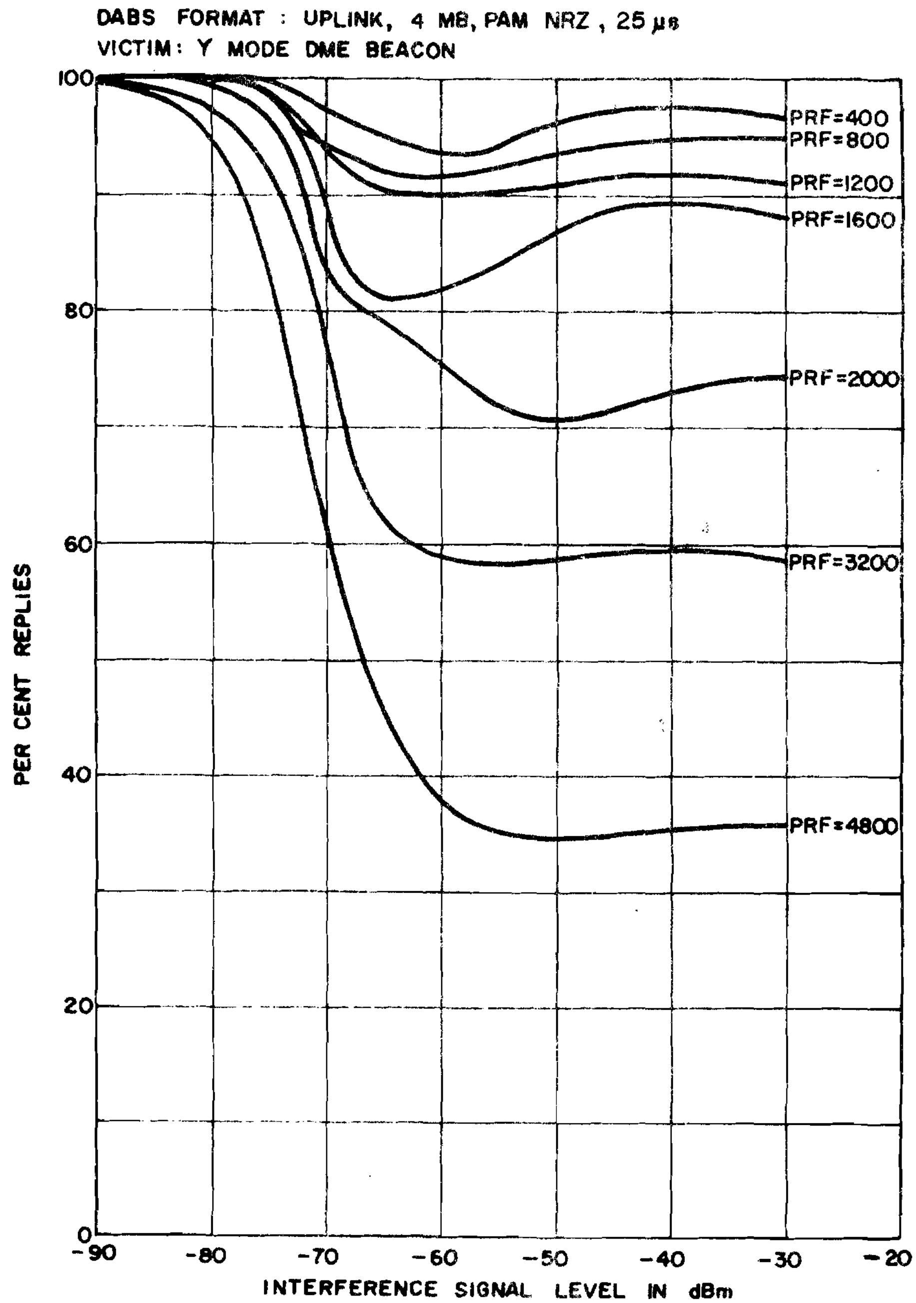


Figure A-13. Percent replies vs interference signal level and PRF.

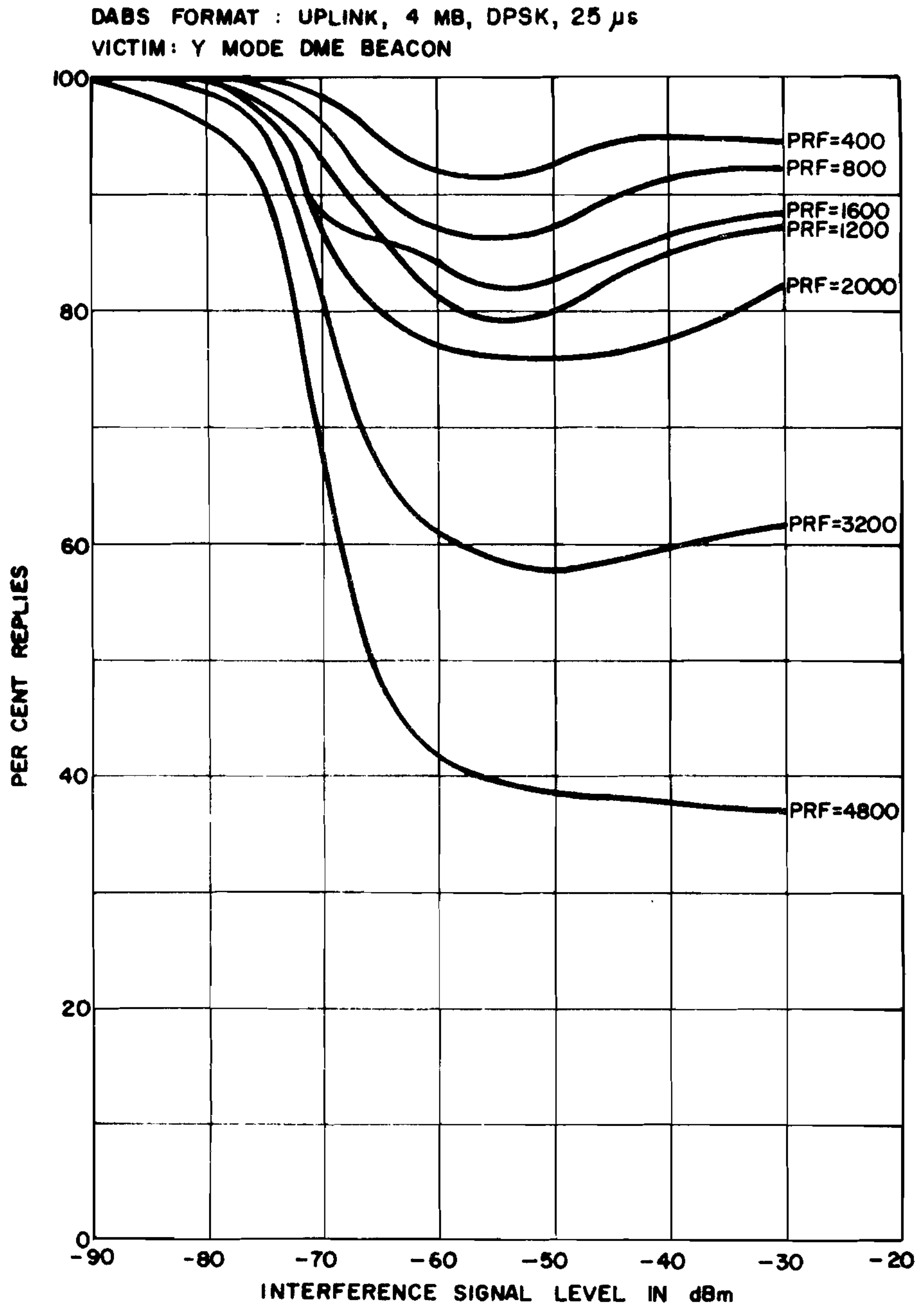


Figure A-14. Percent replies vs interference signal level and PRF.

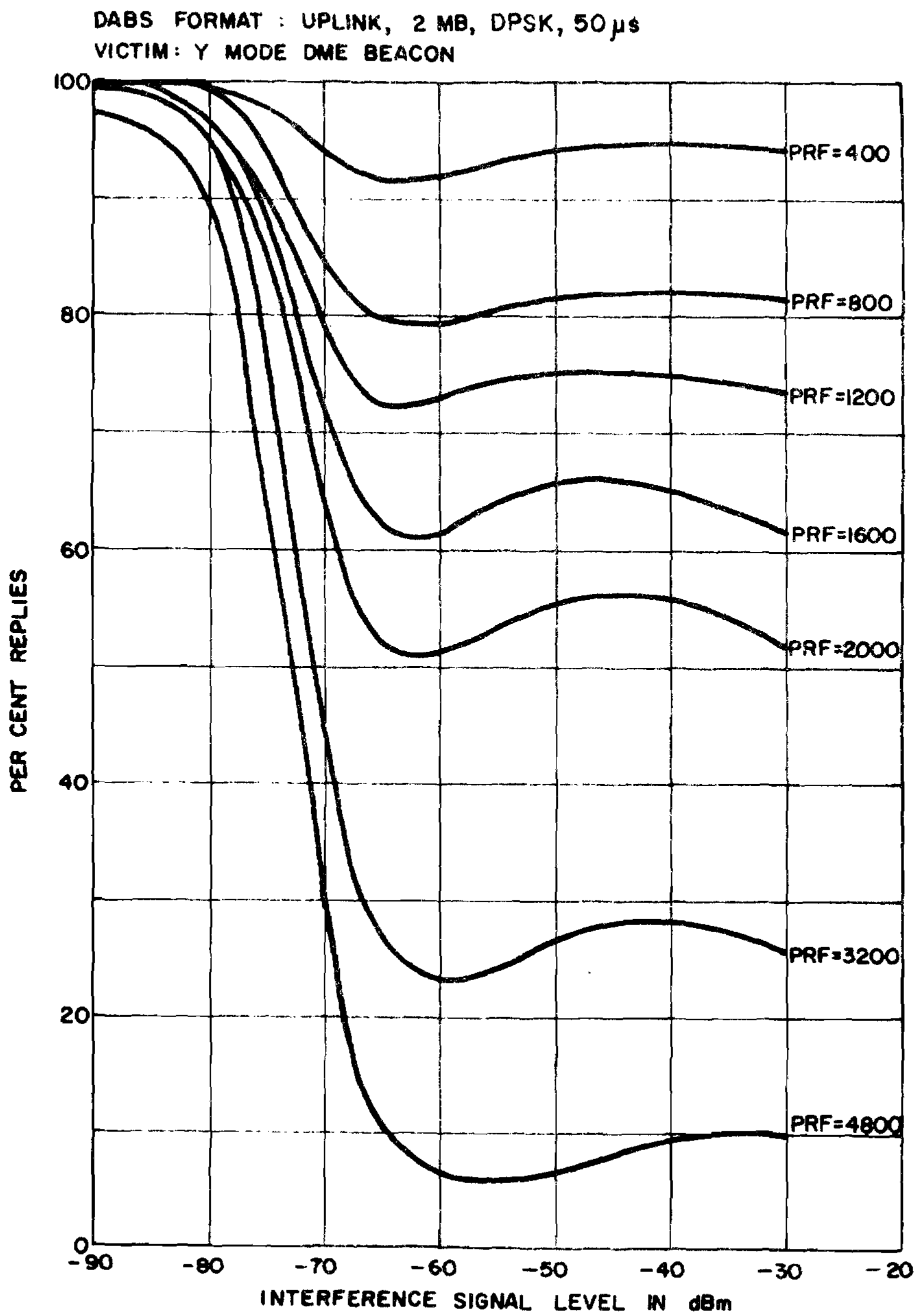


Figure A-15. Percent replies vs interference signal level and PRF.

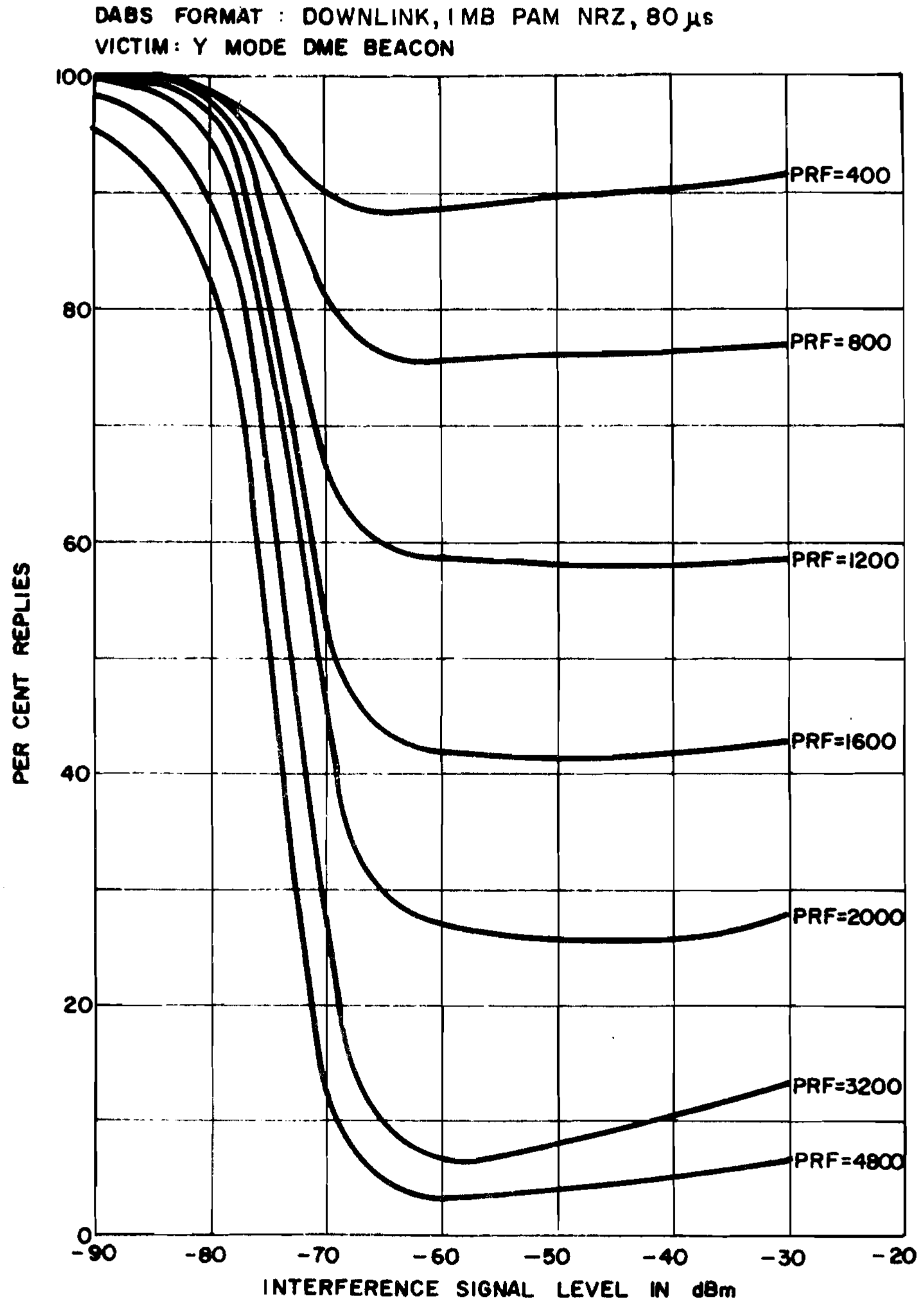


Figure A-16. Percent replies vs interference signal and PRF.

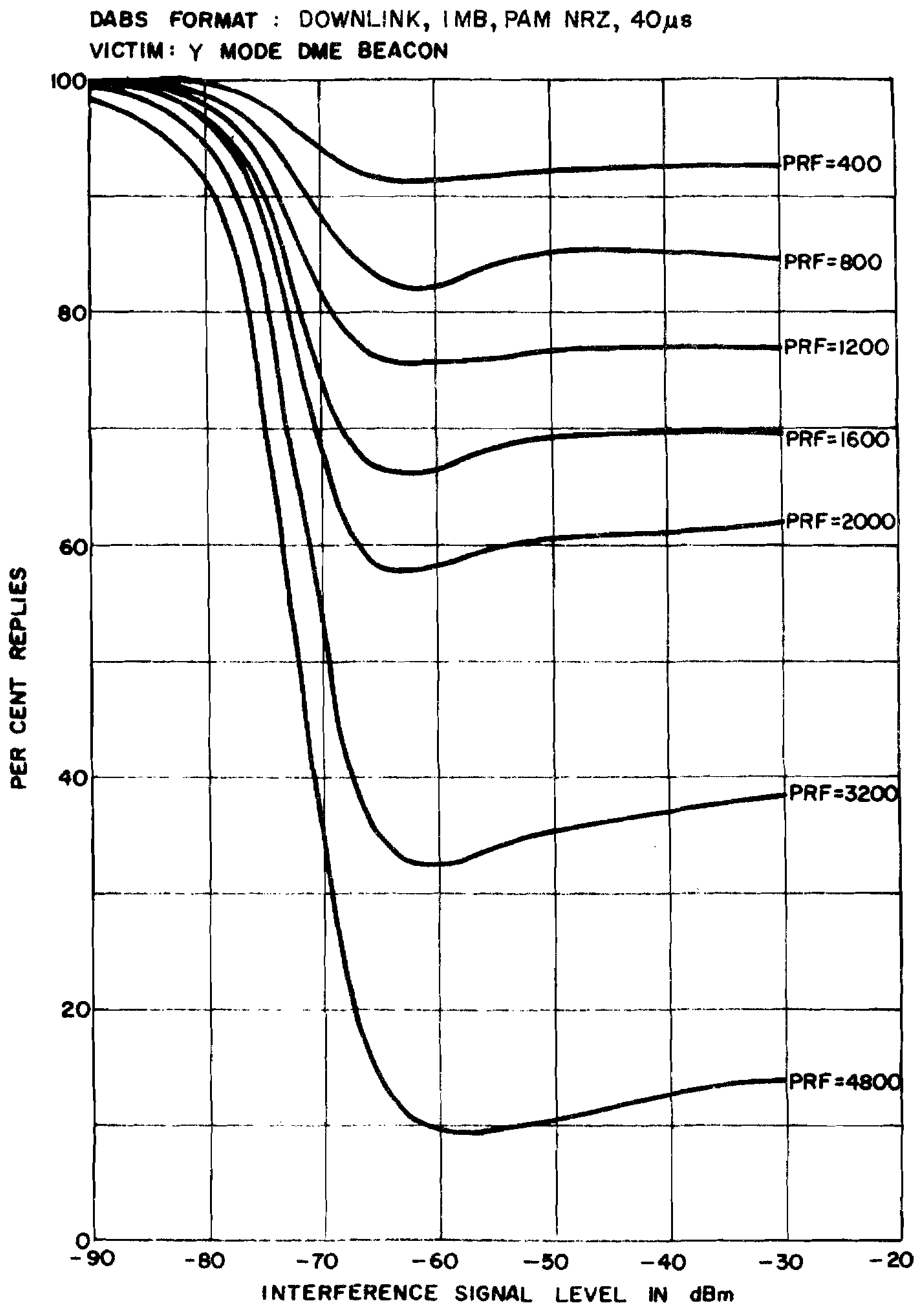


Figure A-17. Percent replies vs interference signal level and PRF.

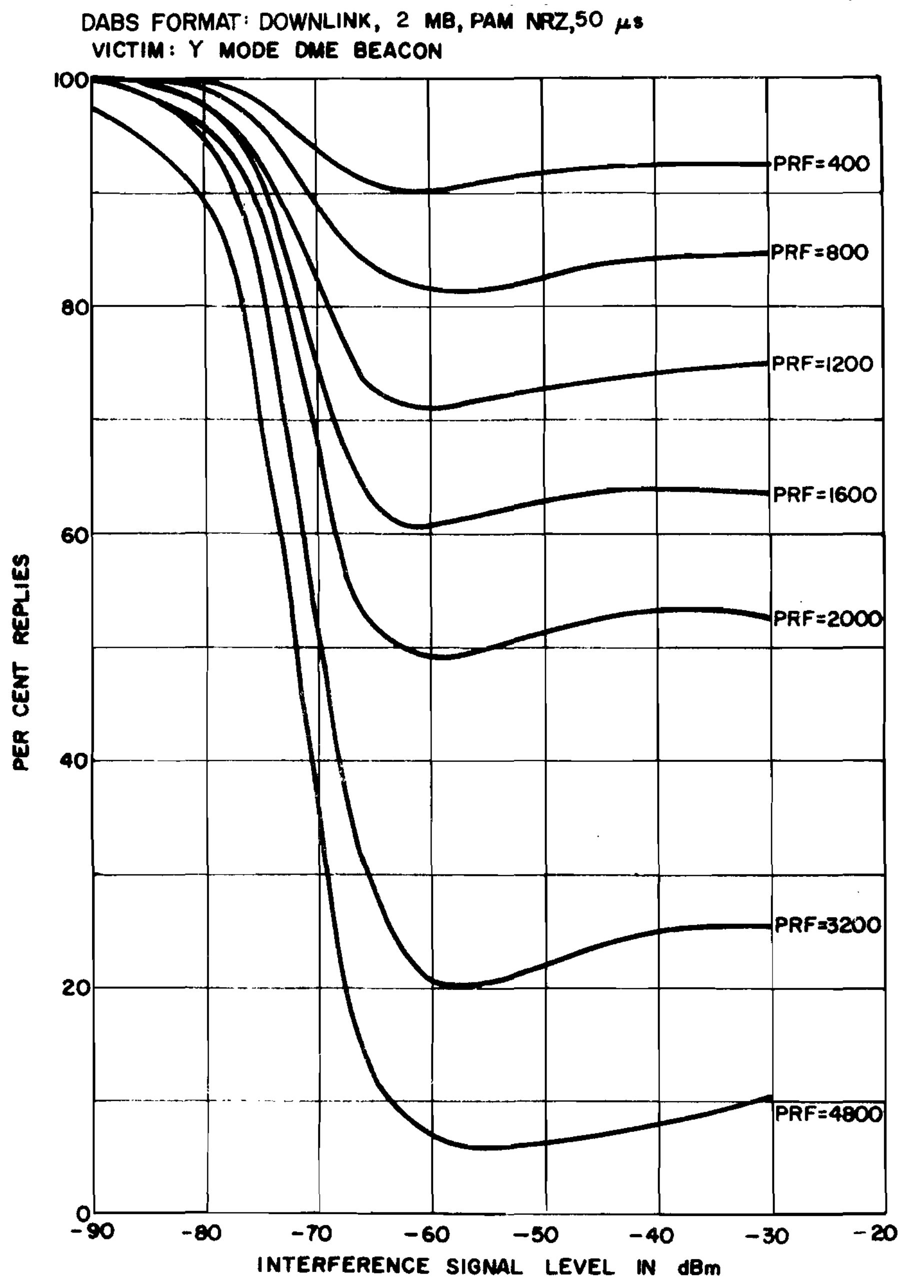


Figure A-18. Percent replies vs interference signal level and PRF.

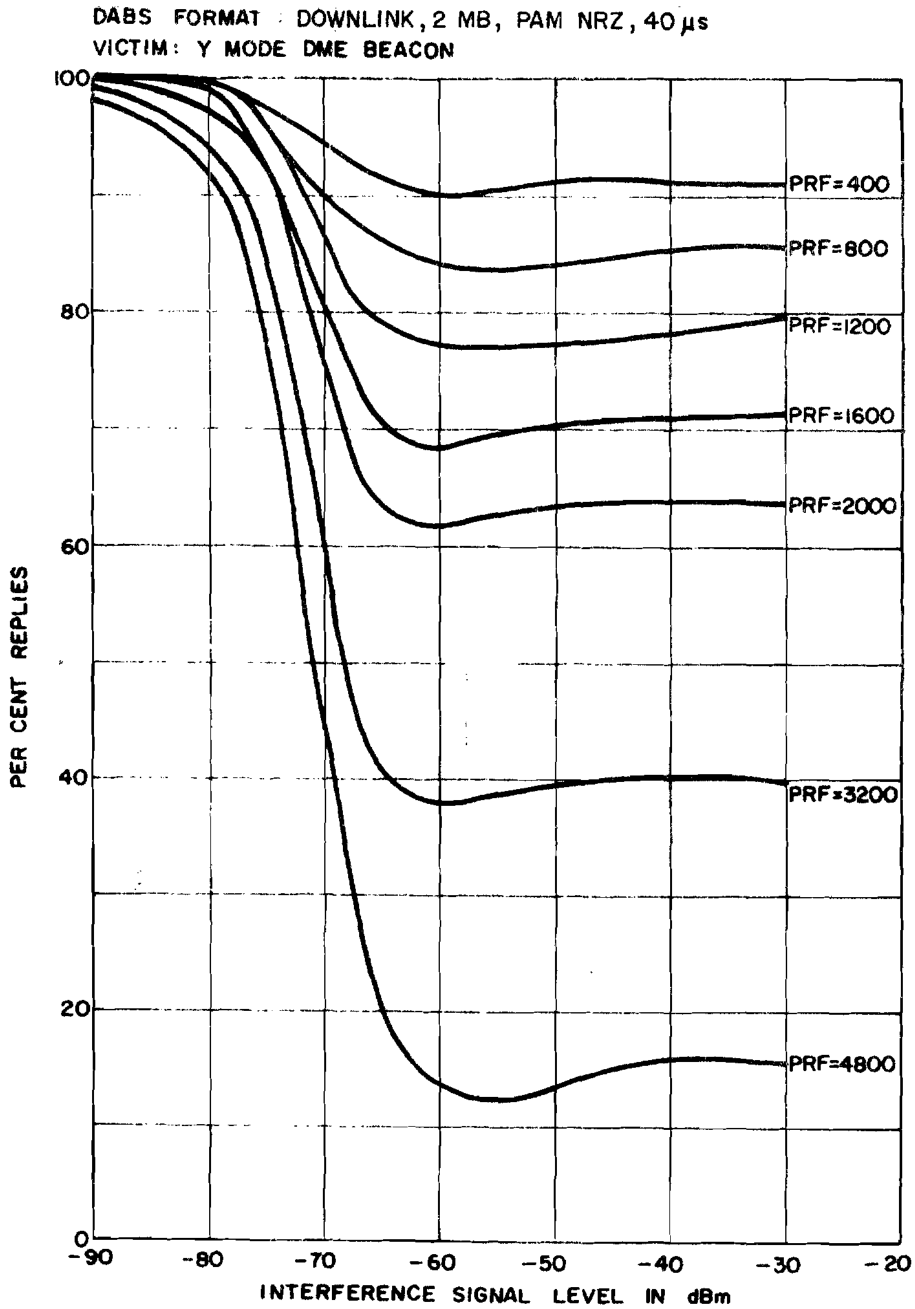


Figure A-19. Percent replies vs interference signal level and PRF.

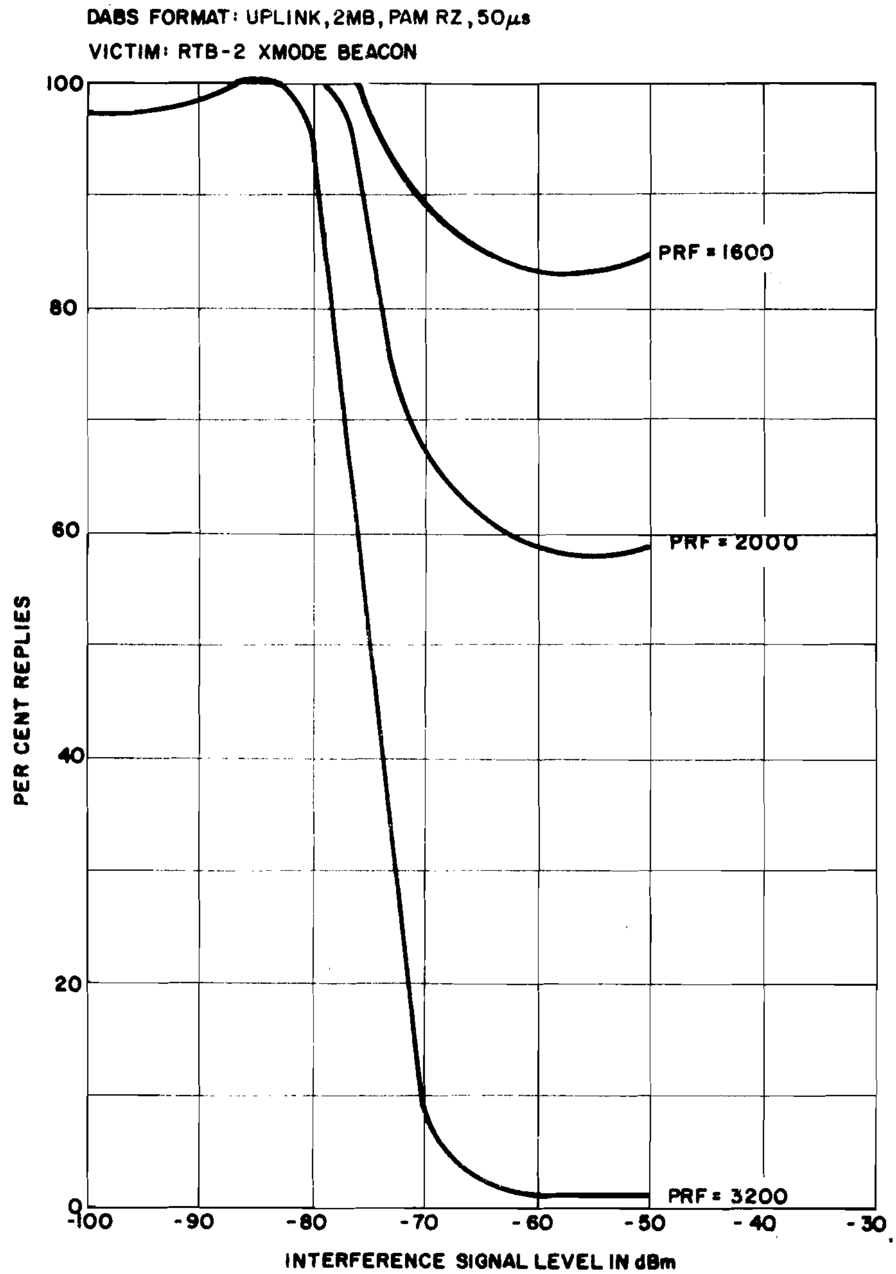


Figure A-20. Percent replies vs interference signal level and PRF.

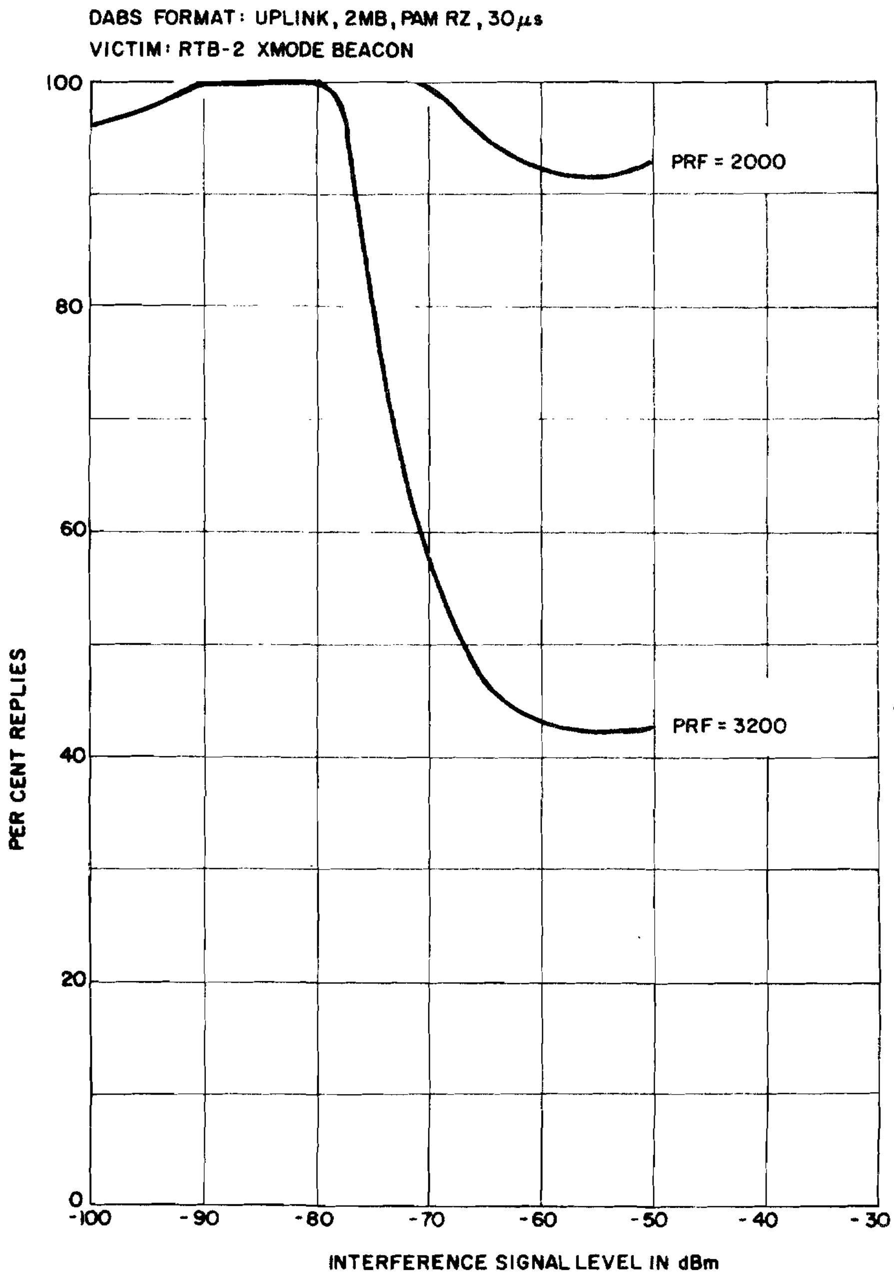


Figure A-21. Percent replies vs interference signal level and PRF.

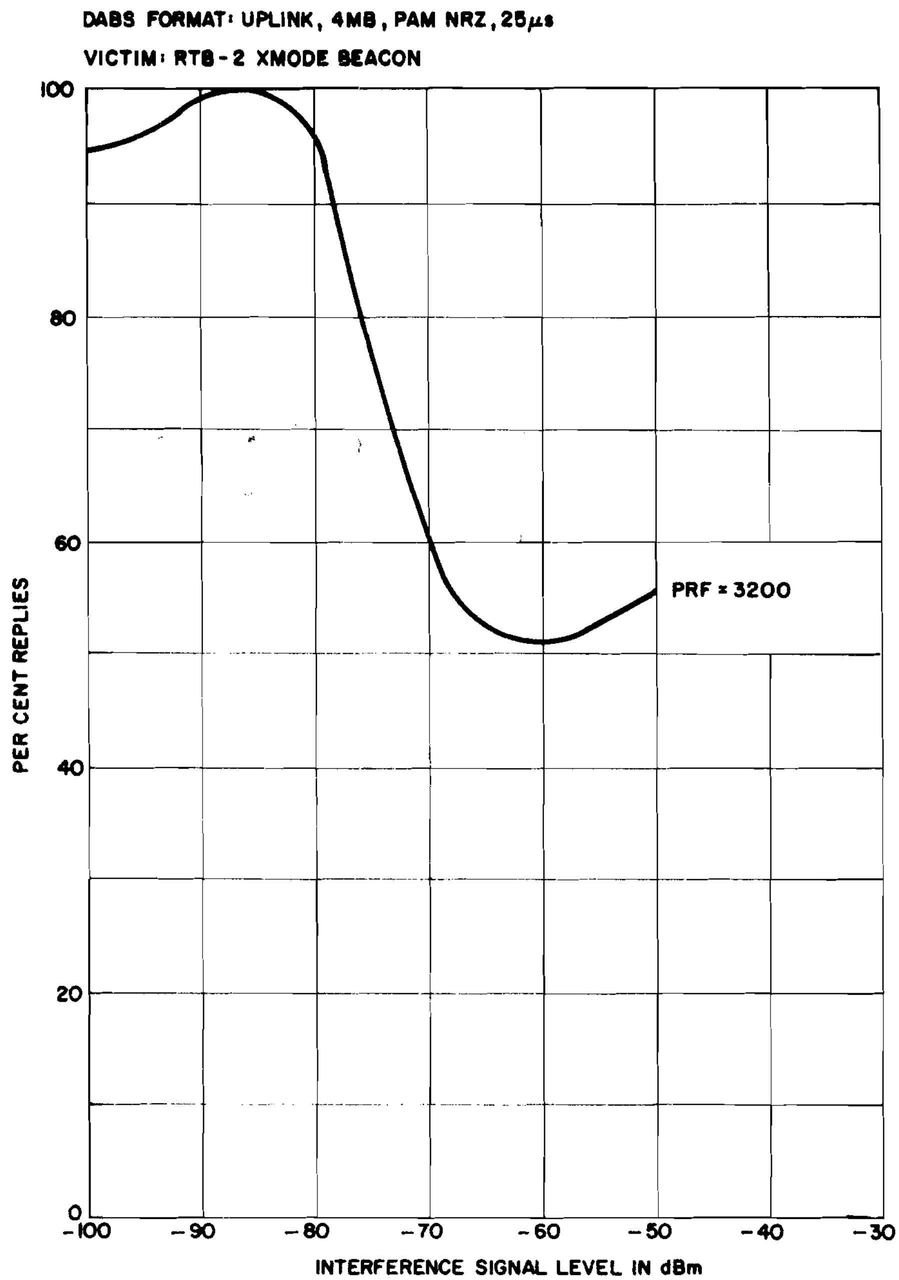


Figure A-22. Percent replies vs interference signal level and PRF.

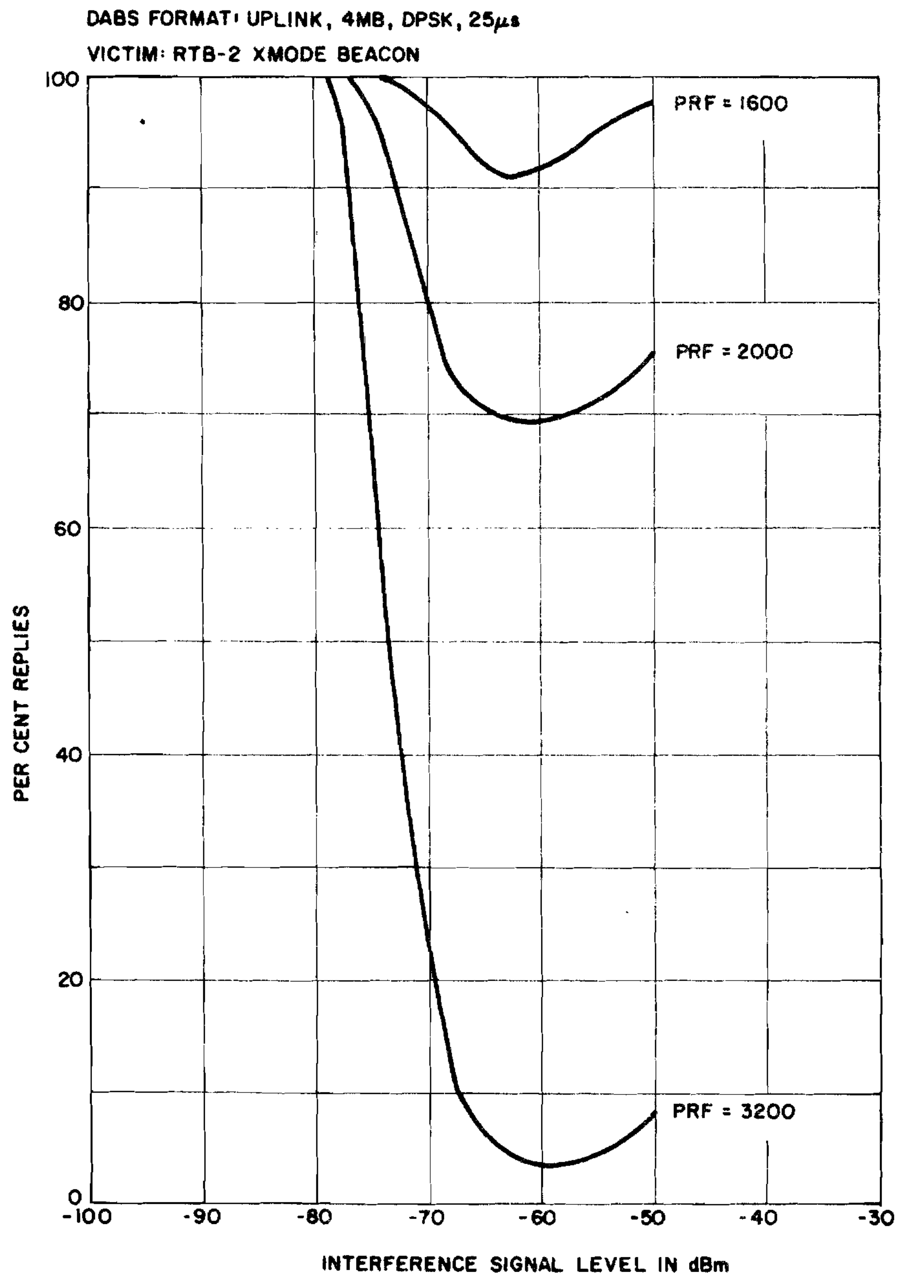


Figure A-23. Percent replies vs interference signal level and PRF.

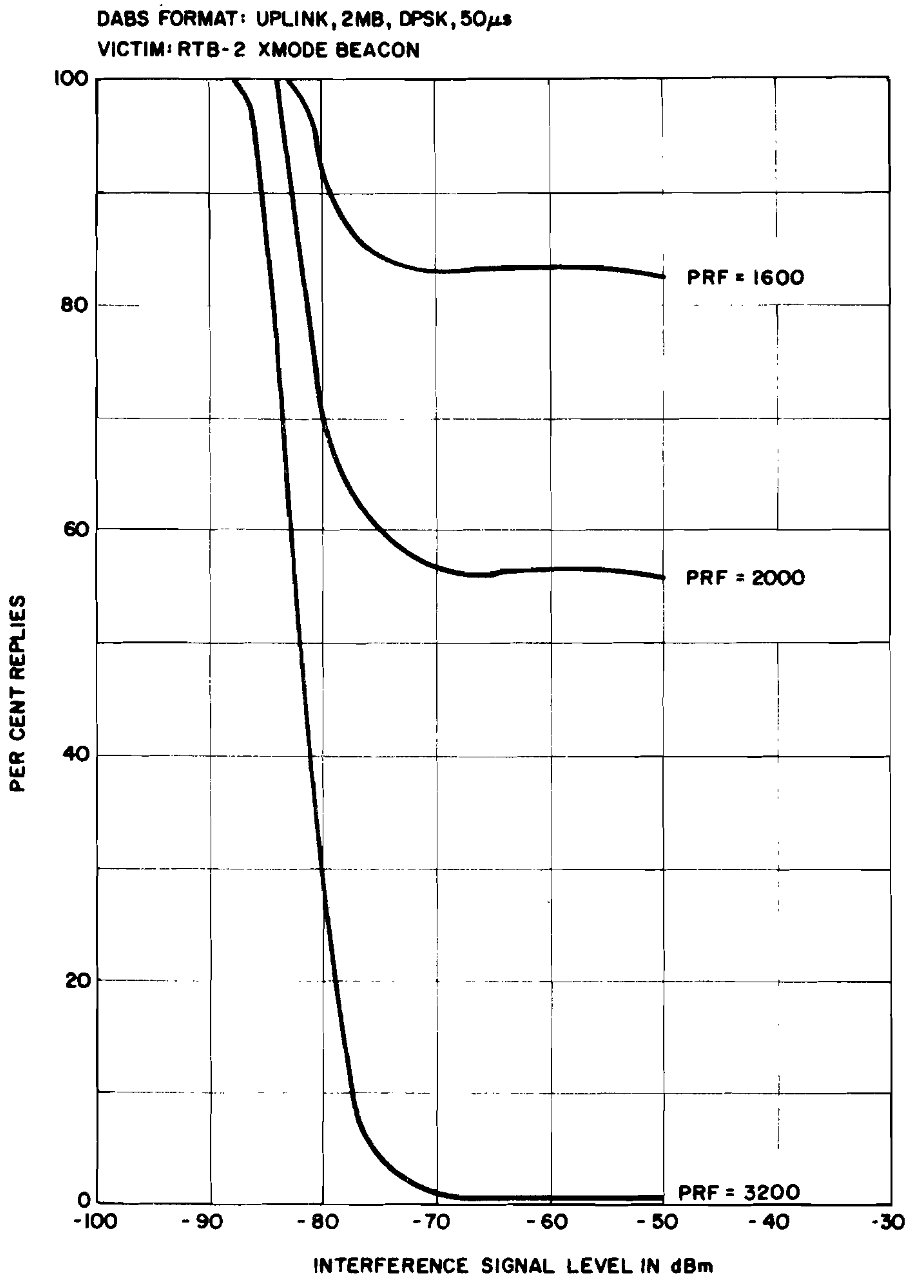


Figure A-24. Percent replies vs interference signal level and PRF.

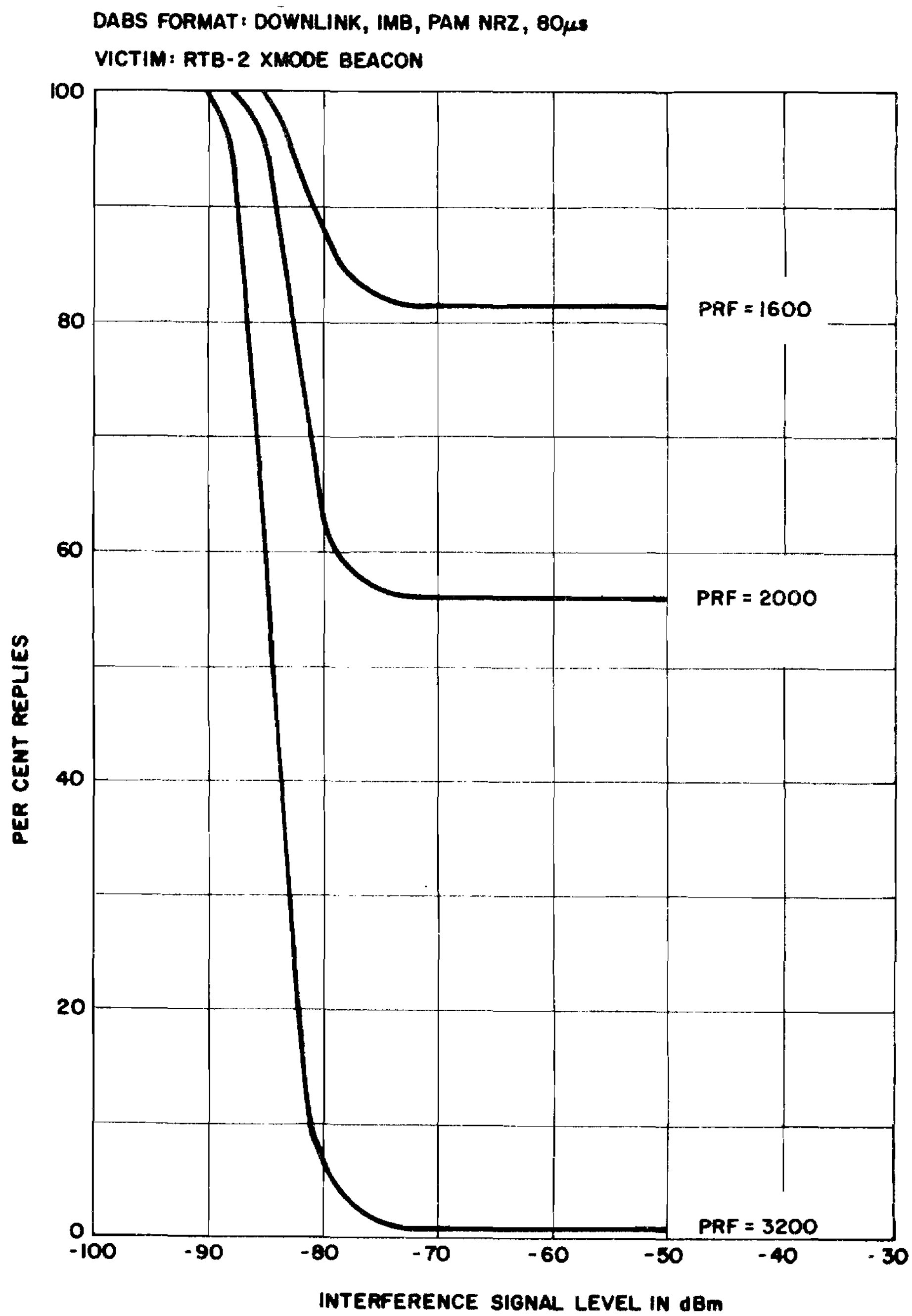


Figure A-25. Percent replies vs interference signal level and PRF.

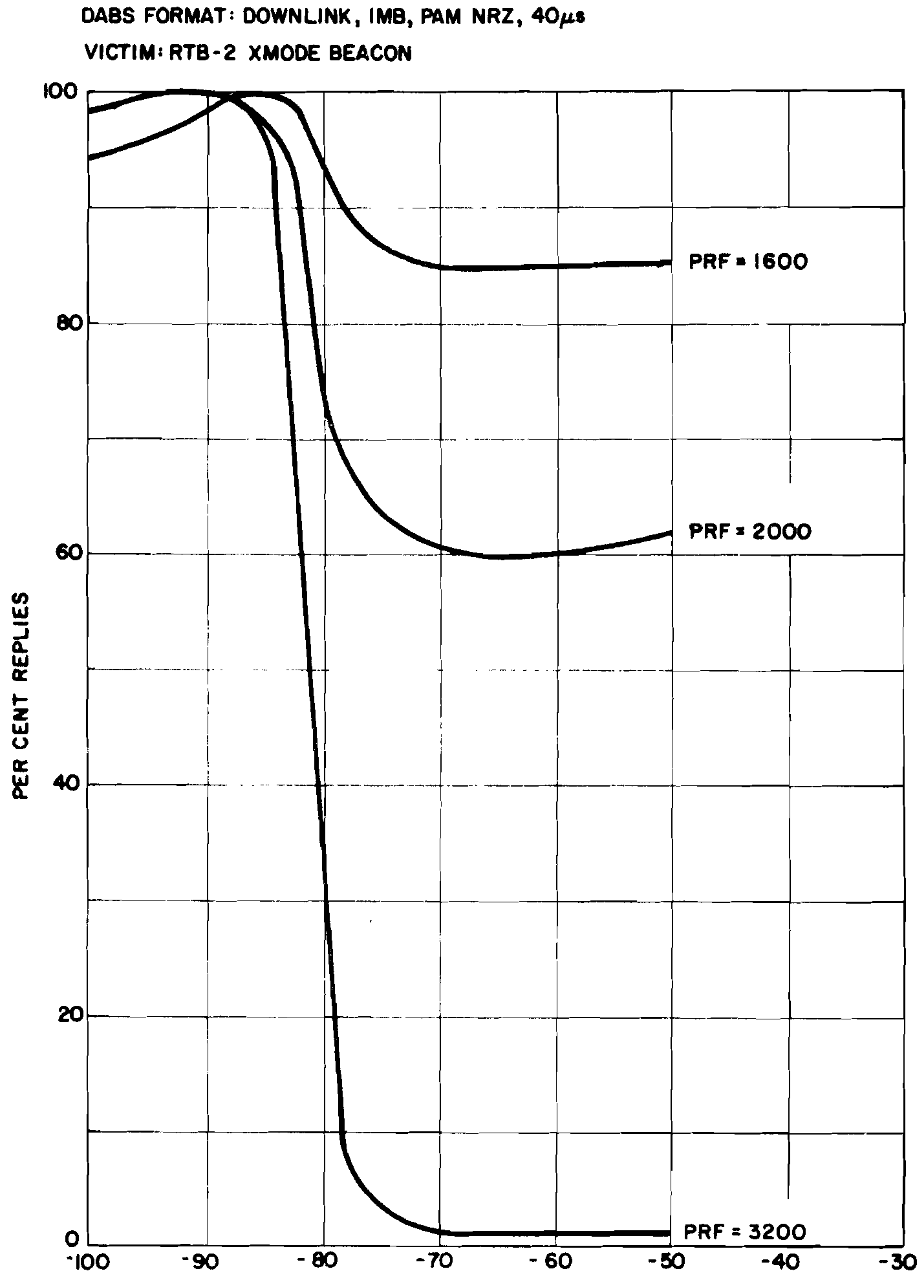


Figure A-26. Percent replies vs interference signal level and PRF.

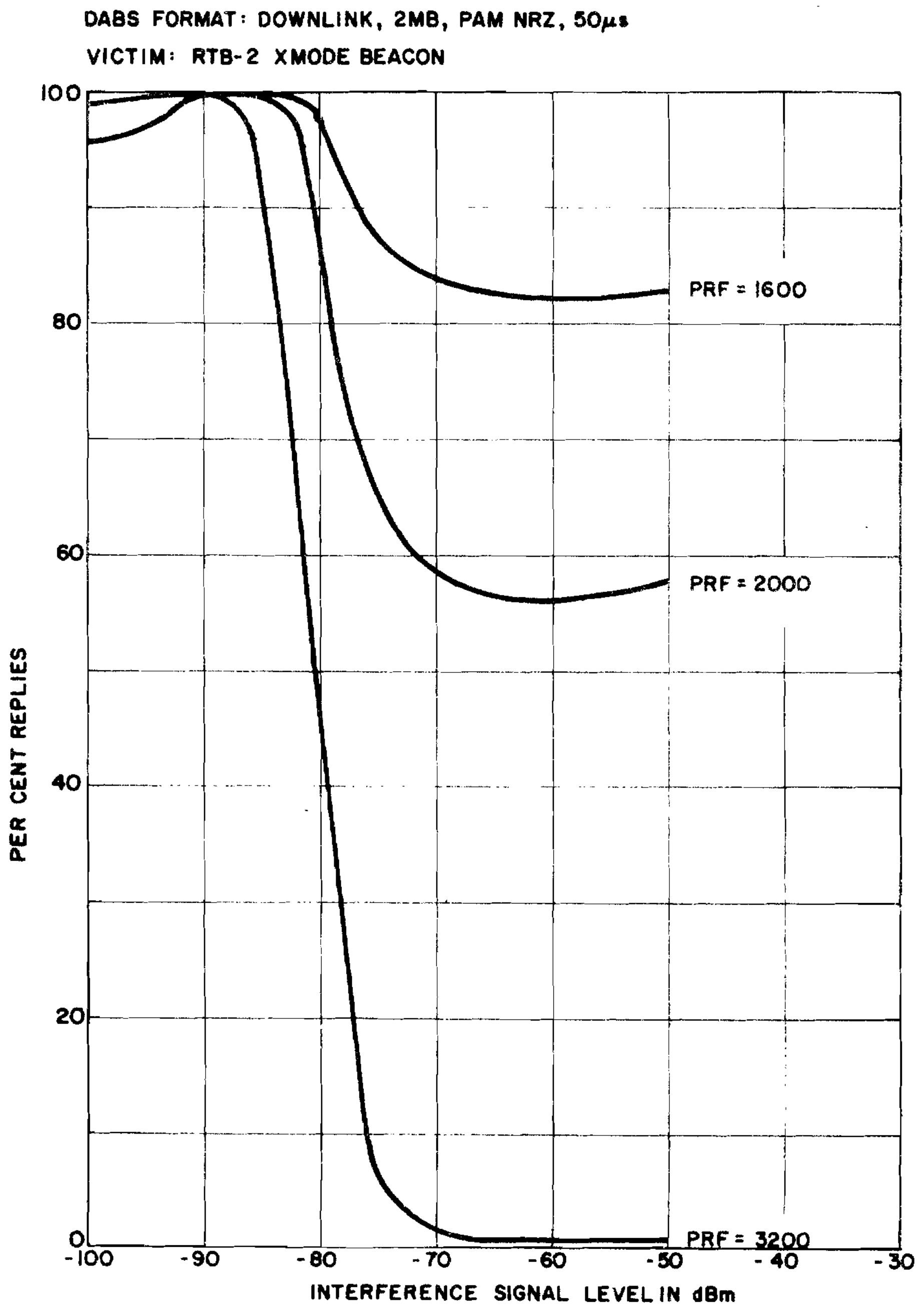


Figure A-27. Percent replies vs interference signal level and PRF.

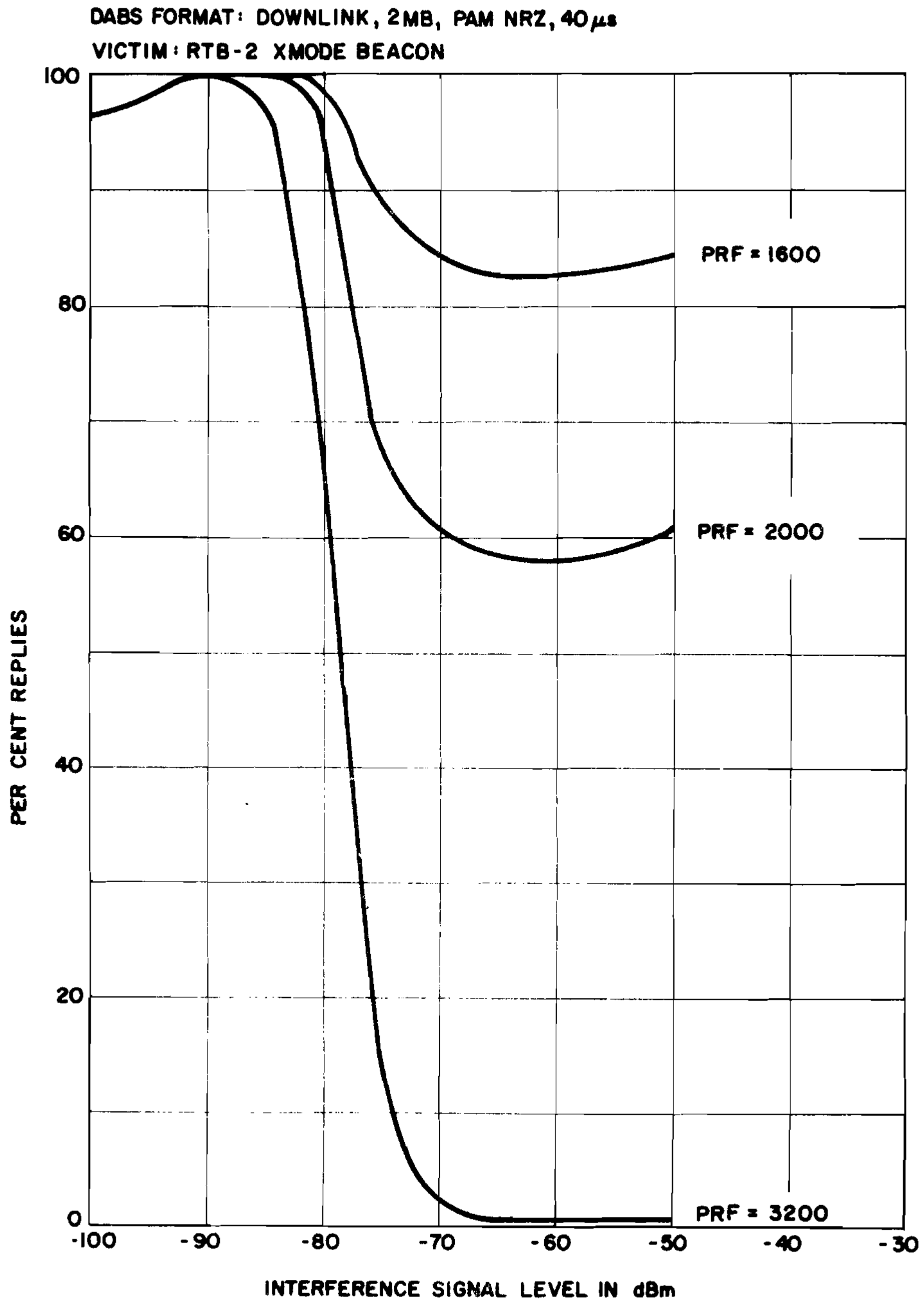


Figure A-28. Percent replies vs interference signal level and PRF.

TABLE A-2

NUMBER OF REPLIES VERSUS INTERFERENCE SIGNAL LEVEL AND FREQUENCY

VICTIM
X Mode DME Beacon
Receive Freq: 1051 MHz

DABS
Format: Uplink, 2MB, PAM RZ, 50μs
PRF: 3200 pps

Δf = 0

I.P.L.*	Replies	%**
None	1482	-
-69	1096	73.9
-71	1206	81.4
-73	1321	89.1
-75	1365	92.1
-77	1412	95.3
None	1481	-

Δf = 1 MHz

I.P.L.*	Replies	%**
None	1400	-
-63	1027	73.2
-65	1144	81.5
-67	1222	87.0
-69	1254	89.3
-71	1334	95.0
None	1406	-

Δf = 2 MHz

I.P.L.*	Replies	%**
None	1494	-
-63	1040	68.9
-65	1148	76.1
-67	1297	84.7
-69	1369	90.7
-71	1437	95.2
None	1523	-

Δf = 6 MHz

I.P.L.*	Replies	%**
None	1445	-
-49	1065	73.3
-51	1192	82.1
-53	1268	87.3
-55	1323	91.1
-57	1383	95.3
None	1457	-

Δf = 10 MHz

I.P.L.*	Replies	%**
None	1403	-
-36	1028	72.5
-38	1146	80.9
-40	1229	86.7
-42	1300	91.7
-44	1326	93.6
None	1435	-

Δf = 22 MHz

I.P.L.*	Replies	%**
None	1441	-
-39	1063	75.0
-41	1191	84.0
-43	1283	90.5
-45	1333	94.1
-47	1342	94.7
None	1392	-

Δf = 50 MHz

I.P.L.*	Replies	%**
None	1461	-
-28	1013	68.8
-30	1113	75.6
-32	1193	81.1
-34	1245	84.6
-36	1328	90.3
None	1480	-

* I.P.L. = Interference power level (dBm).
** % = Reply count expressed as a percentage of the count when there is no interference.

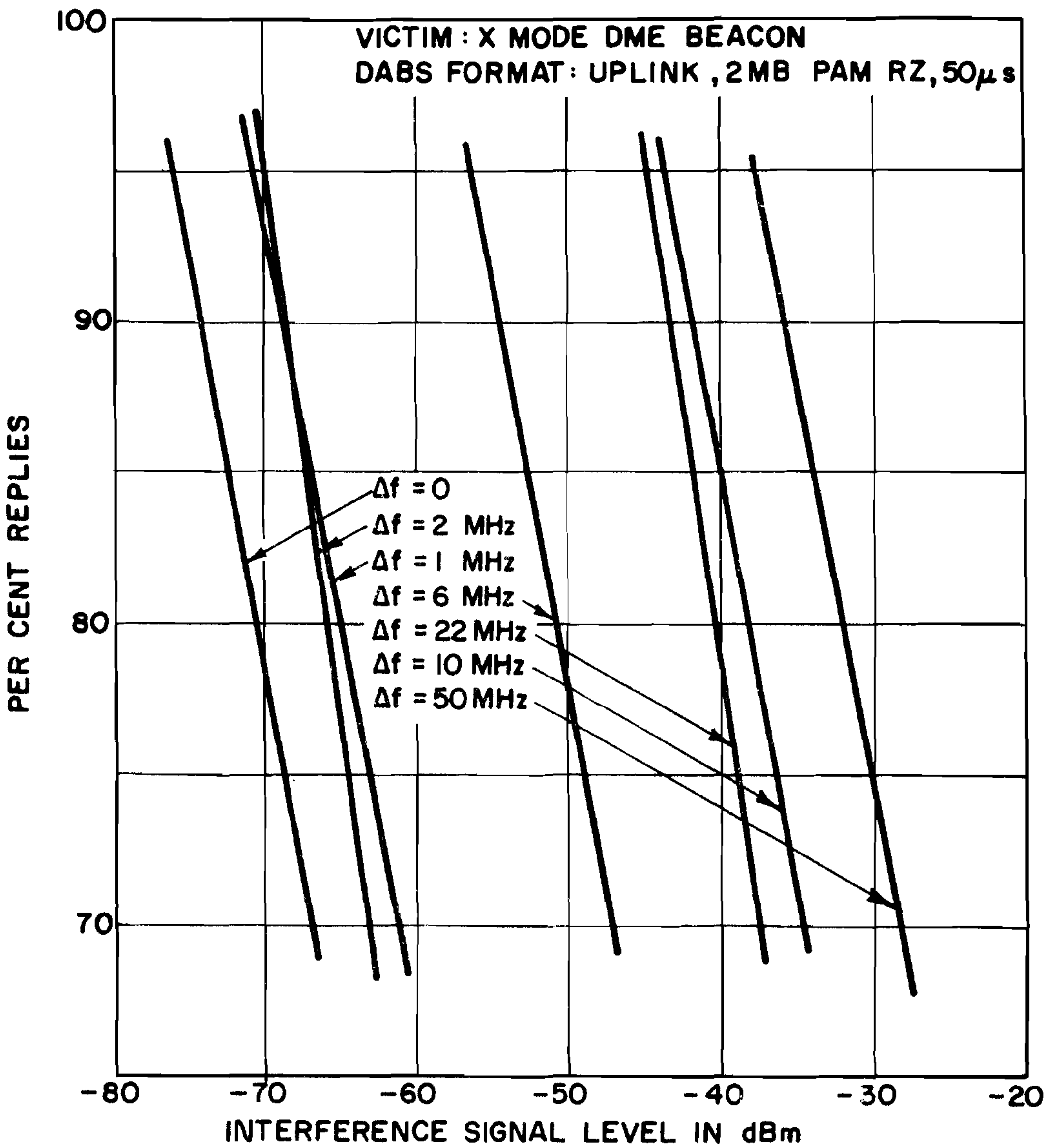


Figure A-29. Percent replies vs interference signal level and frequency.

TABLE A-3

OFF-FREQUENCY REJECTION OF X MODE DME BEACON, DABS FORMAT NUMBER 1

Percent Replies \ Δf (MHz)	1	2	6	10	22	50
90	5.3	5.3	19.7	32.4	30.9	38.3
85	5.2	5.0	19.6	32.4	30.4	38.3
80	5.2	4.2	20.1	32.4	30.1	38.4
75	5.3	3.9	20.0	32.4	29.9	38.4
70	5.3	3.7	18.7	32.4	29.3	38.5
Avg. OFR (dB)	5.3	4.4	19.6	32.4	30.1	38.4

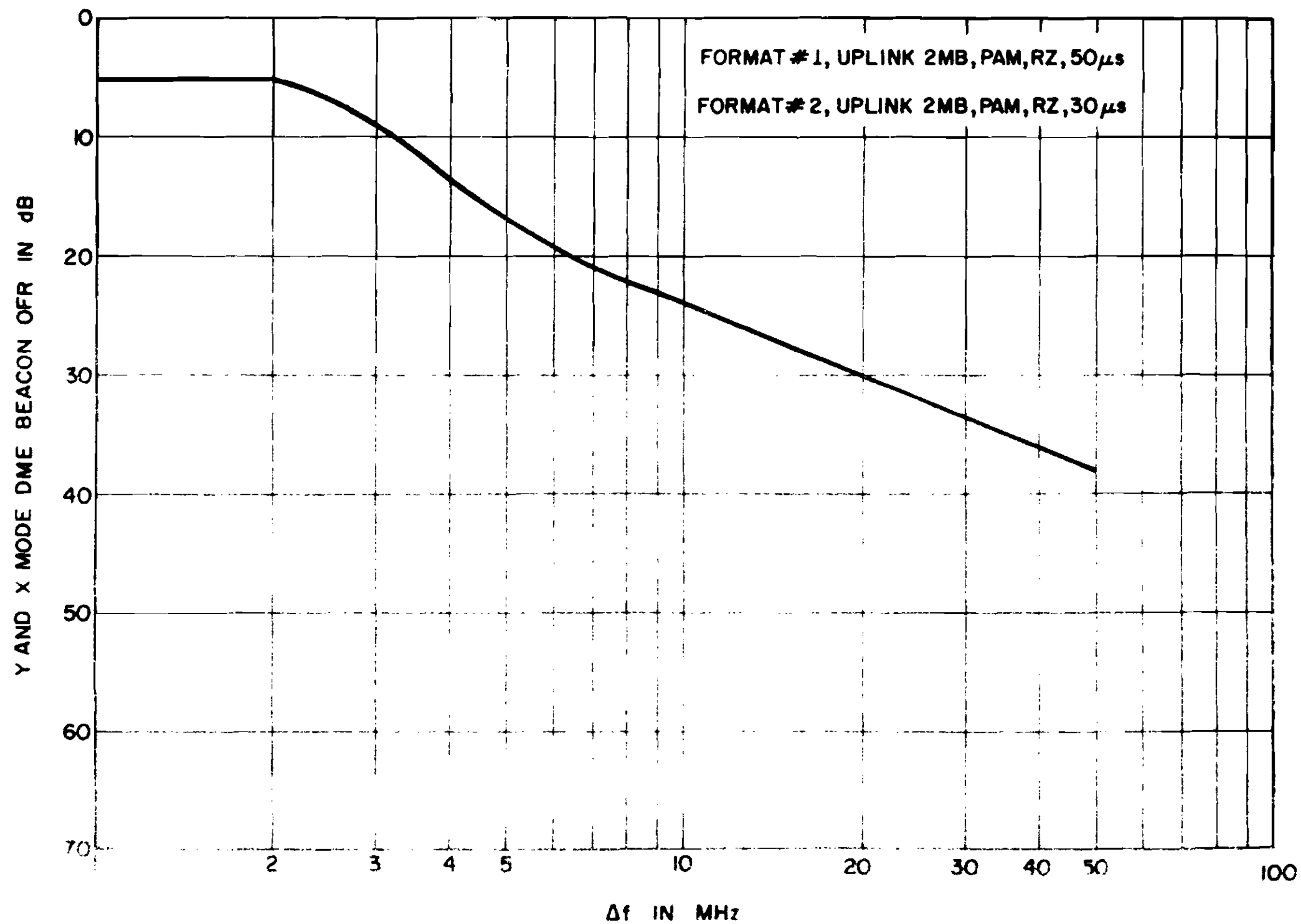


Figure A-30. X and Y mode DME beacon off-frequency rejection of DABS uplink formats 1 and 2.

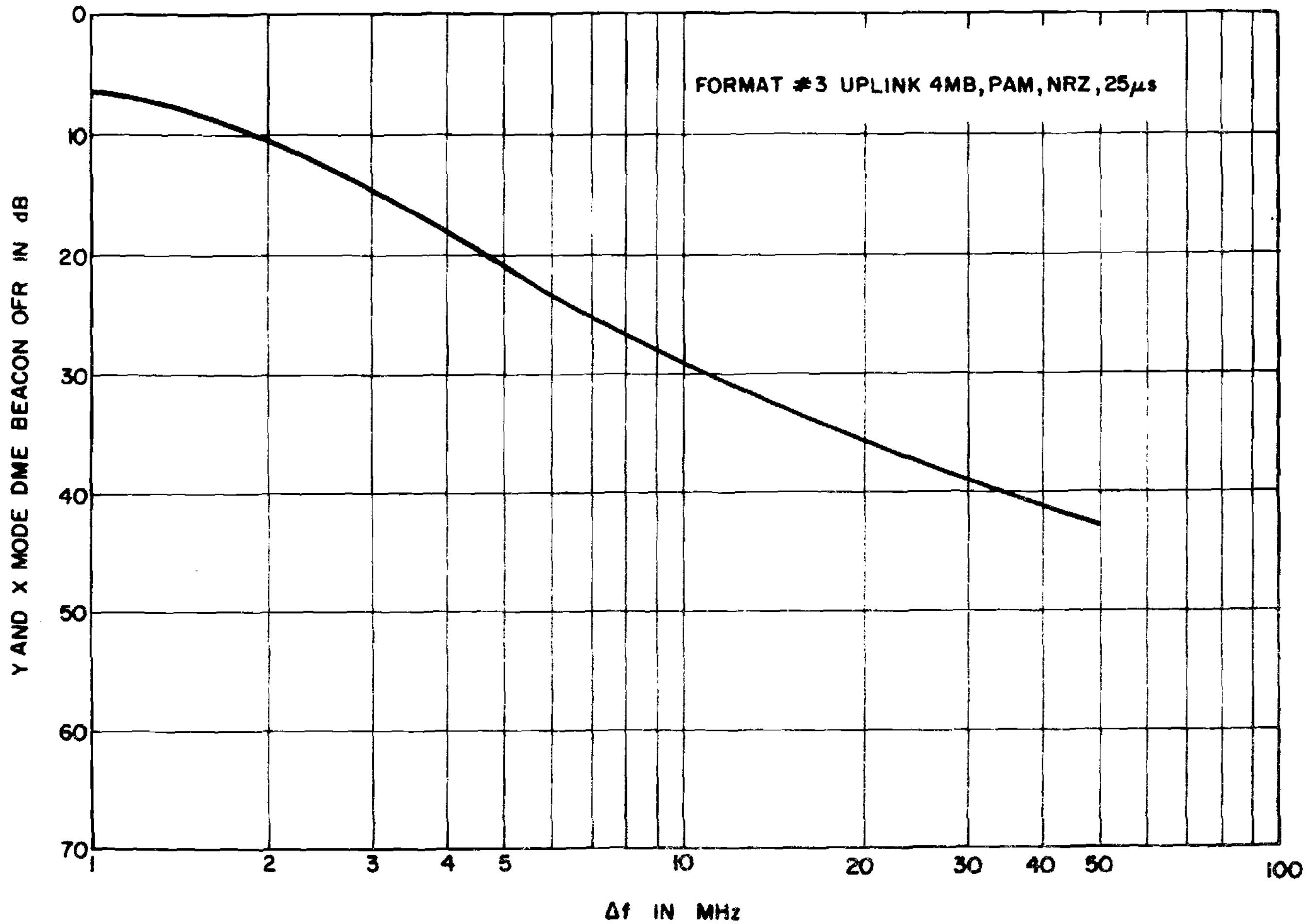


Figure A-31. X and Y mode DME beacon off-frequency rejection of DABS format 3.

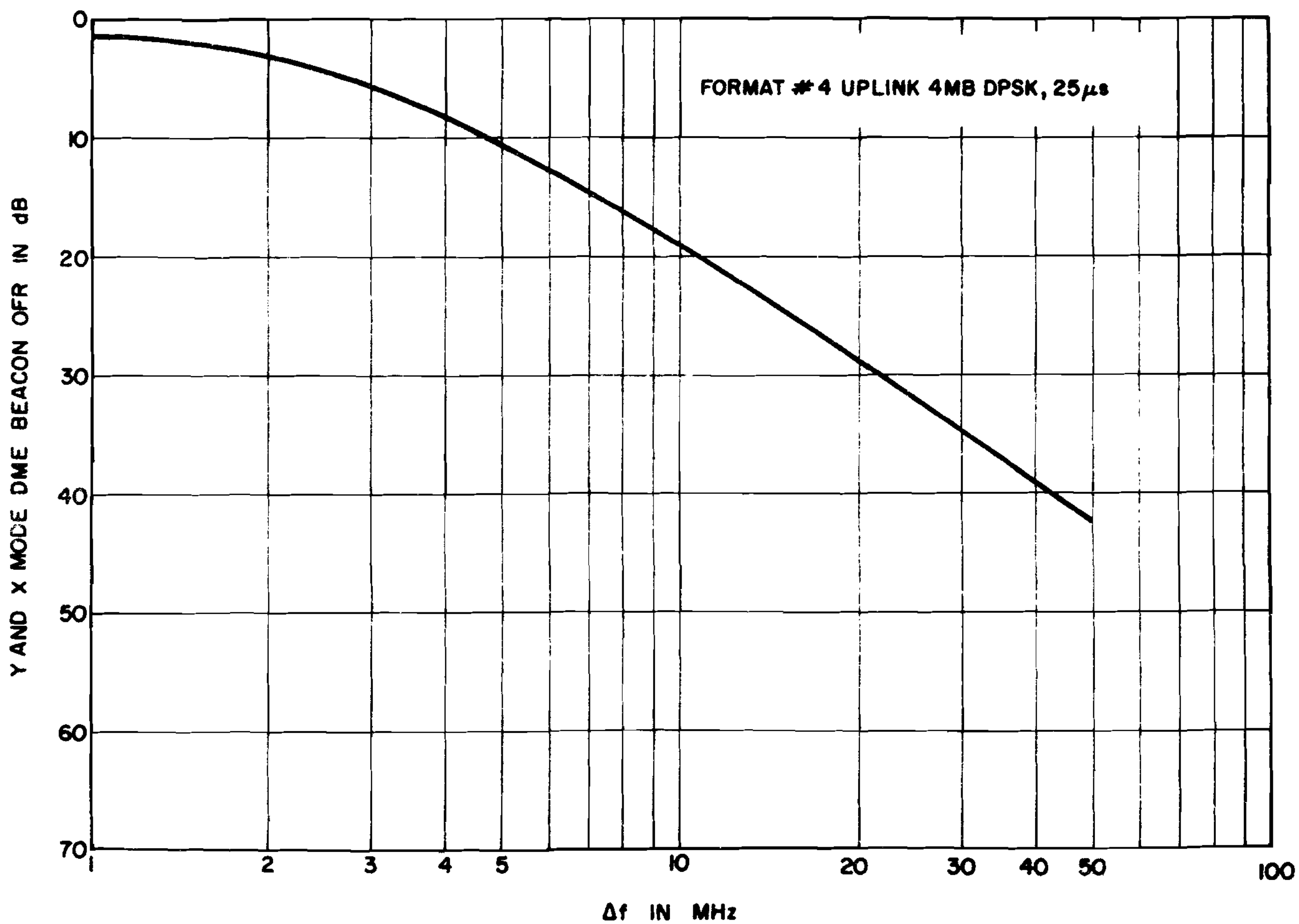


Figure A-32. X and Y mode DME beacon off-frequency rejection of DABS format 4.

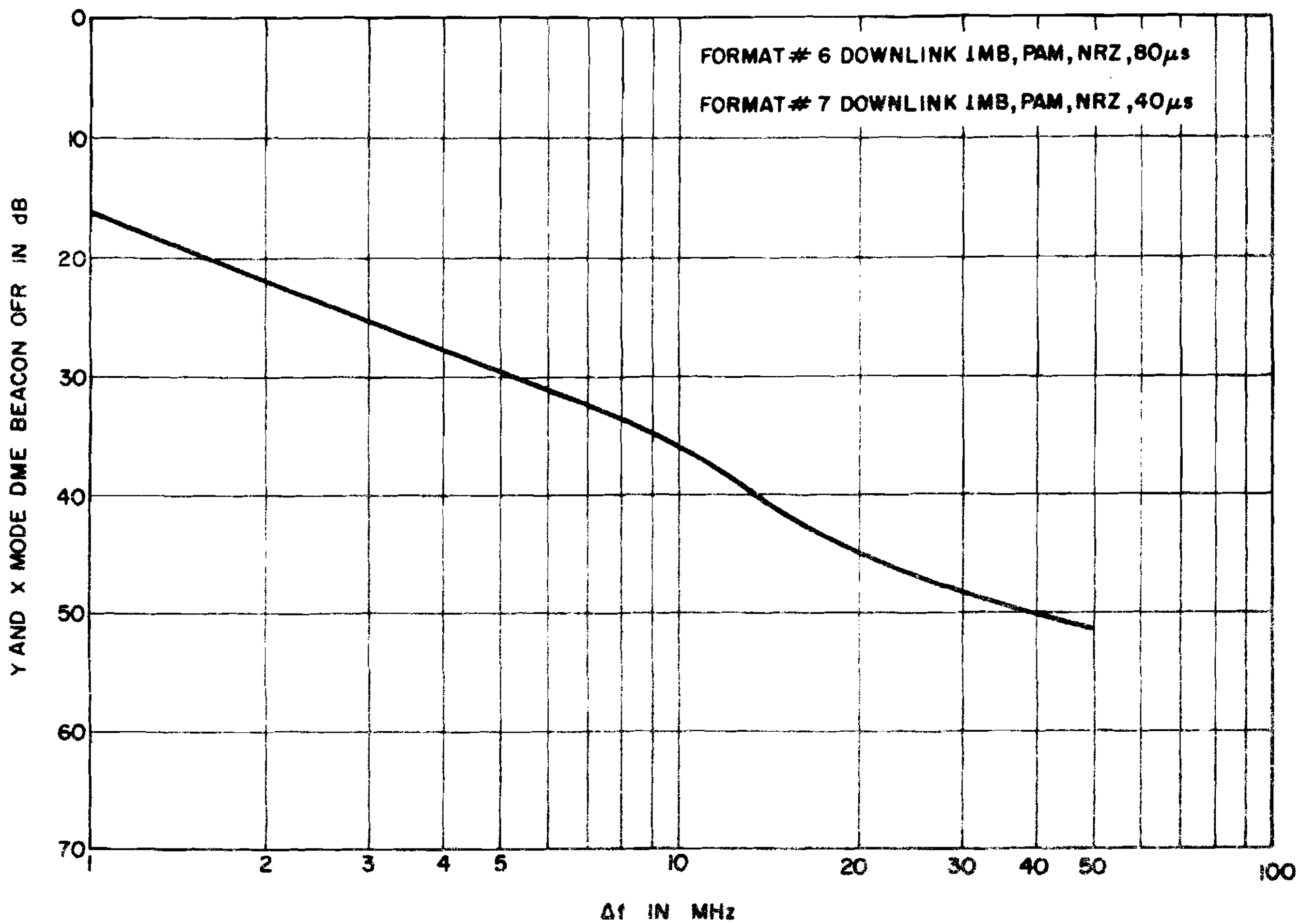


Figure A-33. X and Y mode DME beacon off-frequency rejection of DABS formats 6 and 7.

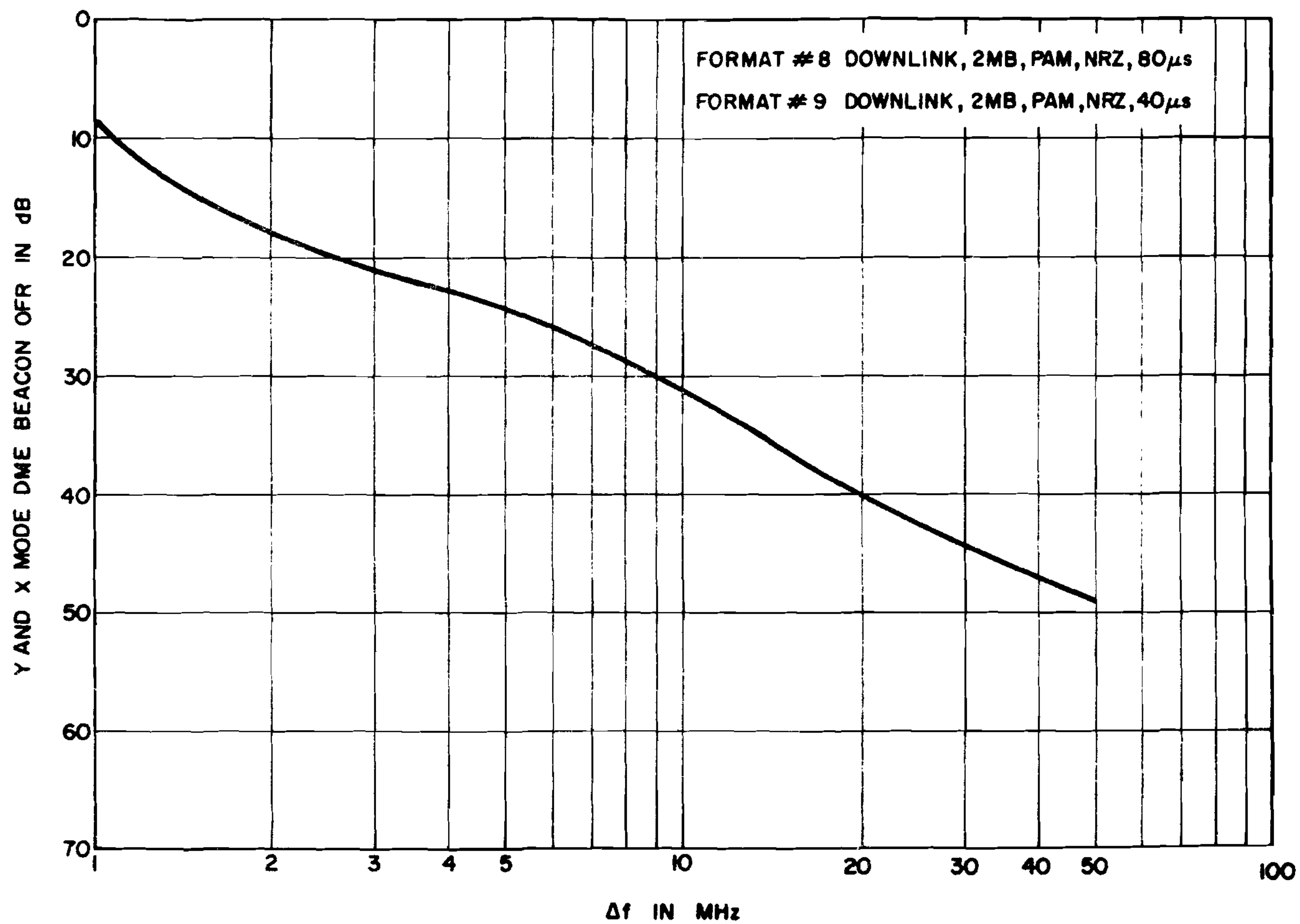


Figure A-34. X and Y mode DME beacon off-frequency rejection of DABS formats 8 and 9.

Minor differences in procedures included: (1) reducing interference signal levels in steps of 1 dB, vice 2 dB, in the measurement of reply counts, and (2) making measurements only to Δf = 22 MHz, vice 50 MHz. These OFR curves are Figures A-35 through A-39.

INTERROGATOR TESTS

The effect of DABS interference on TACAN interrogators was measured using a qualitative, rather than quantitative, test procedure. Using an AN/ARN-22 beacon simulator to generate the desired signal at the MDS level, the AN/ARN-21 TACAN interrogator was set up to simulate range and bearing lock. The DABS Signal Simulator was again used to introduce interference into the environment. In this case, however, the criterion used to determine degradation was the power level of the interference signal at which the azimuth indicator portion of the interrogator broke lock. After repeated experimentation it was found that, in every case, the range indicator portion would remain locked to the simulated beacon signal and give a correct reading at much higher levels of interference power than would the azimuth indicator (hence the assumption that azimuth lock is more susceptible than range lock to DABS interference).

With no interference present, the interrogator was allowed to lock onto the simulated beacon signal. Then, with an initial interference PRF of 5000 per second, the DABS signal was introduced and its level was increased until the interrogator broke lock. Once this break-lock power level was determined and recorded, the interference power was very carefully lowered to find the maximum interference level at which the interrogator would re-acquire lock. This procedure was repeated for a range of interference PRF values for each DABS format. As the figures in TABLE A-4 indicate, in most cases the maximum interference power level for acquire lock was approximately 3 dB below the level required for break-lock. Test results for representative DABS formats are given in TABLES A-5 through A-10.

Off-Frequency Rejection Data

The azimuth break-lock criterion was used in determining interrogator off-frequency rejection to DABS interference. The equipment was set up as in the previous interrogator tests. With the DABS signal simulator tuned to the same frequency as the interrogator receiver, the interference signal level was increased until the azimuth indicator broke lock. This was done for each of four interference PRF's: 3000, 2000, 1000 and 800. The DABS simulator was then off-tuned and the procedure was repeated for a series of frequency differentials between the interrogator receiver and the DABS signal. Sample results are shown in TABLE A-11.

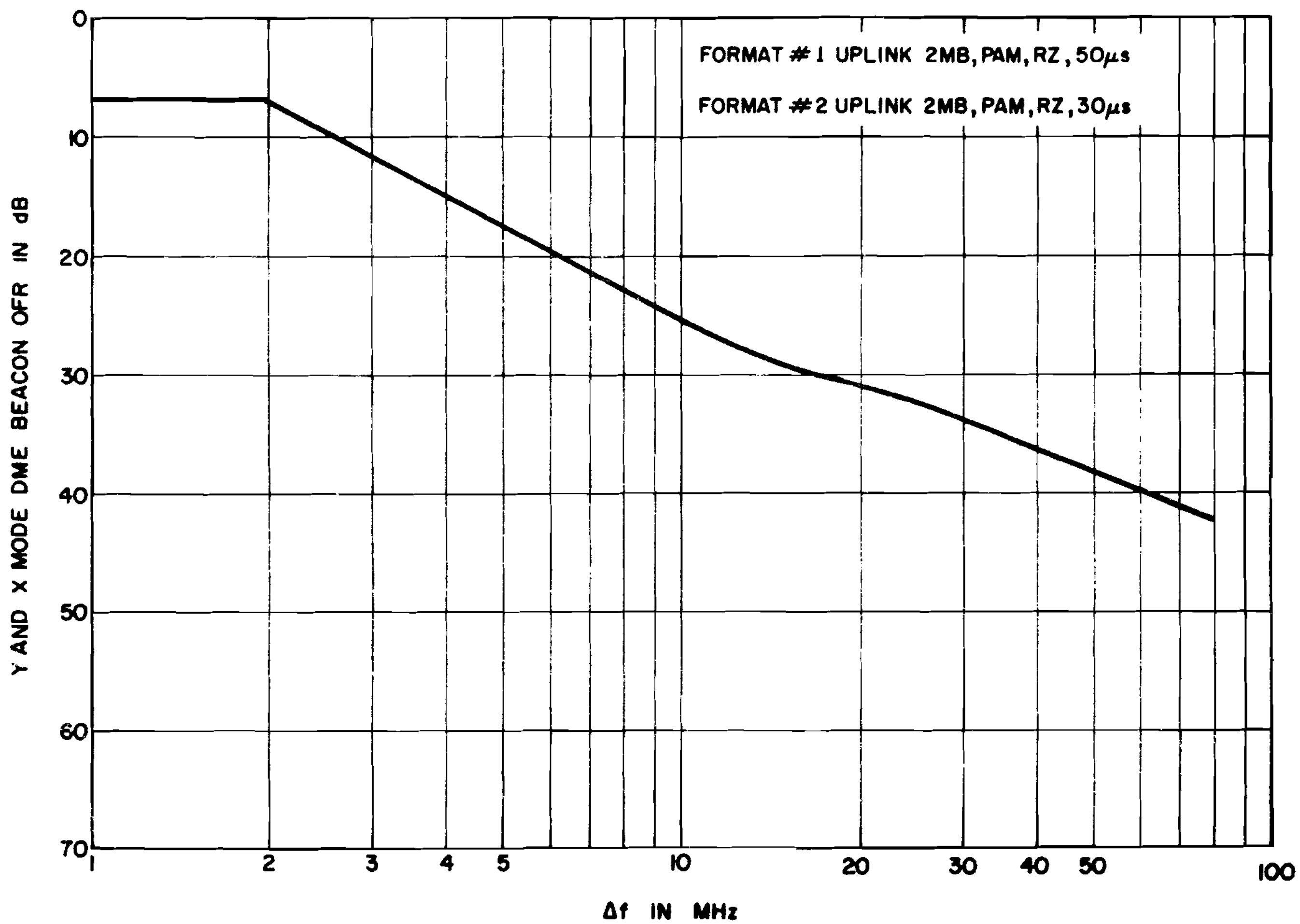


Figure A-35. X and Y mode RTB-2 beacon off-frequency rejection of DABS formats 1 and 2.

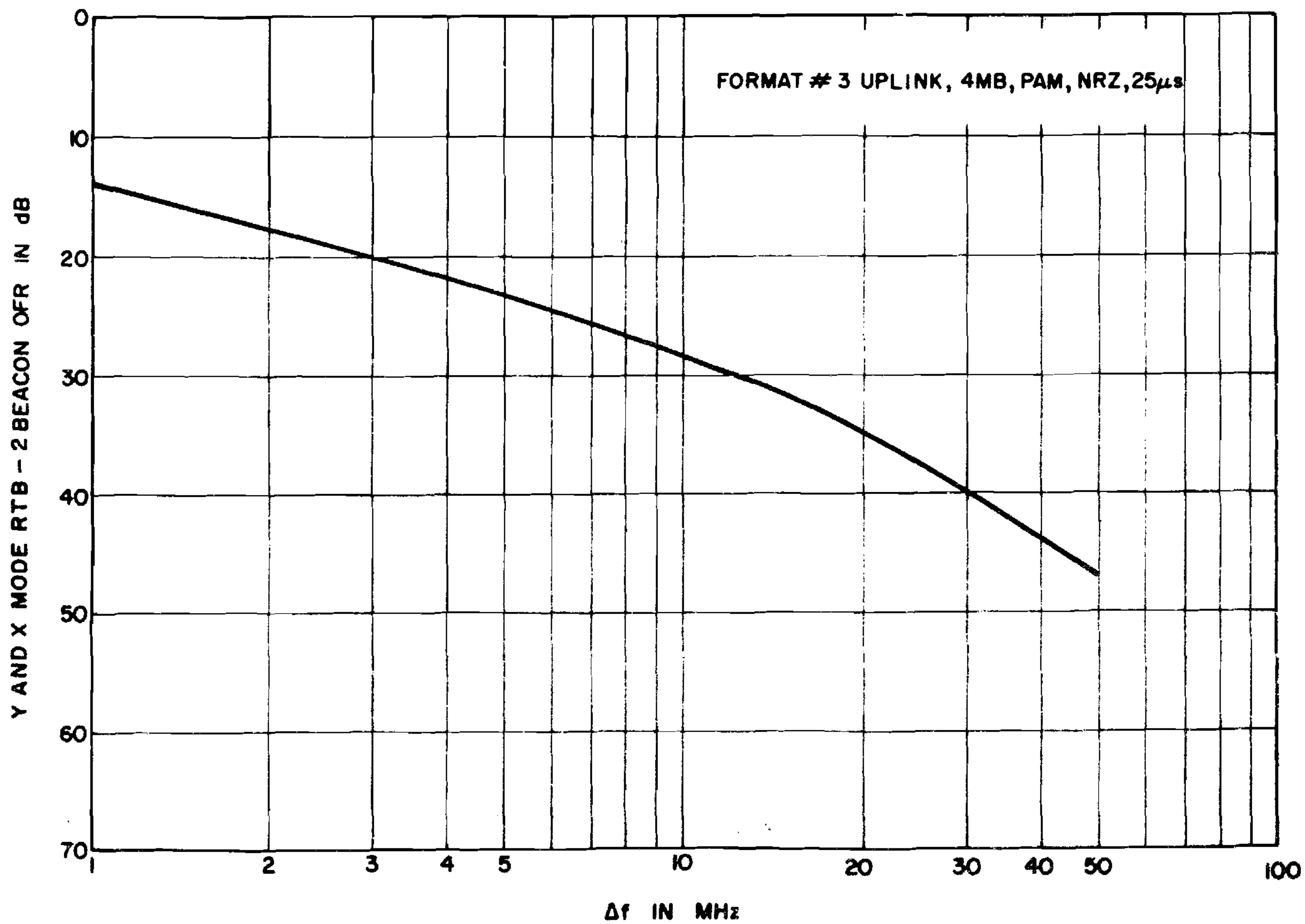


Figure A-36. X and Y mode RTB-2 beacon off-frequency rejection of DABS format 3.

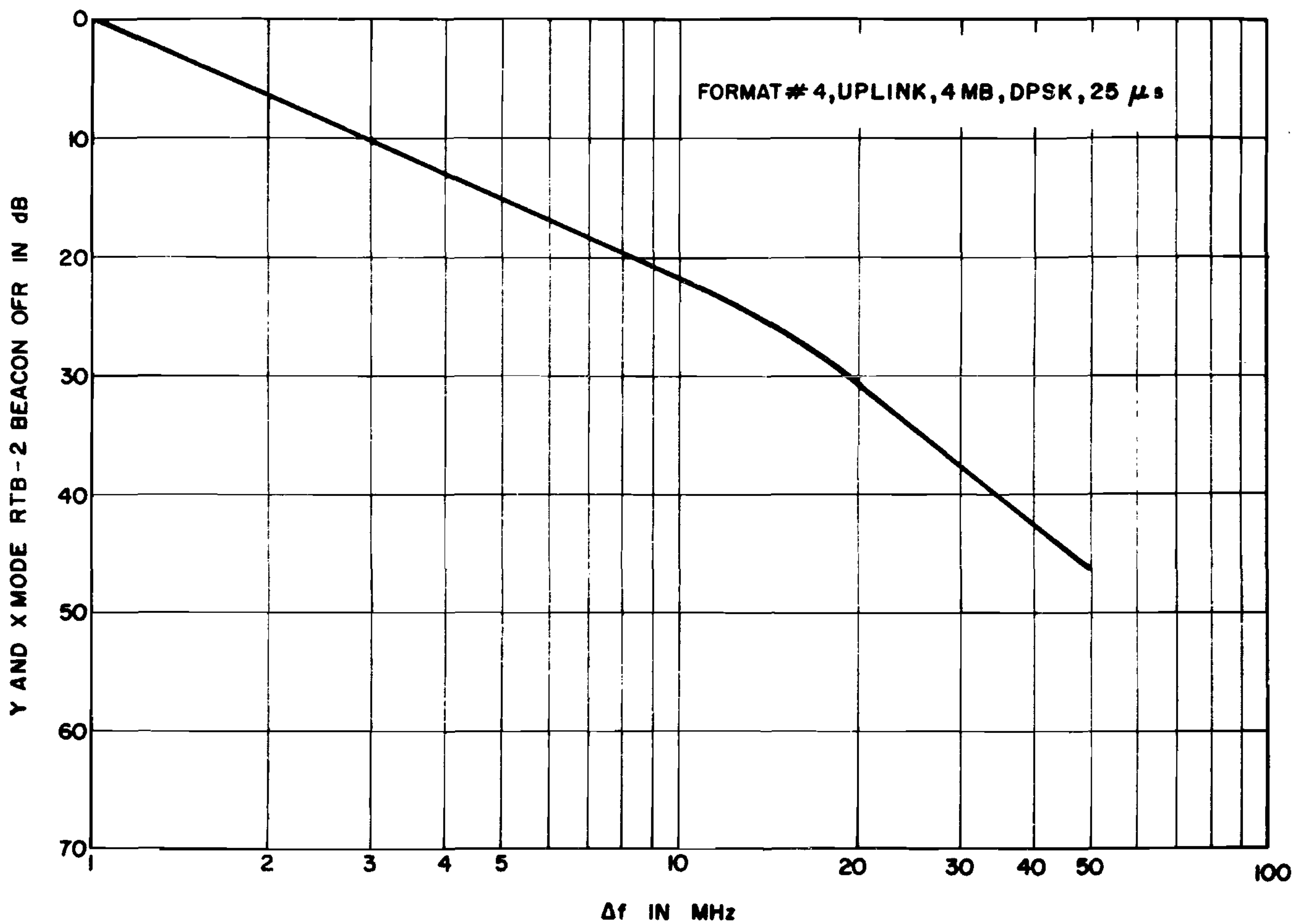


Figure A-37. X and Y mode RTB-2 beacon off-frequency rejection of DABS format 4.

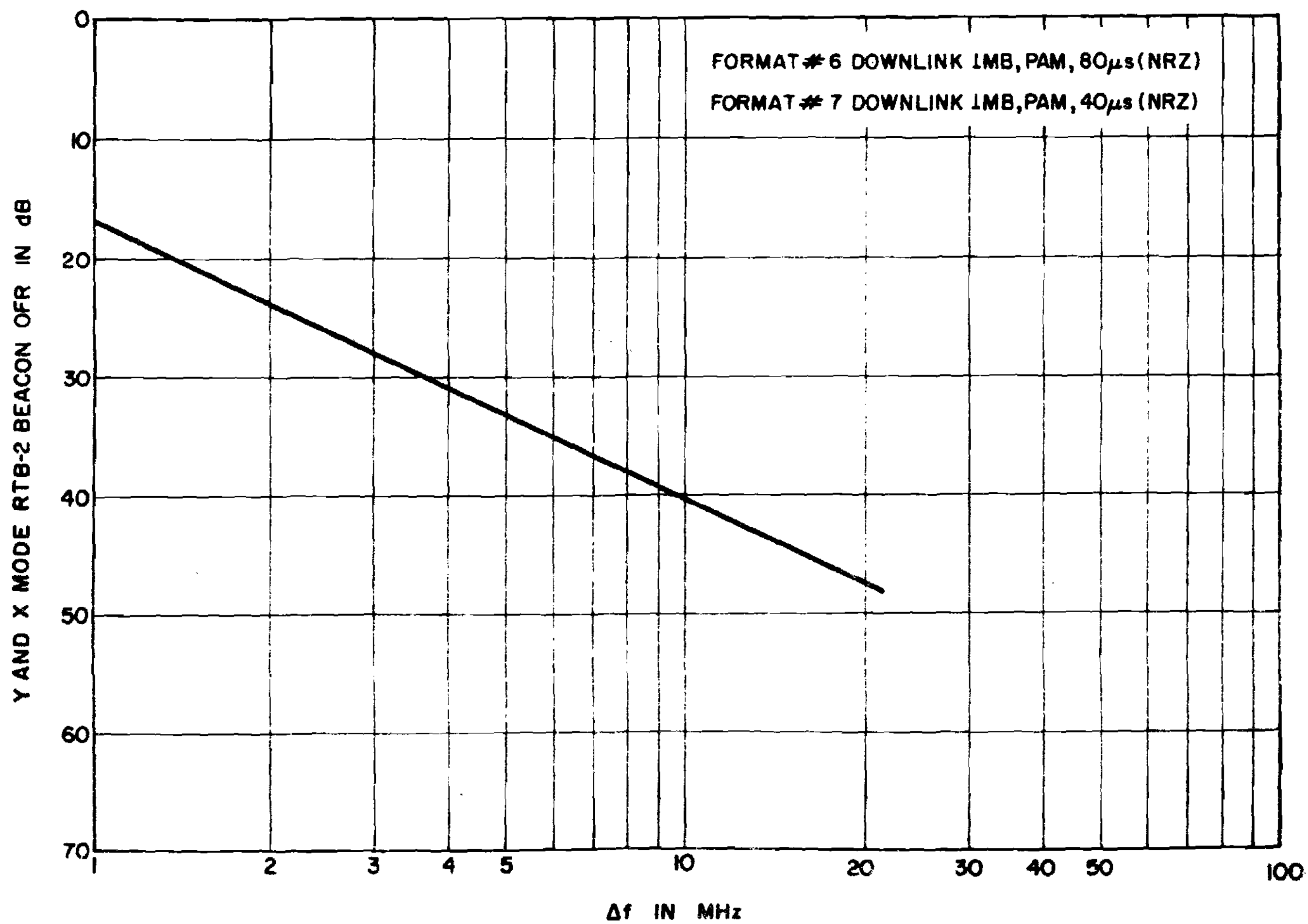


Figure A-38. X and Y mode RTB-2 beacon off-frequency rejection of DABS formats 6 and 7.

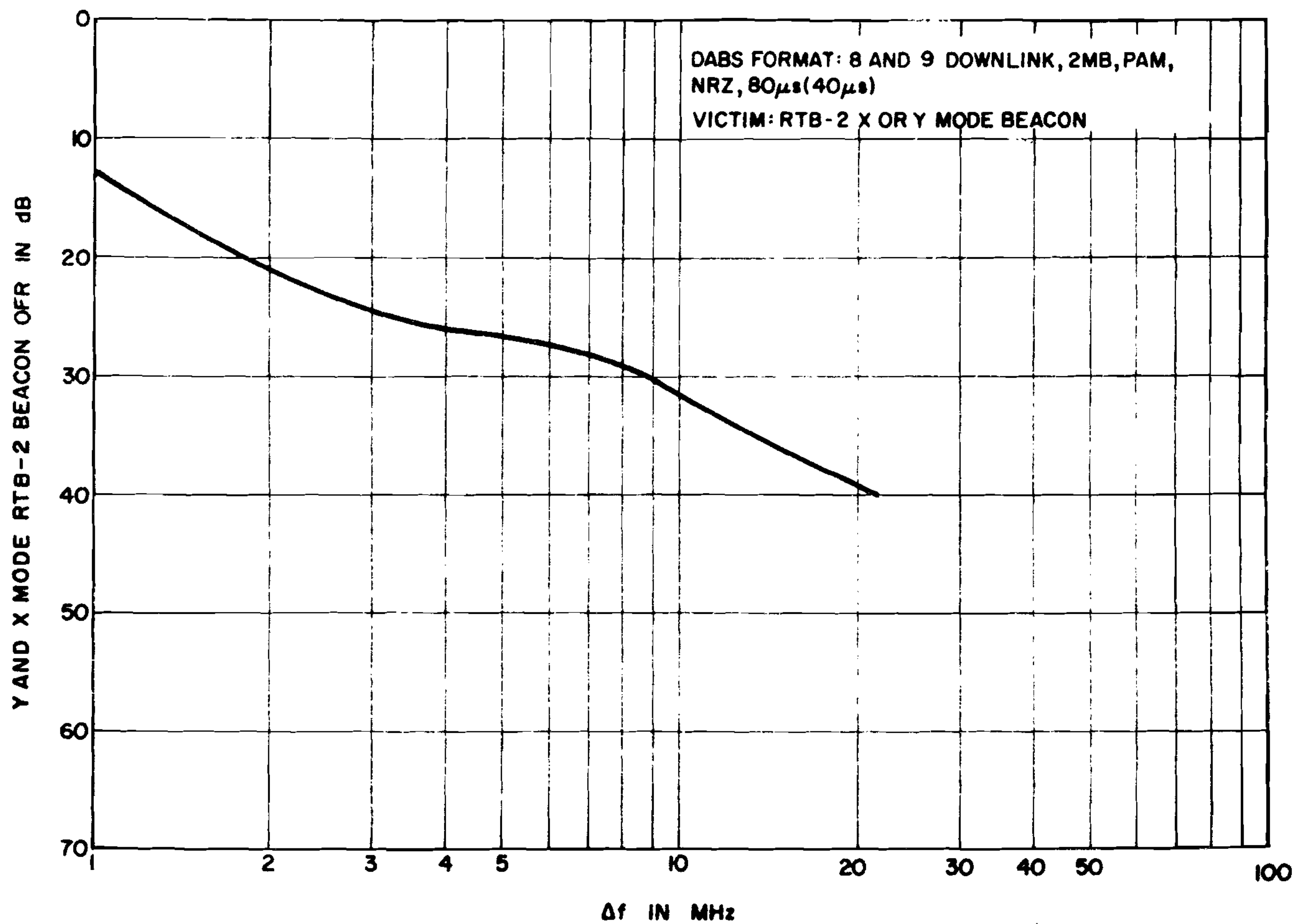


Figure A-39. X and Y mode RTB-2 beacon off-frequency rejection of DABS Formats 8 and 9.

TABLE A-4

INTERROGATOR TESTS

INTERROGATOR
ARN/21C #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

DABS
Format: Uplink, 2 MB, PAM, RZ, 50μs
Signal at Receiver MDS Level = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (32μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-77	3.0	-80	-77	2.95	-79	-78	2.95	-80
1.0k	-76	3.0	-78	-75	3.0	-77	-77.5	2.95	-79.5
800	-75	3.0	-78	-72.5	3.0	-74.5	-75.5	2.95	-77.5
600	-14	3.0	-77.5	-70.5	3.1	-73	-74	3.0	-76
500	-73.5	3.0	-76.5	-70	3.1	-72	-72.5	3.0	-75
400	-72	3.0	-74	-69	3.15	-71	-70.5	3.0	-72.5
300	-69.5	3.0	-71.5	-67	3.15	-69	-68.5	3.05	-71
200	-64	3.2	-66	-64	3.2	-67	-63	3.15	-65
150	-60	3.2	-62	-61	3.2	-64	-58.5	3.2	-62

TABLE A-5

INTERROGATOR TESTS

INTERROGATOR
ARN/21C, #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

DABS
Format: Uplink, 2 MB, PAM, RZ, 30μs
Signal at Receiver MDS Level = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (12 μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-76	2.98	-78	-76	3.0	-78	-73	3.05	-75
1.0k	-75	3.0	-77	-74	3.0	-76	-71	3.1	-73
800	-74	3.0	-76	-72	3.05	-74	-70	3.1	-73
600	-73	3.0	-75	-70.5	3.1	-72.5	-69	3.1	-71
500	-71.5	3.05	-73.5	-69	3.2	-71	-68	3.15	-70
400	-69	3.1	-71	-68	3.15	-70	-67	3.15	-69
300	-68	3.1	-70	-66	3.2	-68	-65.5	3.2	-68
200	-63	3.2	-66	-64	3.2	-66	-61.5	3.25	-63.5
150	-61	3.2	-63	-62	3.2	-65	-54	3.25	-62

TABLE A-6

INTERROGATOR TESTS

INTERROGATOR
ARN/21C #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

DABS
Format: Uplink, 4 MB, PAM, NRZ, 25μs
Signal at Receiver MDS Level = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (7 μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-82.5	2.95	-84.5	-80	2.96	-84	-69	3.05	-72
1.0k	-80	3.0	-83	-77	2.95	-81	-68	3.05	-70
800	-79	2.97	-82	-76	3.0	-78	-67	3.1	-69
600	-78	2.97	-81	-74	3.05	-76	-65.5	3.1	-67.5
500	-76.5	3.0	-79.5	-73	3.1	-75	-64	3.15	-66
400	-74	3.05	-76	-72	3.1	-74	-62.5	3.2	-64.5
300	-73	3.1	-76	-71	3.15	-73	-61	3.2	-63
200	-70.5	3.1	-72.5	-69	3.2	-71	-57	3.2	-59
150	-68.5	3.15	-70.5	-68	3.2	-70	-52	3.25	-57.0

TABLE A-7

INTERROGATOR TESTS

INTERROGATOR
ARN/21C, #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

DABS
Format: Uplink, 4 MB, DPSK, 25μs
Signal at Receiver MDS Level = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (7 μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-72.5	3.05	-74.5	-73	3.05	-75	-63	3.1	-66
1.0k	-71	3.1	-74	-71	3.1	-73	-61	3.1	-63
800	-70	3.1	-72	-69	3.1	-72	-59	3.15	-61
600	-69	3.1	-71	-67	3.15	-71	-58	3.15	-60
500	-68	3.1	-70	-66.5	3.15	-69	-57	3.15	-59
400	-67	3.1	-69	-66	3.15	-68	-56	3.15	-58
300	-63	3.15	-65	-64	3.15	-66	-54	3.15	-56
200	-57	3.15	-59	-60	3.2	-62	-49	3.15	-51
150	-46	3.2	-57	-55.5	3.2	-57.5	-43	3.25	-49

TABLE A-8

INTERROGATOR TESTS

INTERROGATOR
ARN/21C #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

DABS
Format: Uplink, 2 MB, DPSK, 50μs
Signal at Receiver MDS Level = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (32μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-78	2.98	-80	-77	3.0	-80	-77	3.0	-79
1.0k	-76.5	3.0	-78.5	-75	3.05	-77	-75	3.0	-77
800	-75	3.0	-78	-73	3.05	-75	-74	3.0	-77
600	-74	3.0	-77	-71	3.1	-74	-73	3.05	-75
500	-73	3.0	-76	-70	3.1	-73	-71.5	3.1	-74.5
400	-71	3.05	-74	-69.5	3.1	-71.5	-70	3.1	-72
300	-69	3.1	-71	-68	3.15	-70	-67	3.1	-70
200	-60	3.15	-62	-64	3.15	-66	-61	3.15	-63
150	-55	3.2	-58	-62	3.15	-64	-54	3.15	-57

TABLE A-9

INTERROGATOR TESTS

INTERROGATOR
ARN/21C #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

Format: Downlink, 1 MB, PAM, NRZ, 40μs
Signal at Receiver MDS Level = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (22 μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-82	3.0	-85	-80	3.0	-83	-81	3.0	-83
1.0k	-80	3.0	-82	-77	3.0	-79	-79	3.0	-81
800	-80	3.2	-82	-76	3.0	-79	-78	3.0	-80
600	-78	3.0	-81	-75	3.05	-77	-77	3.0	-79
500	-77	3.0	-79	-74	3.1	-76	-75	3.1	-77
400	-75	3.05	-77	-73	3.1	-75	-74	3.1	-76
300	-73	3.1	-75	-72	3.1	-74	-72	3.15	-74
200	-69	3.15	-71	-70	3.2	-72	-70	3.15	-72
150	-65	3.2	-68	-67	3.2	-69	-63	3.2	-69

TABLE A-10

INTERROGATOR TESTS

INTERROGATOR
ARN/21C #16314
Receiver Freq: 1024 MHz
No Interference AGC = 2.95V

DABS
Format: Downlink, 2 MB, PAM, NRZ, 40μs
Signal at Receiver MDS = -85 dBm

DABS PRF (PPS)	DABS Signal Level for Breaklock & Acquire Azimuth								
	DABS Periodic			DABS Random			DABS Periodic, Message Modified for Y Mode (22 μs)		
	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC at Break (Volts)	Min. P.I. to Acquire (dBm)	P.I. Break (dBm)	AGC (Volts)	Min. P.I. to Acquire (dBm)
1.6k	-81	3.0	-83	-80	3.0	-83	-79	3.0	-81
1.0k	-79	3.0	-81	-75	3.1	-78	-77.5	3.0	-79.5
800	-78	3.0	-80	-76	3.05	-78	-76	3.05	-78
600	-76.5	3.0	-78.5	-74	3.1	-76	-75	3.1	-78
500	-75.5	3.0	-77.5	-72	3.1	-75	-74	3.1	-76
400	-74	3.1	-76.0	-72	3.1	-74	-72	3.15	-74
300	-73	3.1	-75	-71	3.15	-73	-71	3.2	-73
200	-69	3.2	-71	-70	3.2	-72	-68	3.2	-70
150	-68	3.2	-70	-68	3.2	-70	-66	3.2	-69

TABLE A-11

DME/TACAN INTERROGATOR OFR TESTS[a]

INTERROGATOR
AN/21C #16314
Desired Signal Level -85 dBm
No Interference AGC Level = 3.05V

DABS
Format: Uplink, 2 MB, PAM, RZ, 50μs
PRF: Periodic

Δf = 0

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-79	3.1
2.0k	-79	3.1
1.0k	-77	3.05
800	-76	3.05

Δf = +8 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-60	3.1
2.0k	-60	3.1
1.0k	-58	3.1
800	-57	3.1

Δf = +1 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-68	3.1
2.0k	-67	3.1
1.0k	-65	3.1
800	-63	3.1

Δf = +10 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-43	3.1
2.0k	-42	3.1
1.0k	-40	3.1
800	-39	3.1

Δf = +2 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-73	3.1
2.0k	-73	3.1
1.0k	-71	3.1
800	-69	3.1

Δf = +14 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-53	3.1
2.0k	-52	3.1
1.0k	-50	3.1
800	-49	3.1

Δf = +4 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-63	3.1
2.0k	-62	3.1
1.0k	-60	3.1
800	-59	3.1

Δf = 22 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-50	3.1
2.0k	-49	3.1
1.0k	-48	3.1
800	-47	3.1

Δf = +6 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-59	3.08
2.0k	-58	3.08
1.0k	-56	3.05
800	-55	3.05

Δf = +30 MHz

PRF	DABS P.L. (dBm)	AGC (Volts)
3.0k	-40	3.1
2.0k	-39	3.1
1.0k	-38	3.1
800	-37	3.1

[a]DABS power levels and interrogator AGC voltages were recorded at azimuth breaklock.

The off-frequency rejection for the various frequency differentials was then computed for each PRF. This was accomplished by computing the difference between the signal level necessary for azimuth break-lock at $\Delta f = 0$ and the level required for break-lock at each other value of Δf. The average value of OFR at each frequency differential was computed (TABLE A-12) and the resulting averages plotted. Resulting OFR curves for the various DABS formats are shown in Figures A-40 through A-44.

Special note should be made of the fact that these off-frequency rejection curves include interference reaction factors within the victim equipments, e.g., the interfering signal may be interpreted as a valid signal by the victim receiver, resulting in the generation of false replies. As such, these curves do not represent just the intrinsic properties of the victim equipments. They illustrate the interaction of the equipments with the particular interference signals being tested.

TABLE A-12

OFF-FREQUENCY REJECTION
FORMAT #1 UPLINK 2 MB PAM, RZ, 50μs

	OFR (dB)									
PRF	Δf = 0	1	2	4	6	8	10	14	22	30
3.0k	0	11	6	16	20	19	36	26	29	39
2.0k	0	12	6	17	21	19	37	27	30	40
1.0k	0	12	6	17	21	19	37	27	29	39
800	0	13	7	17	21	19	37	27	29	39
Average OFR	0	12	6	17	21	19	37	27	29	39

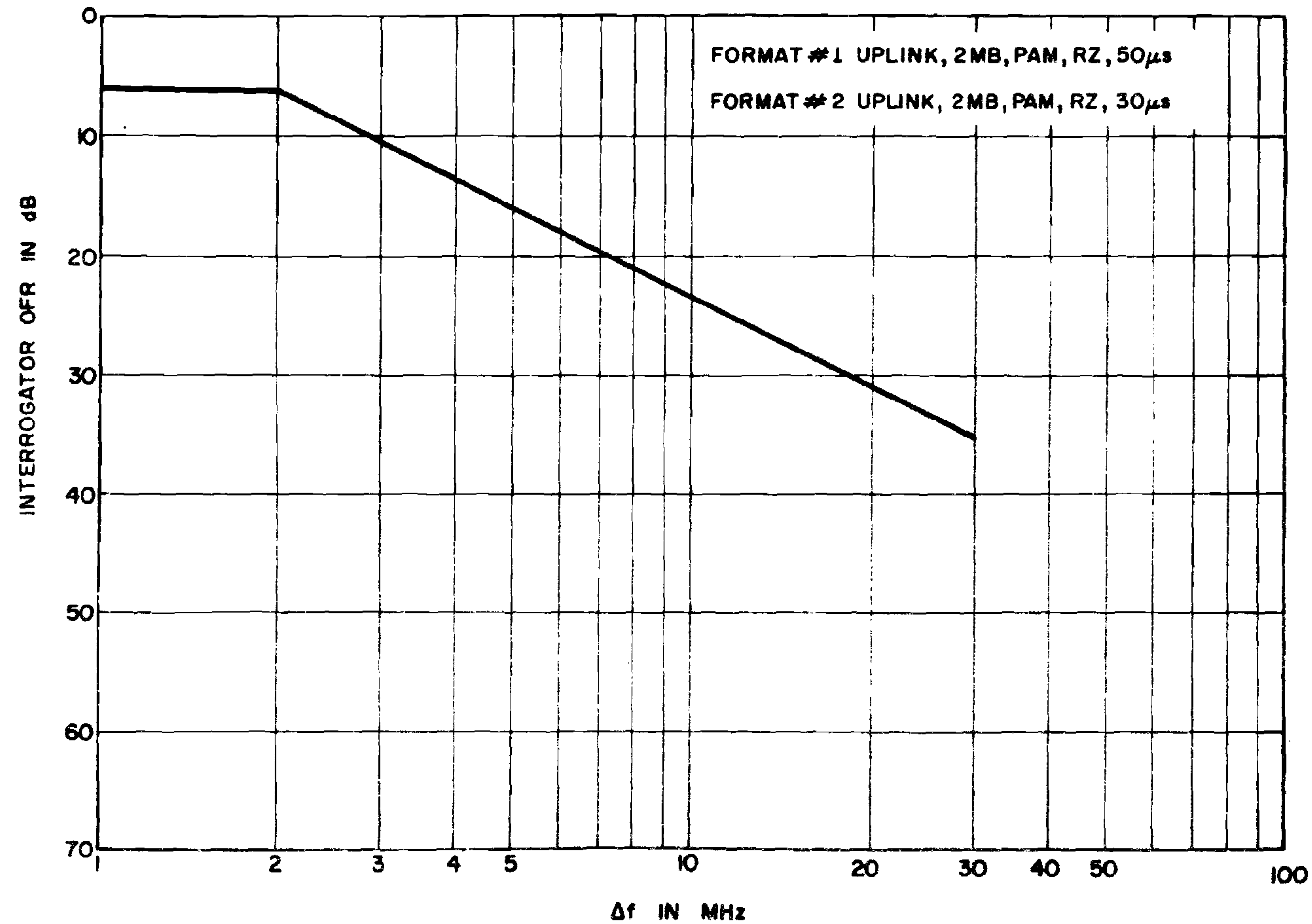


Figure A-40. X and Y mode interrogator off-frequency rejection of DABS formats 1 and 2.

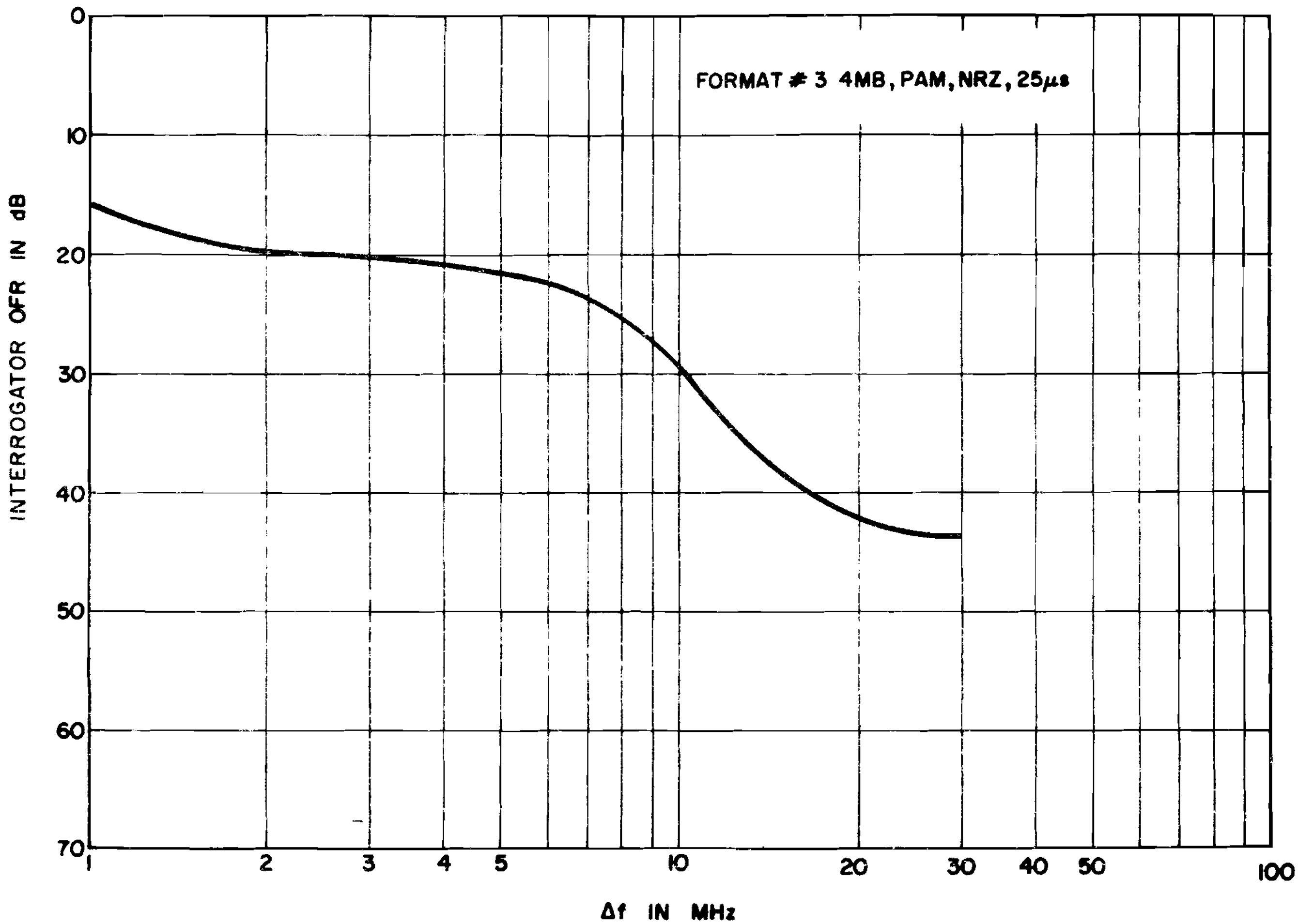


Figure A-41. X and Y mode interrogator off-frequency rejection of DABS format 3.

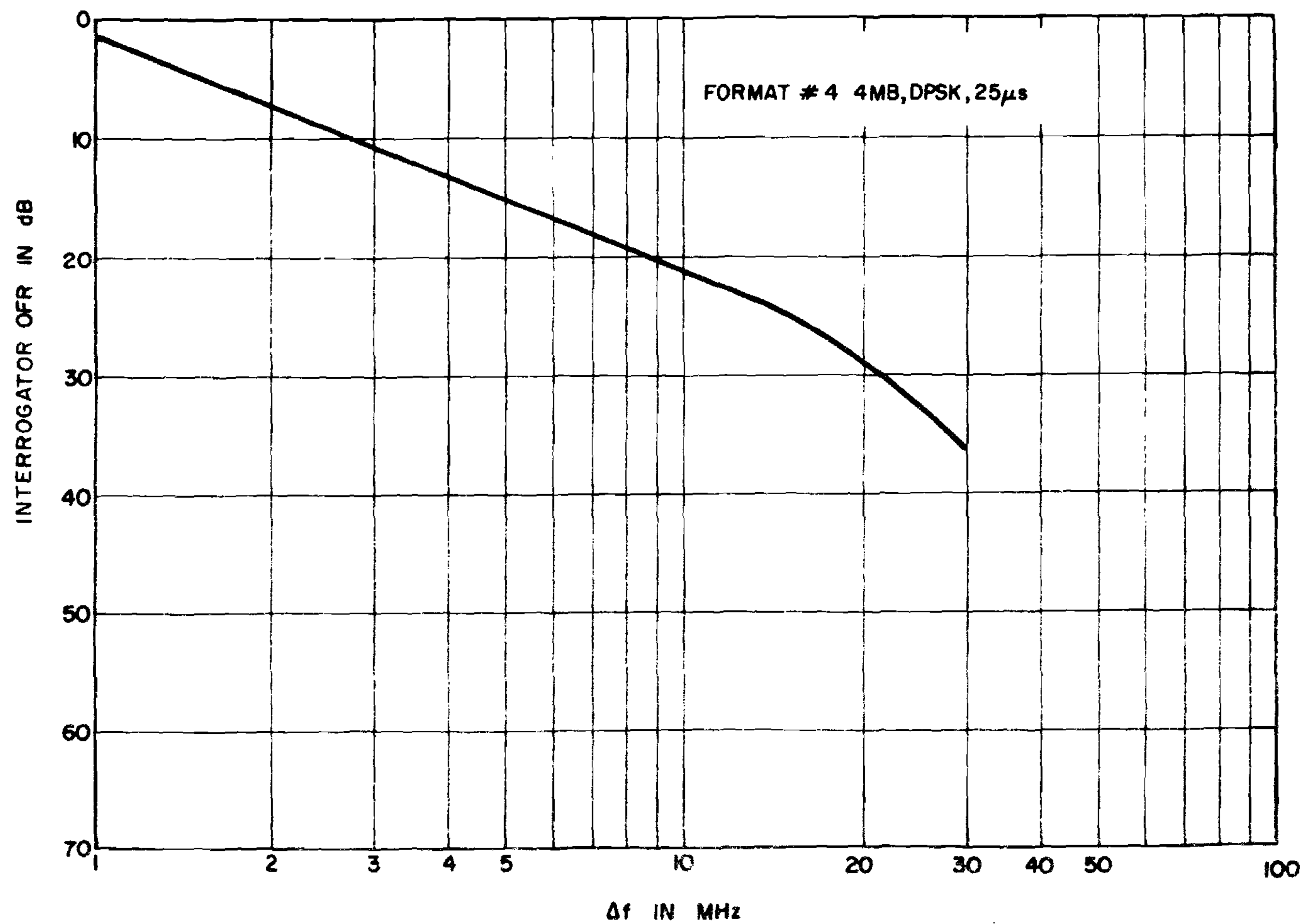


Figure A-42. X and Y mode interrogator off-frequency rejection of DABS format 4.

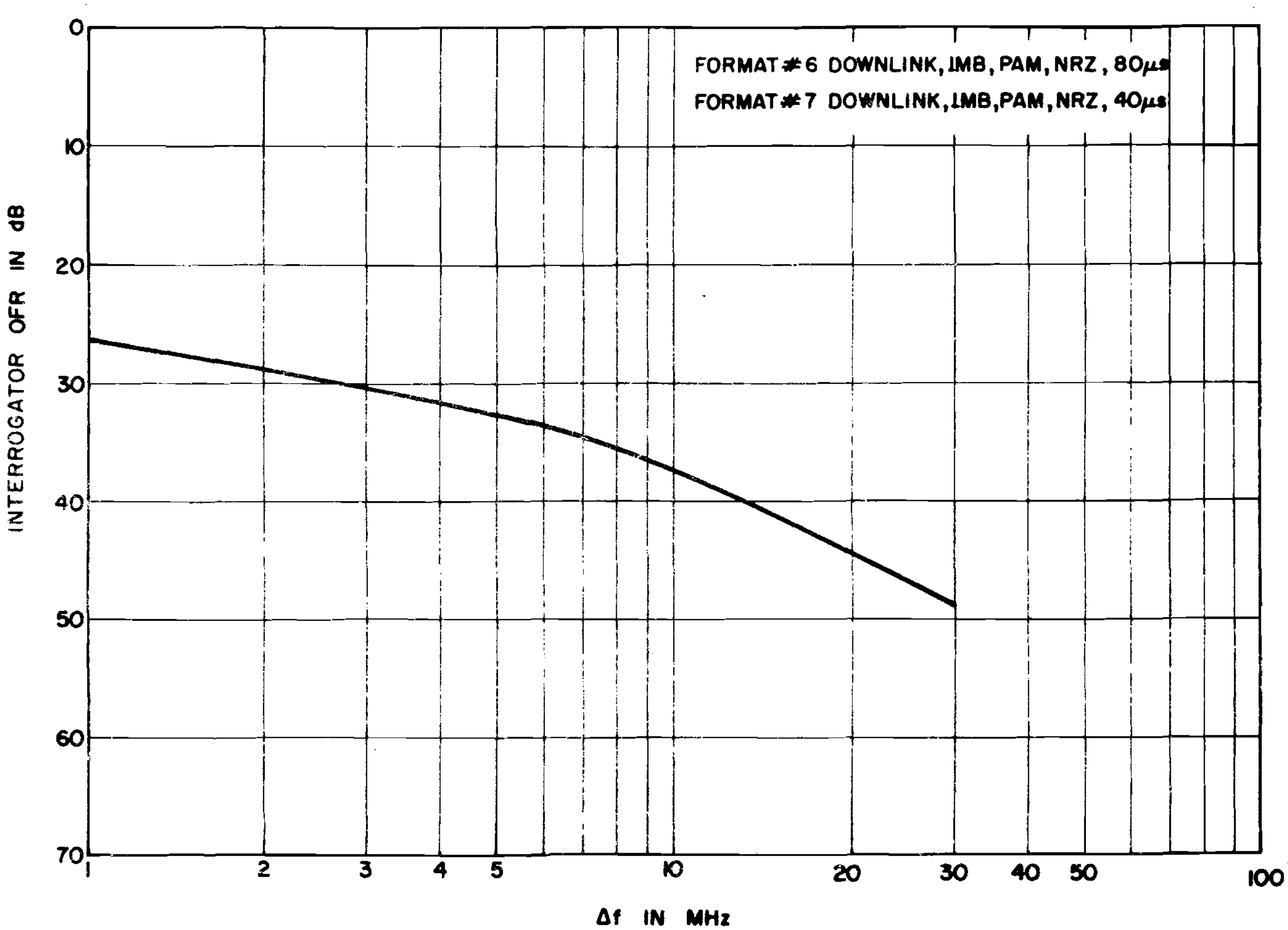


Figure A-43. X and Y mode interrogator off-frequency rejection of DABS formats 6 and 7.

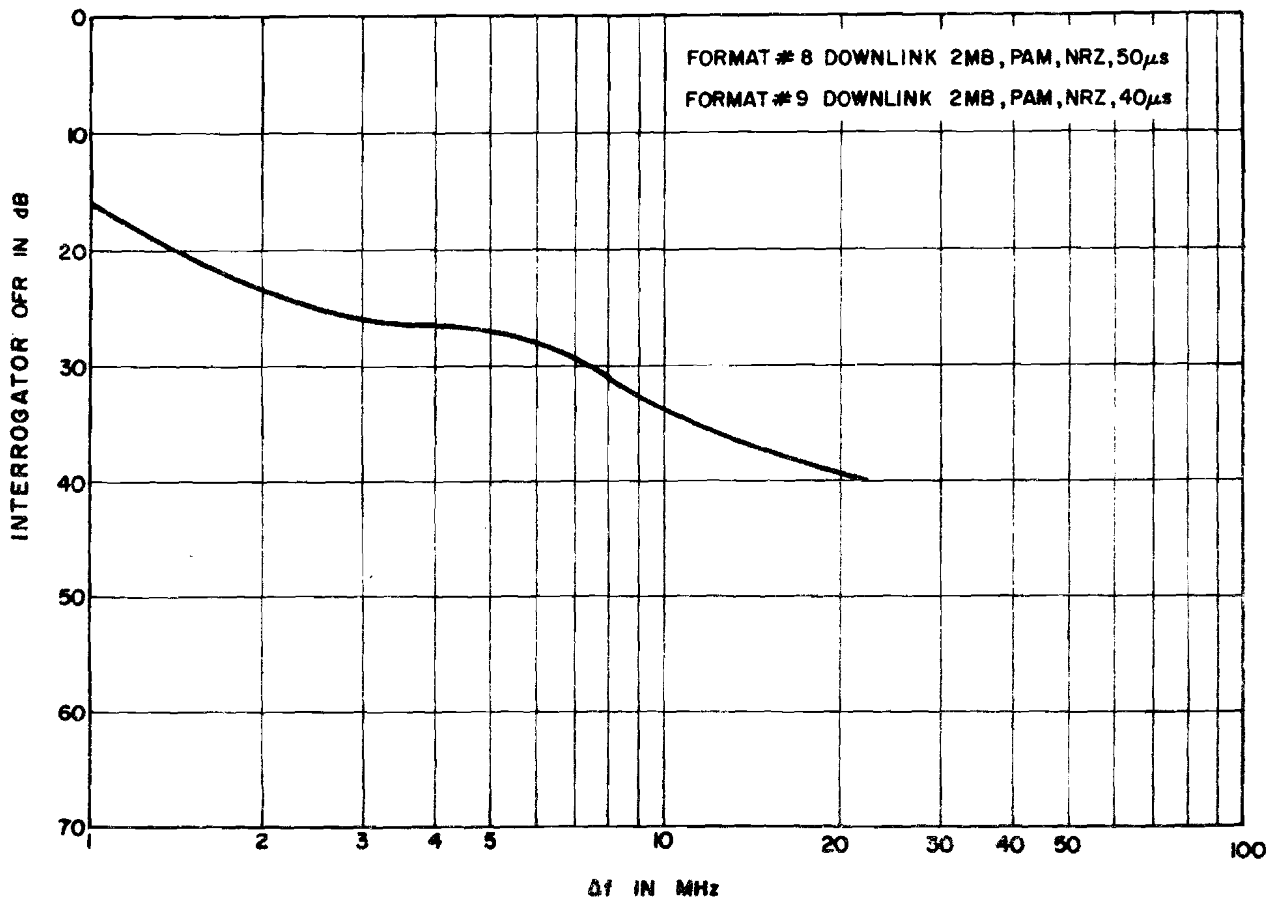


Figure A-44. X and Y mode interrogator off-frequency rejection of DABS formats 8 and 9.

APPENDIX B

RESULTS

In the following data, the proposed DABS signal formats are referred to as Formats 1 through 10. These numbers correspond to formats as follows:

DABS Format	Data Rate	Modulation	Message Length
1	2 MB	PAM, RZ	50 μs
2	2 MB	PAM, RZ	30 μs
3	4 MB	PAM, NRZ	25 μs
4	4 MB	DPSK	25 μs
5	3.2 MB	DPSK	32 μs
6	1 MB	PAM, NRZ	80 μs
7	1 MB	PAM, NRZ	40 μs
8	2 MB	PAM, NRZ	80 μs
9	2 MB	PAM, NRZ	40 μs
10	3.2 MB	PAM, NRZ	40 μs

Data in this appendix has been divided into two sections. The first deals with the effects of DABS uplink formats, and the second deals with the proposed downlink formats. Each of these sections is further subdivided to consider TACAN/DME beacons as victims, followed by interrogators as victims. The contents of the figures in this appendix are as indicated below:

Figure B-1	Plot of percent deadtime as a function of Δf for DABS format #1, with the RTB-2 X mode beacon as victim.
Figure B-2 through B-4	Plots of frequency-distance separation required to produce the data in Figure B-1. The curves represent various fixed percent deadtimes.
Figure B-5 through B-16	Similar to Figures B-1 through B-4 except that DABS formats 2, 3, and 4 are considered.
Figure B-17 through B-19	Plots of percent deadtime as a function of Δf and of frequency-distance separations required to produce these curves. DABS format #5 is considered, with the RTB-2 X mode beacon, transmit power = 250W, as victim.

Figure B-20 through B-22	Similar to Figures B-17 through B-19 except that beacon transmit power = 2.5 kW.
Figure B-23 through B-44	Similar to Figures B-1 through B-22 except that the victim is RTB-2 Y mode beacon.
Figure B-45	Plot of average interference power level received at victim X mode TACAN interrogator when DABS format #1 is used as the interfering signal.
Figure B-46	Plot of frequency-distance separations required to preclude interference in the situation illustrated in Figure B-45.
Figure B-47 through B-55	Similar to Figures B-45 and B-46 except that DABS formats 2, 3, 4, and 5 (P_T = 250W and P_T = 2.5 kW) are considered.
Figure B-56 through B-67	Similar to Figures B-45 through B-56 except that the victim is a Y mode TACAN interrogator.
Figure B-68 through B-72	Plots of percent deadtime for the RTB-2 X mode beacon. DABS signals considered are proposed formats 6, 7, 8, and 9. These values do not taken into account any variations in DABS transponder transmit frequency.
Figure B-73 through B-80	Similar to Figures B-68 through B-72 except that transmit frequency tolerance of the DABS transponder is considered to be 1090 ± 3 MHz.
Figure B-81 through B-85	Similar to Figures B-68 through B-72 except that the victim is the RTB-2 Y mode beacon.
Figure B-86 through B-93	Similar to Figures B-81 through B-85 except that transmit frequency tolerance of the DABS transponder is considered to be 1090 ± 3 MHz.

Figure B-94 through B-97	Plots of percent deadtime for the Butler DME-100 X mode beacon. DABS signals considered are proposed formats 6, 7, 8, and 9. These values do not take into account any variations in DABS transponder transmit frequency.
Figure B-98 through B-105	Similar to Figures B-94 through B-97 except that transmit frequency tolerance of the DABS transponder is considered to be 1090 ± 3 MHz.
Figure B-106 through B-109	Similar to Figures B-94 through B-97 except that the victim is the Butler DME-100 Y mode beacon.
Figure B-110 through B-116	Similar to Figures B-106 through B-109 except that transmit frequency tolerance of the DABS transponder is considered to be 1090 ± 3 MHz.
Figure B-117 through B-121	Plots of computed values of total average interference power received at the victim Y mode TACAN interrogator, DABS signals considered are proposed formats 6, 7, 8, and 9. These values do not take into account any variations in transponder transmit frequency.
Figure B-122 through B-126	Similar to Figures B-117 through B-121 except that transmit tolerance of the transponder is considered to be 1090 ± 3 MHz.

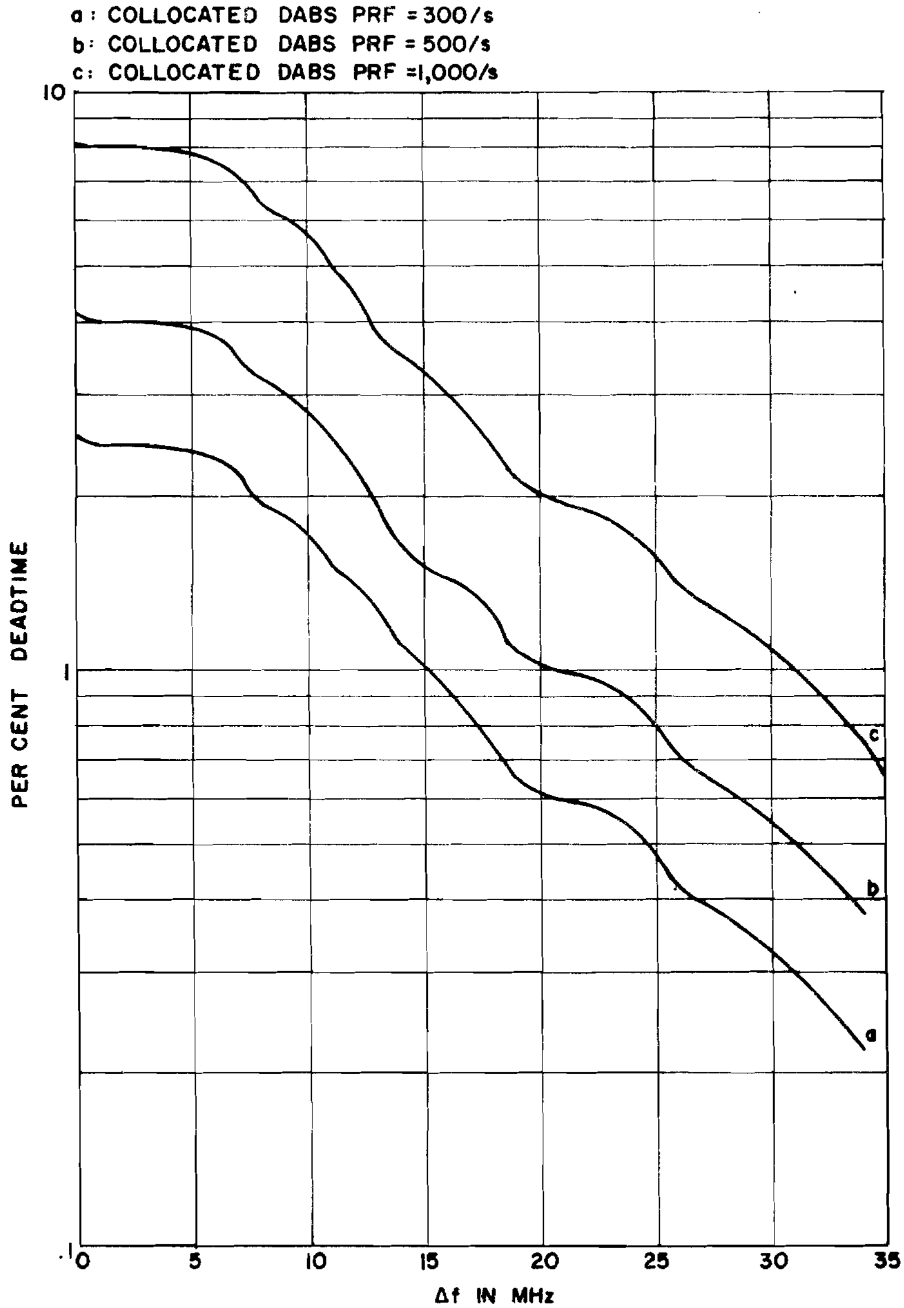


Figure B-1. Percent deadtime vs Δf for RTB-2 X mode, DABS format #1.

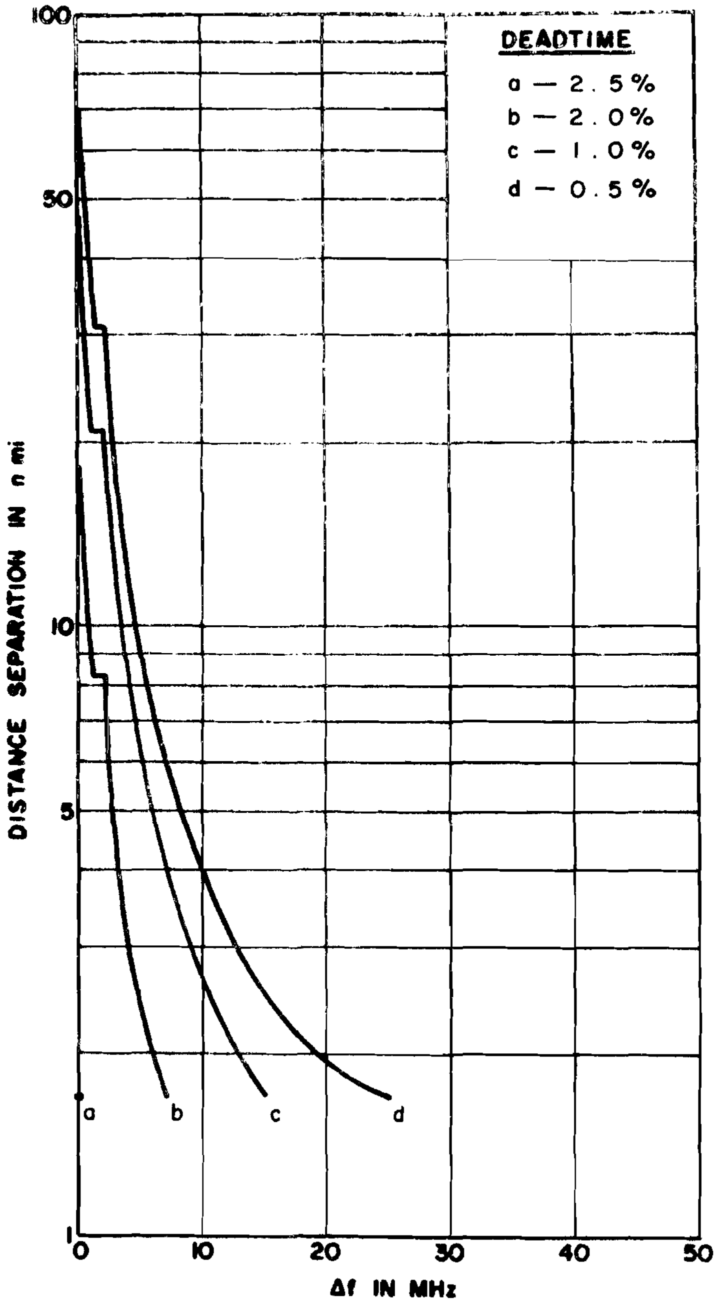


Figure B-2. Distance separation vs Δf for RTB-2 X mode, DABS format #1, DABS PRF = 300/s.

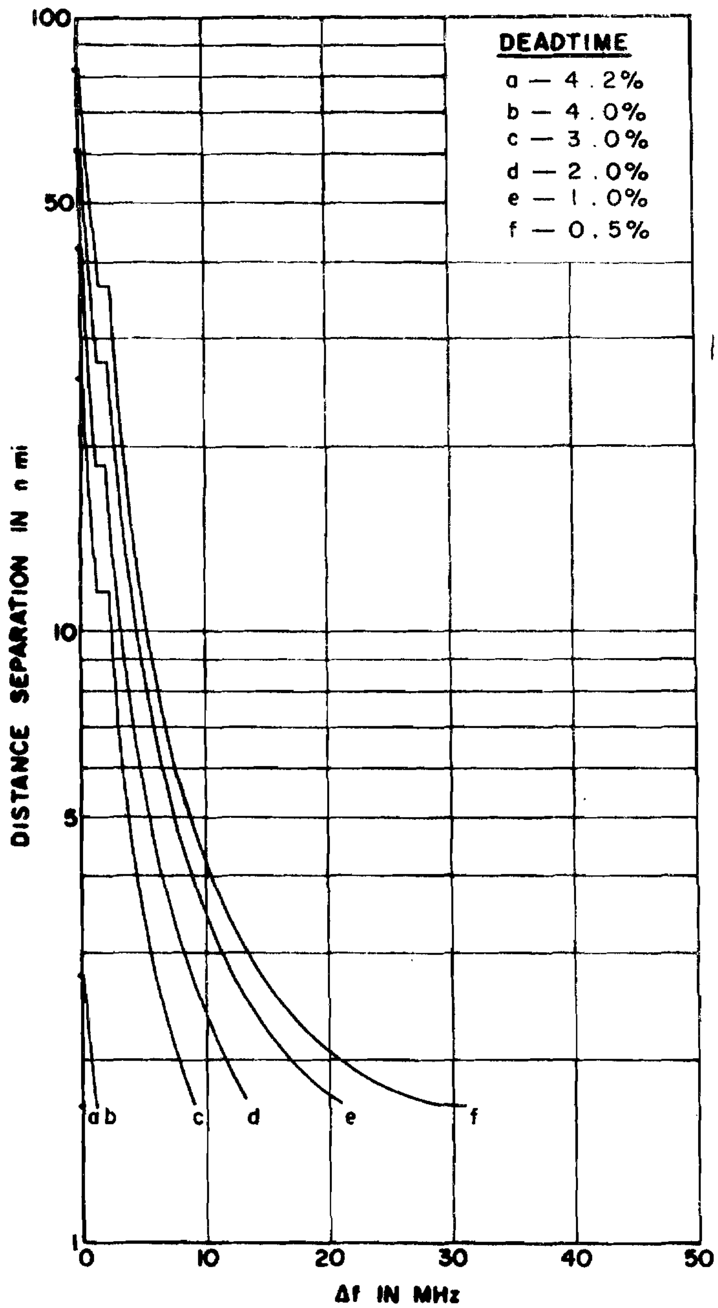


Figure B-3. Distance separation vs Δf for RTB-2 X mode, DABS format #1, DABS PRF = 500/s.

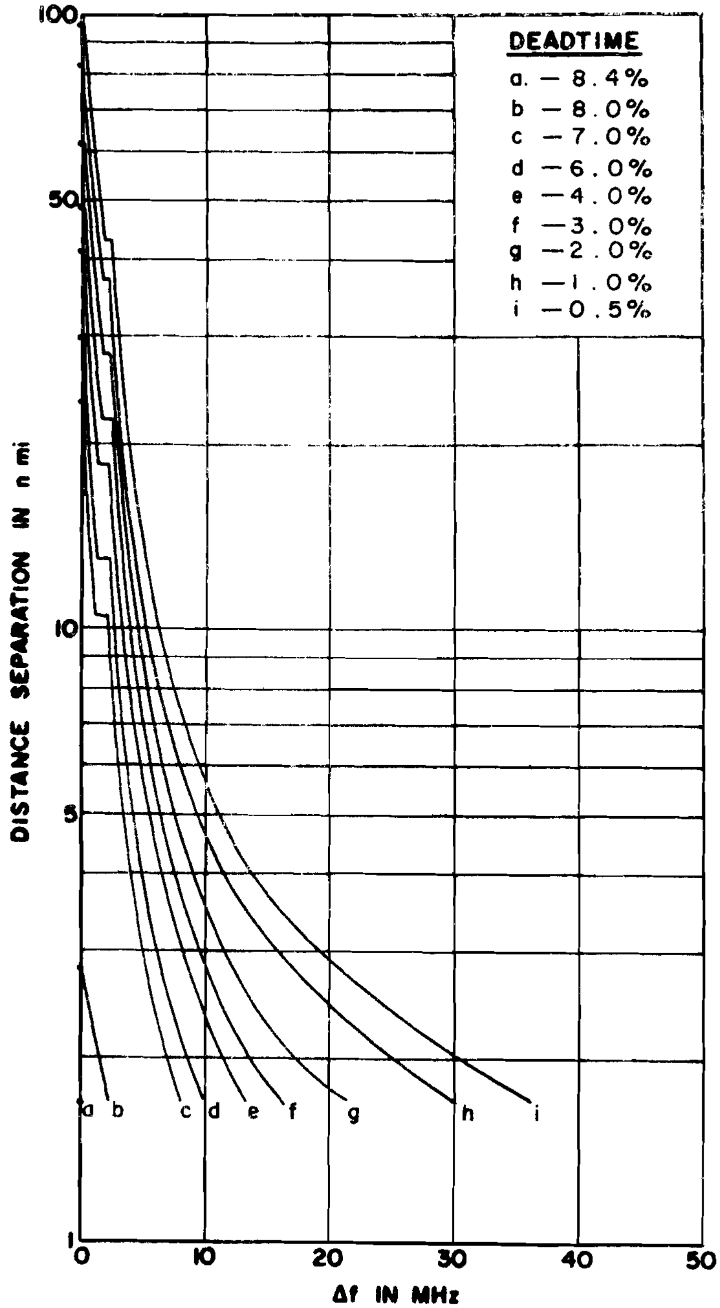


Figure B-4. Distance separation vs Δf for RTB-2 X mode, DABS format #1, DABS PRF = 1000/s.

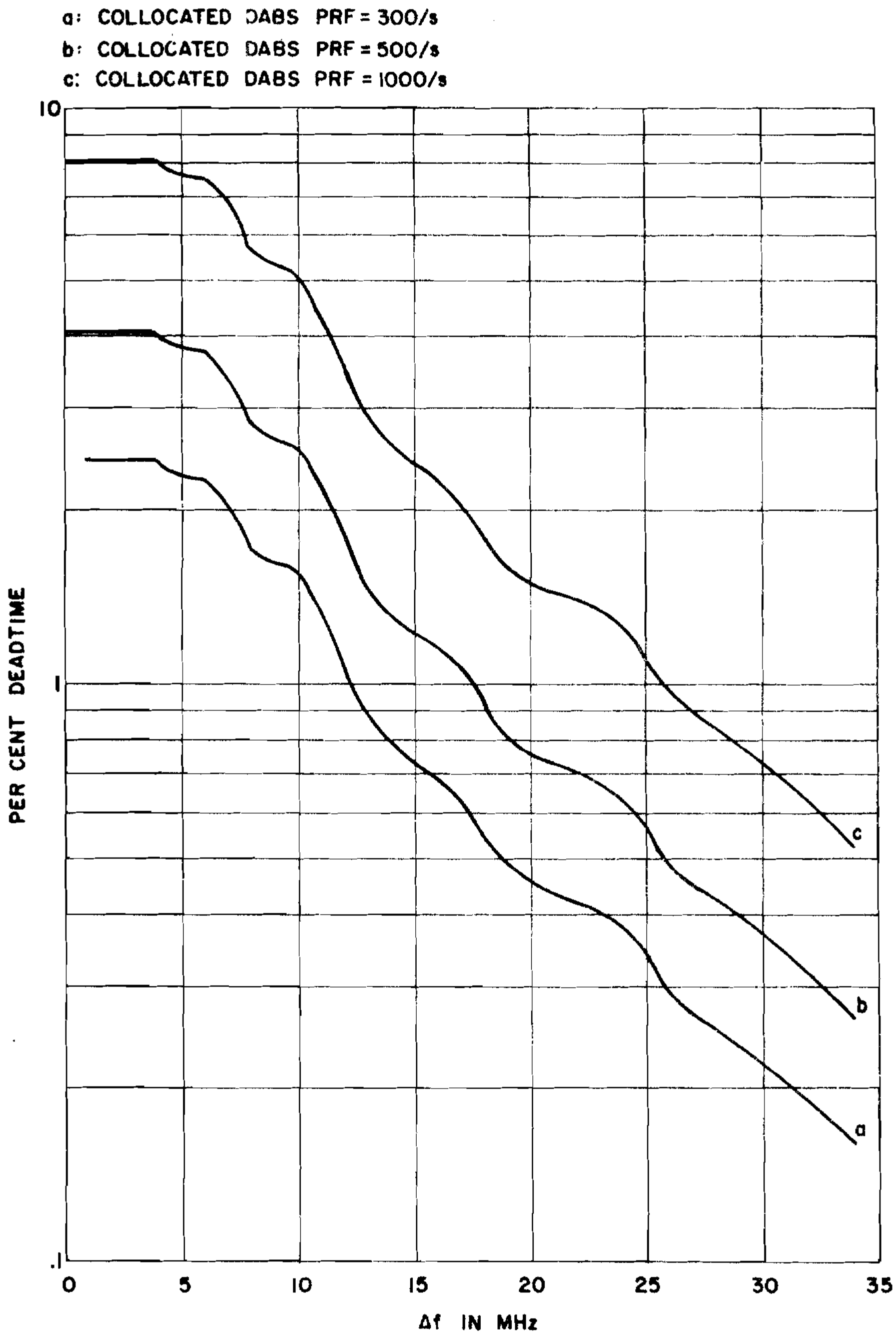


Figure B-5. Percent deadtime vs Δf for RTB-2 X mode, DABS format #2.

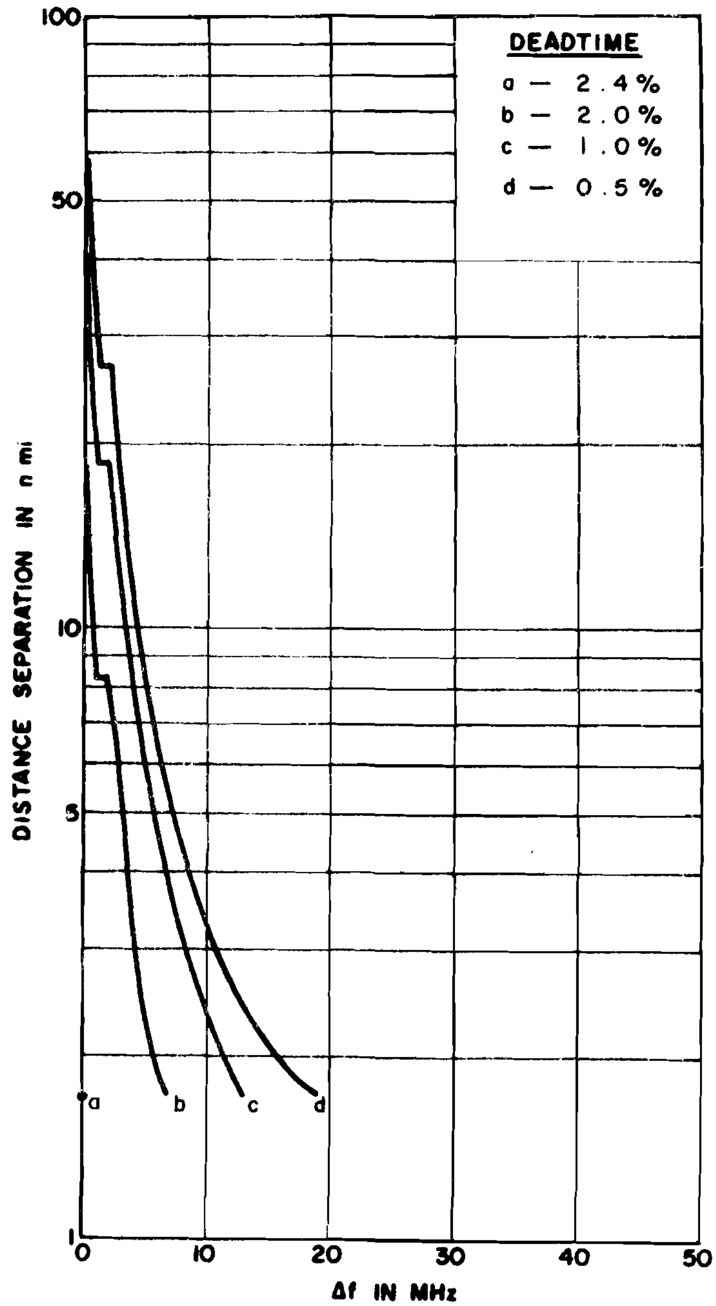


Figure B-6. Distance separation vs Δf for RTB-2 X mode, DABS format #2, DABS PRF = 300/s.

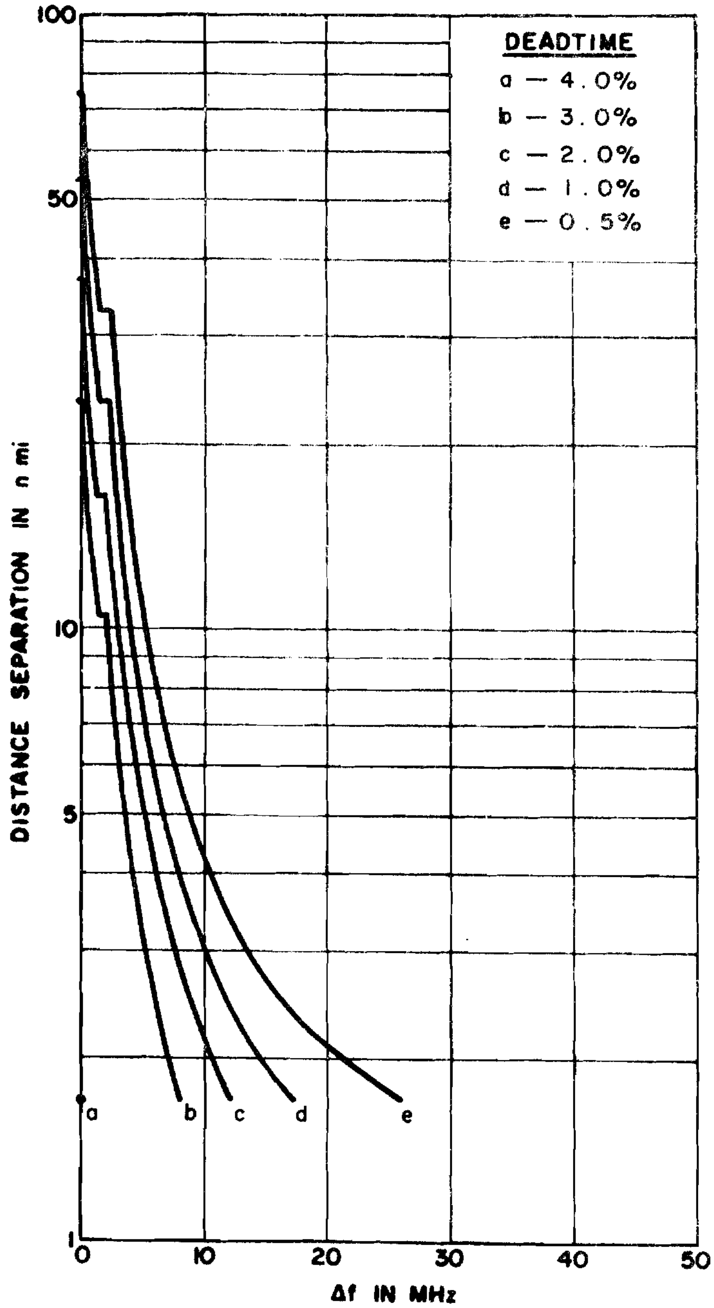


Figure B-7. Distance separation vs Δf for RTB-2 X mode, DABS format #2, DABS PRF = 500/s.

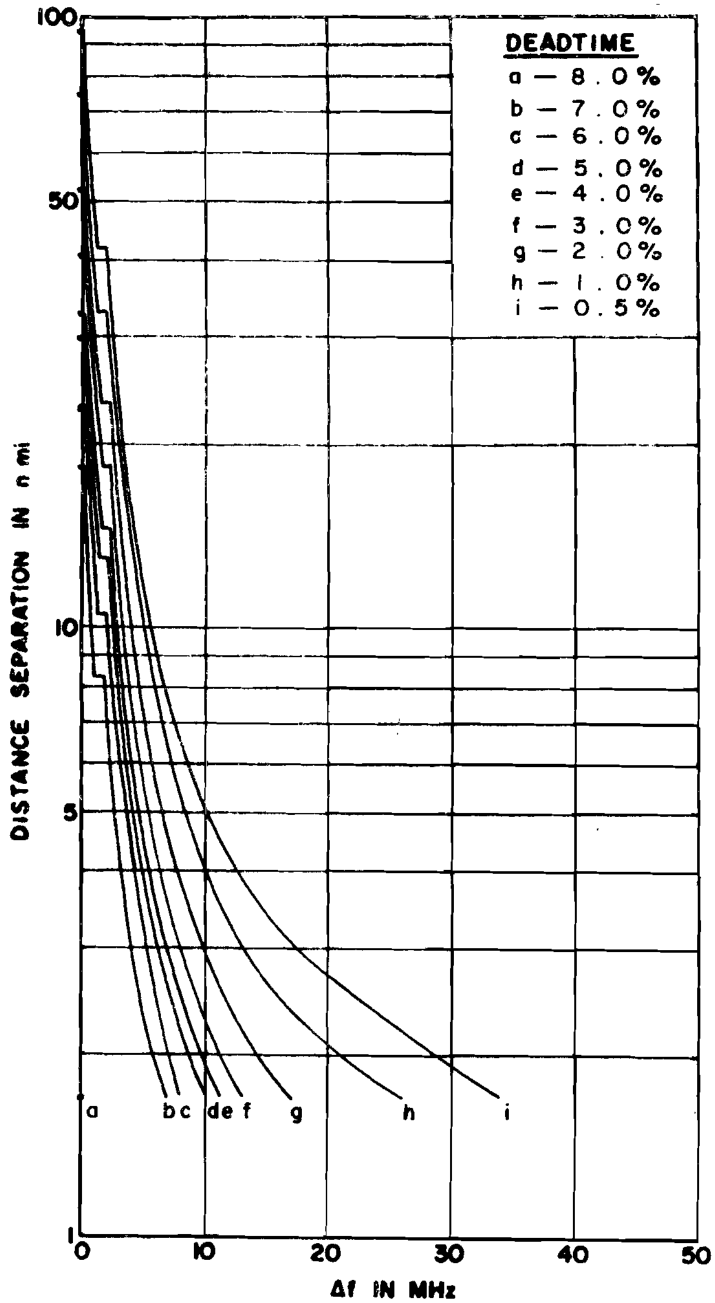


Figure B-8. Distance separation vs Δf for RTB-2 X mode, DABS format #2, DABS PRF = 1000/s.

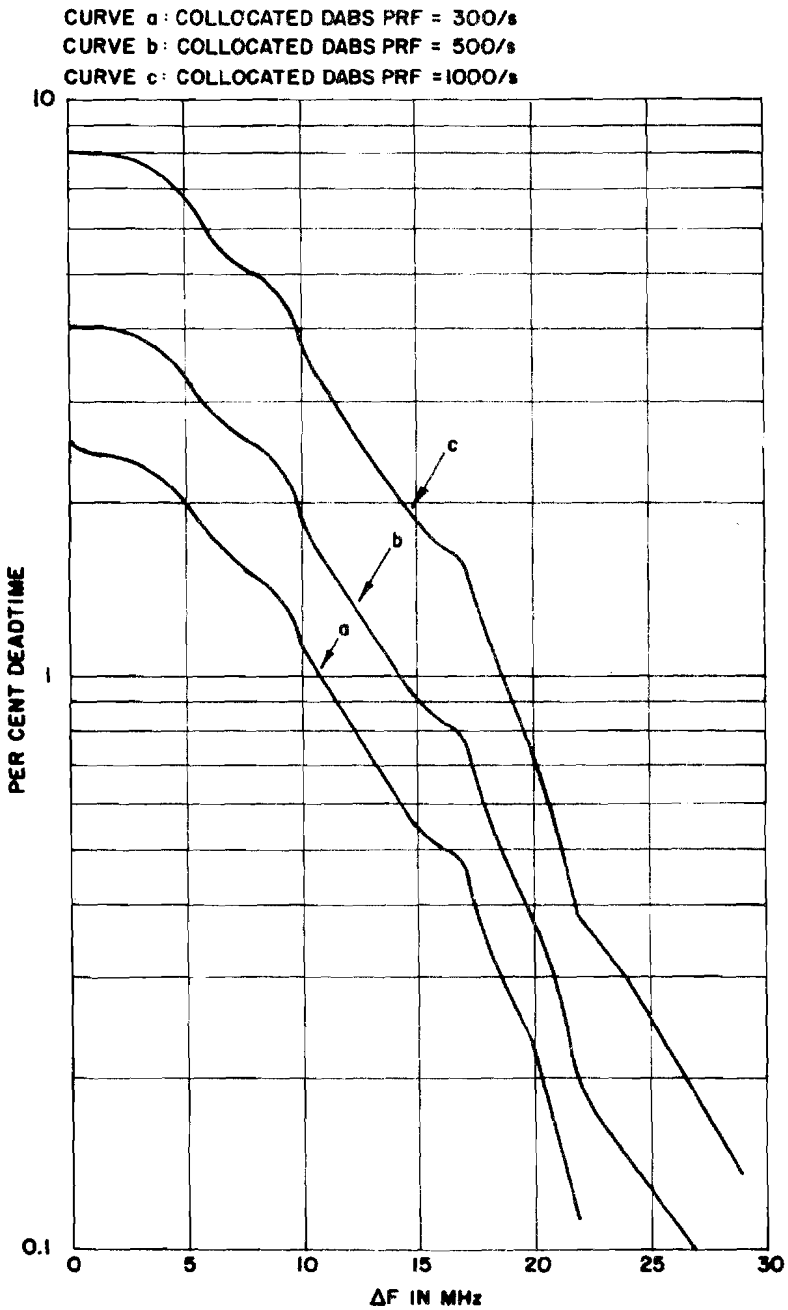


Figure B-9. Percent deadtime vs Δf for RTB-2 X mode, DABS format #3.

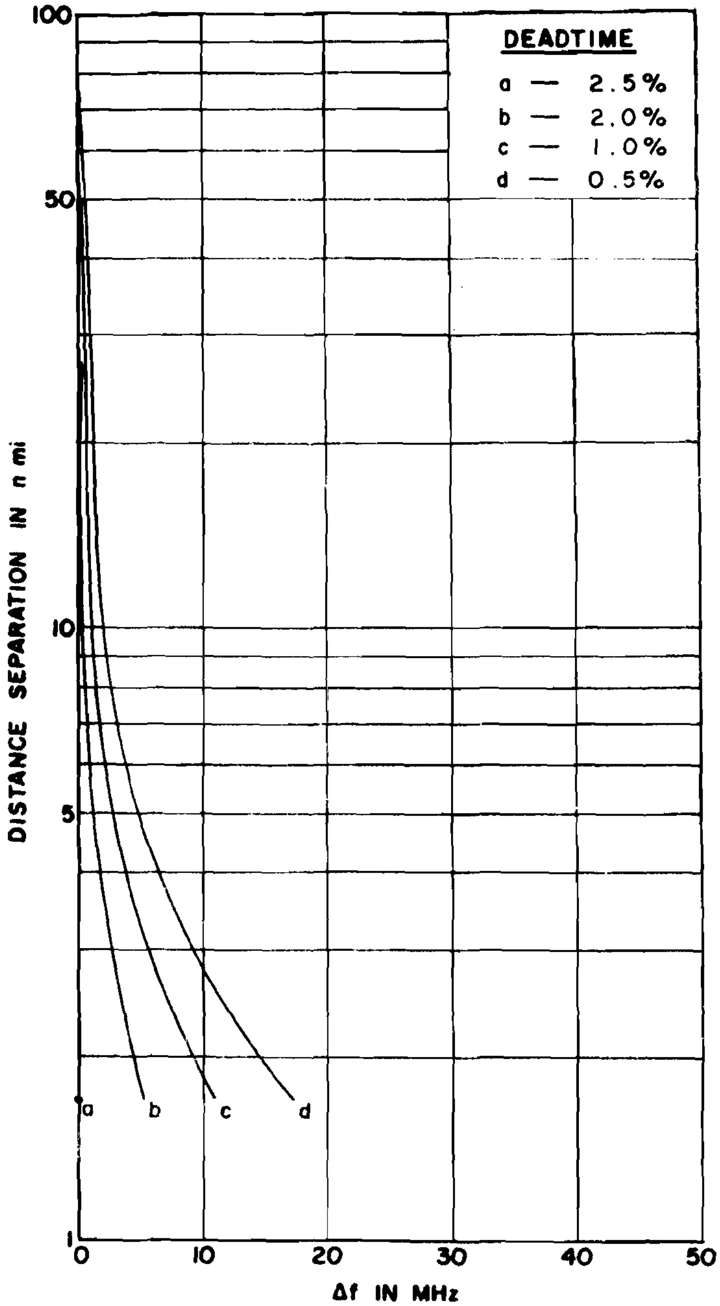


Figure B-10. Distance separation vs Δf for RTB-2, DABS format #3, DABS PRF = 300/s.

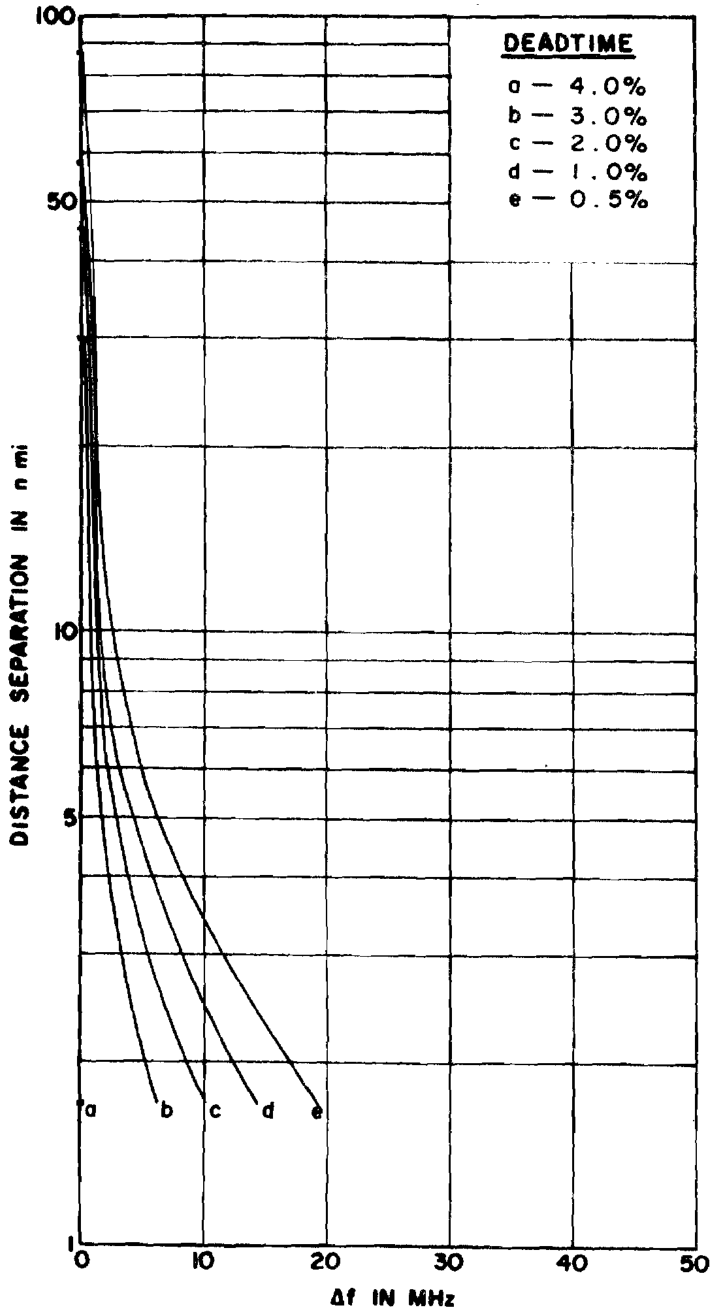


Figure B-11. Distance separation vs Δf for RTB-2 X mode, DABS format #3, DABS PRF = 500/s.

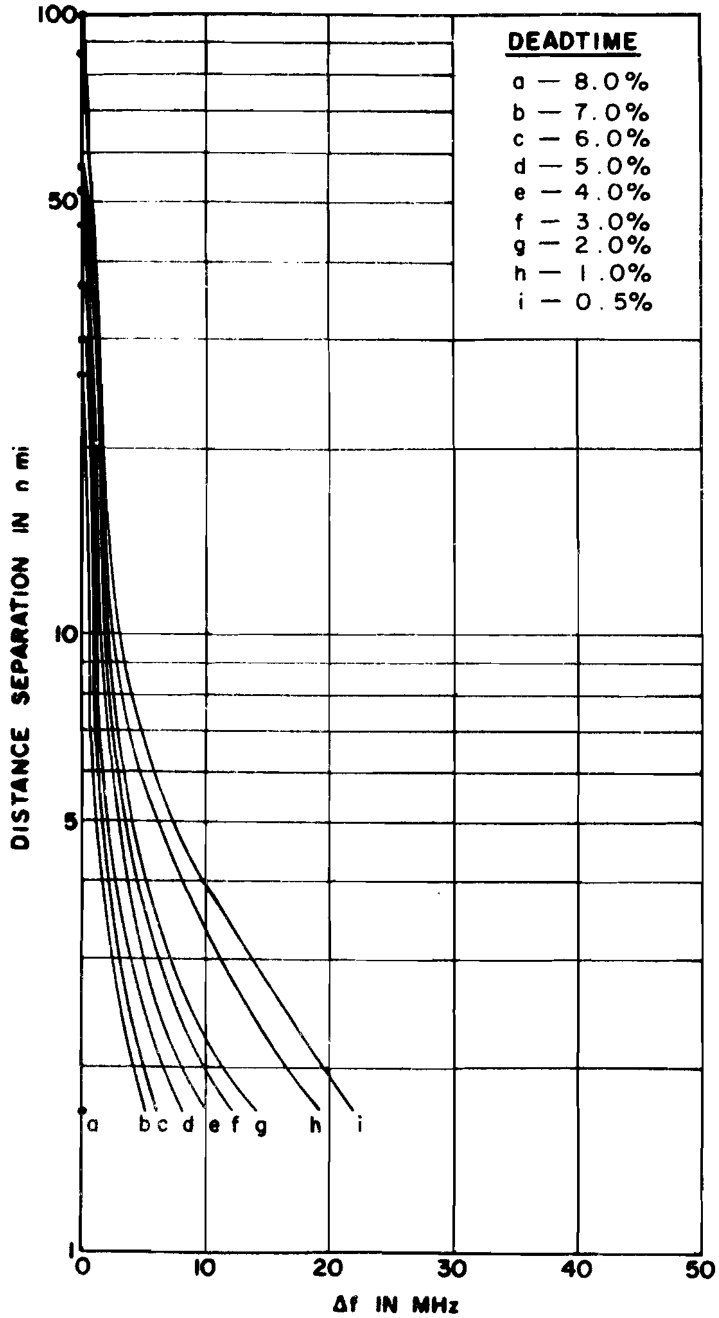


Figure B-12. Distance separation vs Δf for RTB-2 X mode, DABS format #3, DABS PRF = 1000/s.

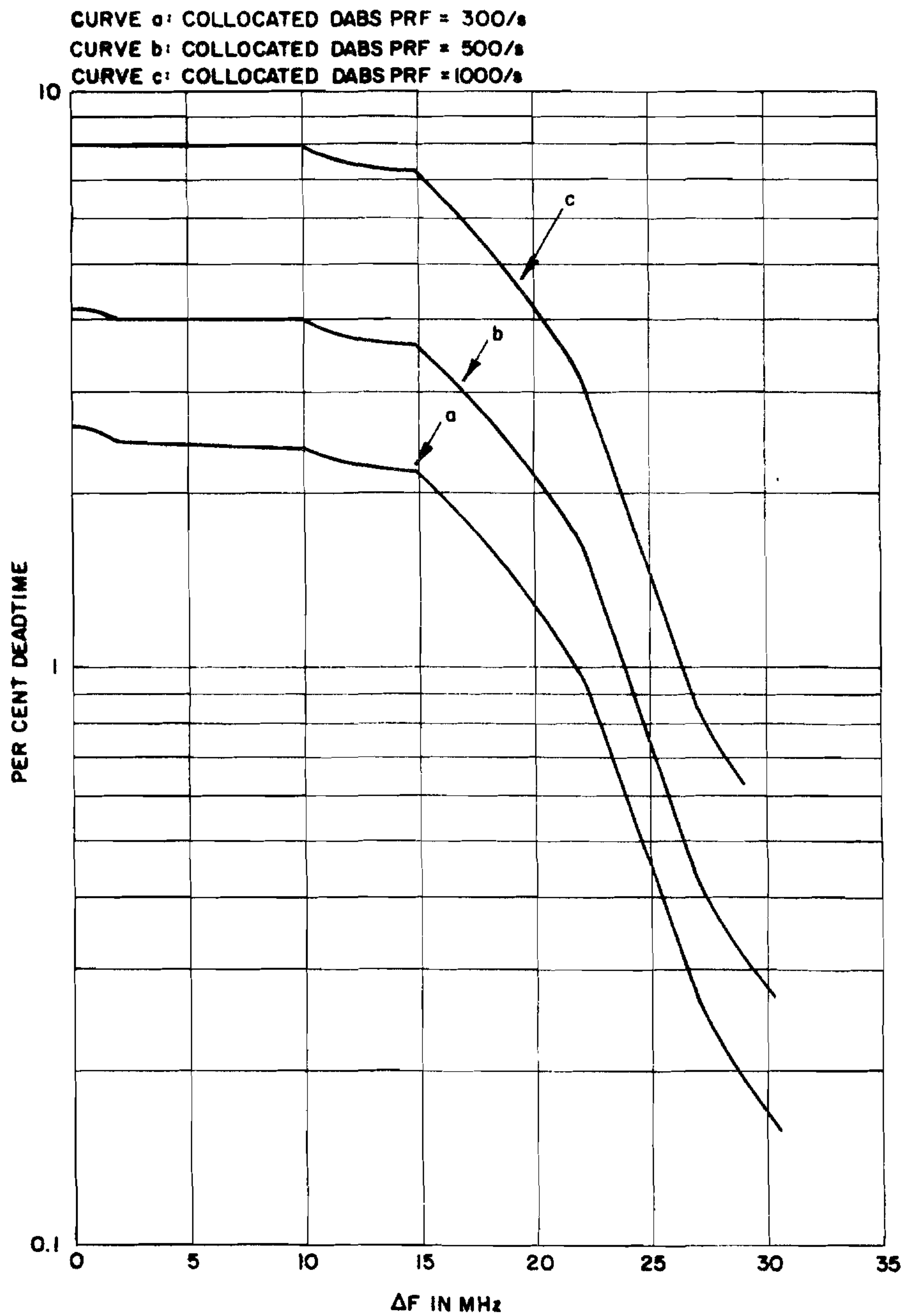


Figure B-13. Percent deadtime vs Δf for RTB-2 X mode, DABS format #4.

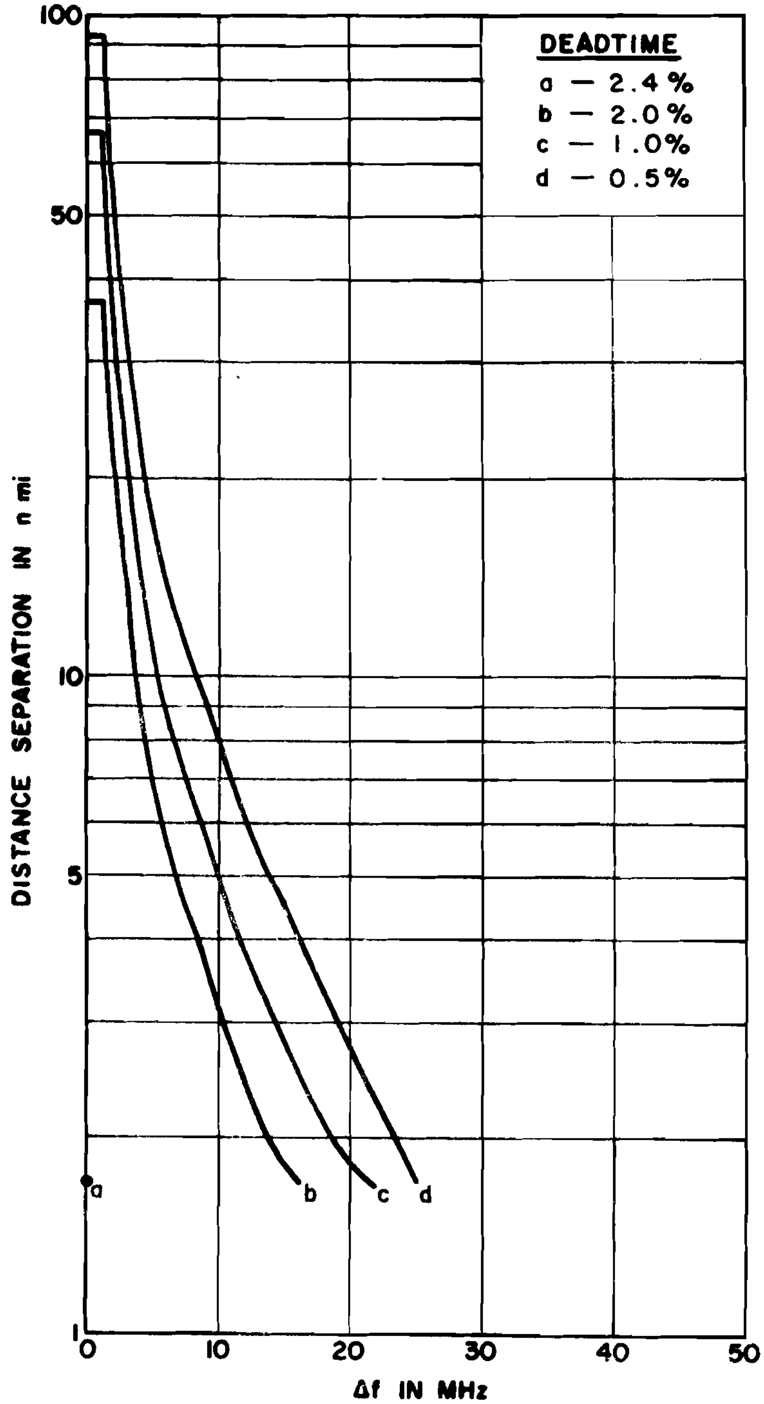


Figure B-14. Distance separation vs Δf for RTB-2 X mode, DABS format #4, DABS PRF = 300/s.

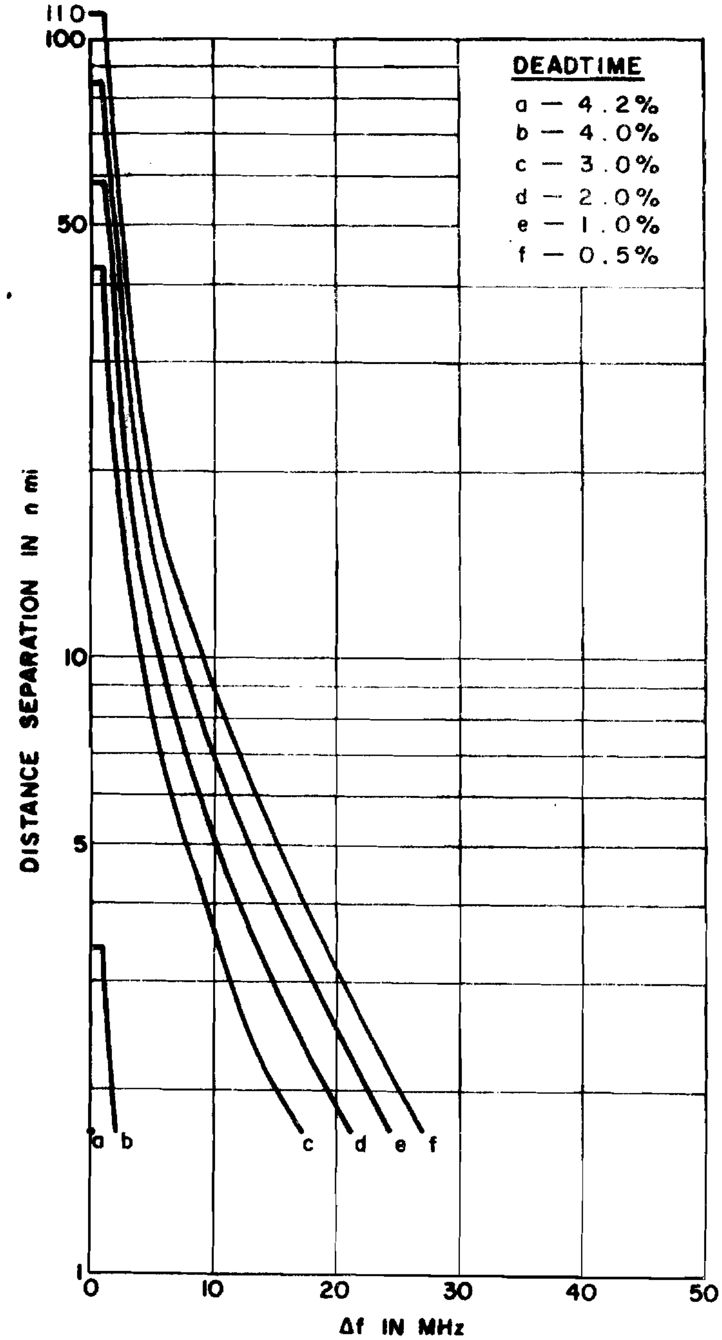


Figure B-15. Distance separation vs Δf for RTB-2 X mode, DABS format #4, DABS PRF = 500/s.

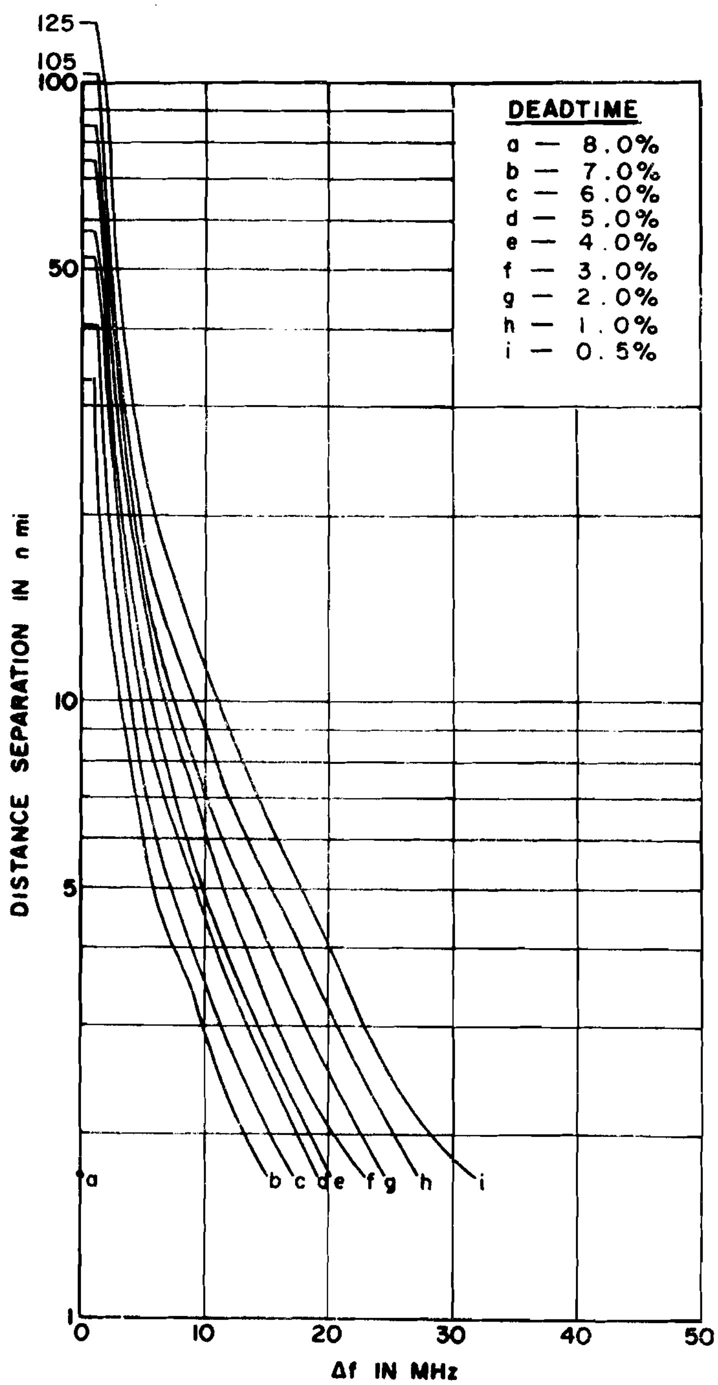


Figure B-16. Distance separation vs Δf for RTB-2 X mode, DABS format #4, DABS PRF = 1000/s.

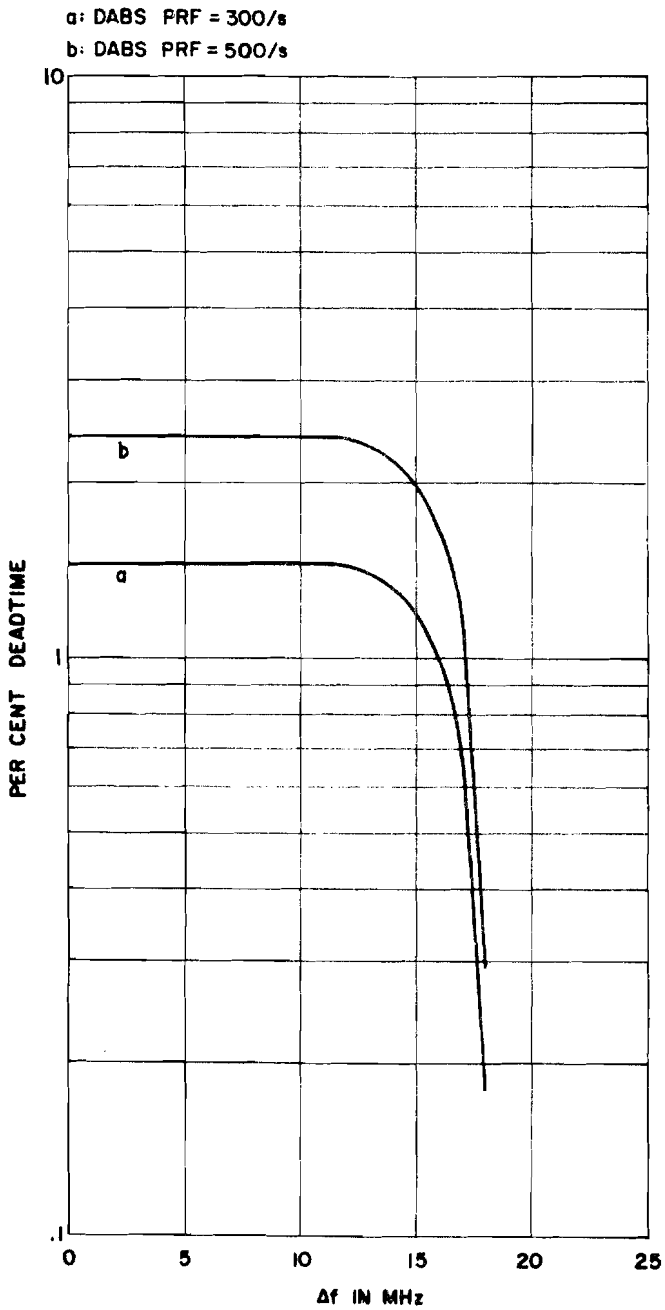


Figure B-17. Percent deadtime vs Δf for RTB-2 X mode, DABS format #5, P_T = 250W.

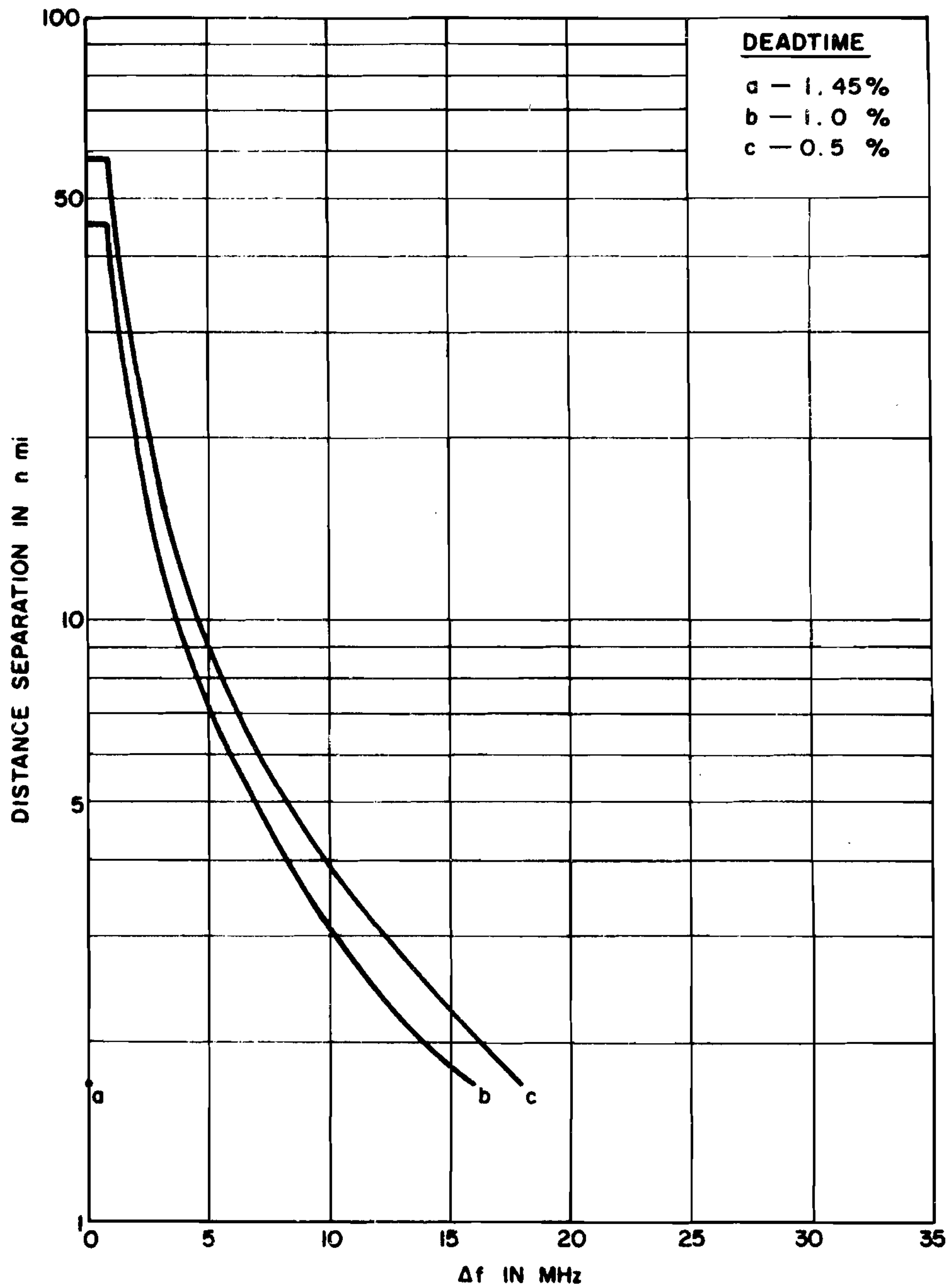


Figure B-18. Distance separation vs Δf for RTE-2 X mode, DABS format #5, P_T = 250 W, DABS PRF = 300/s.

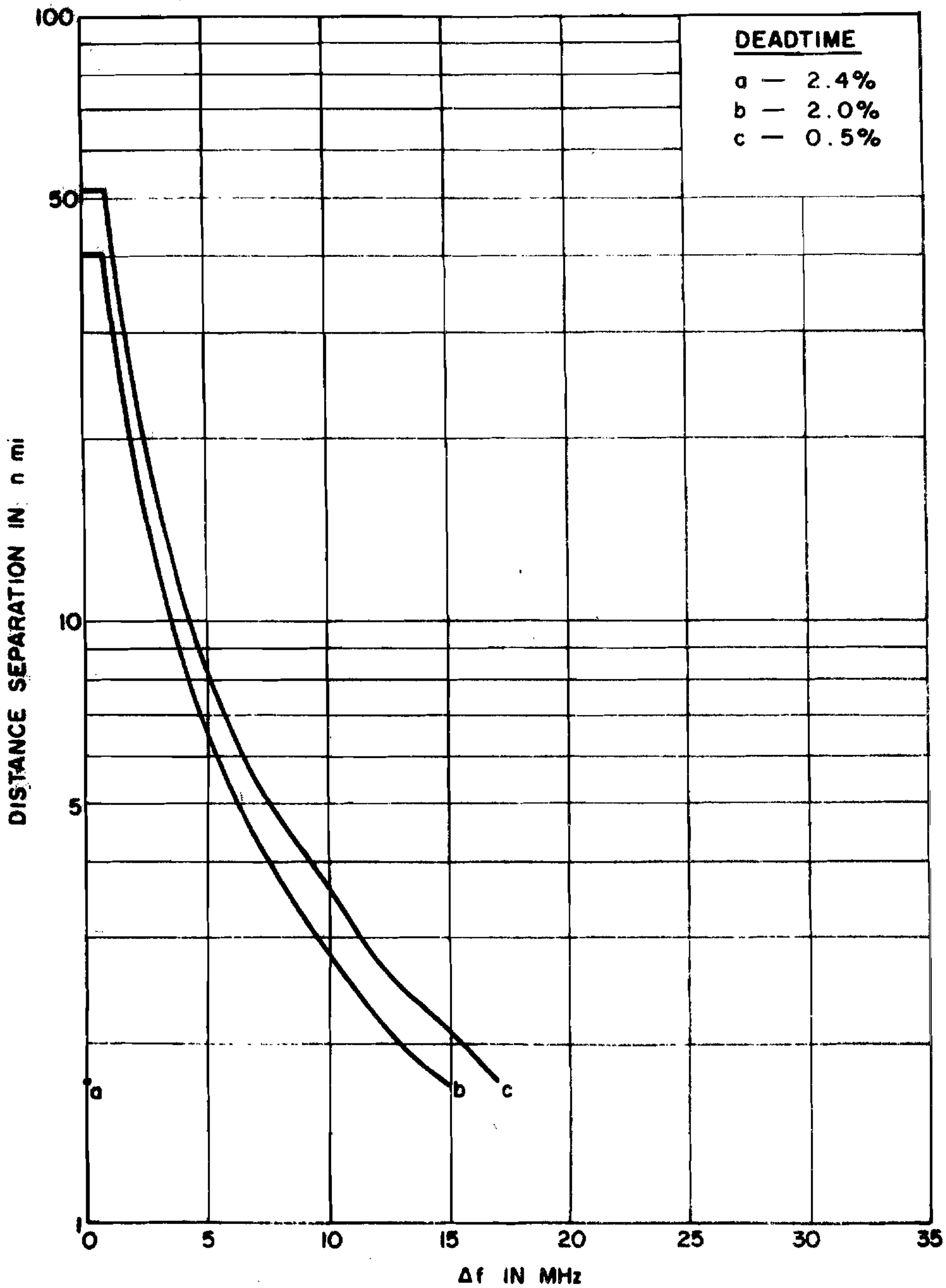


Figure B-19. Distance separation vs Δf for RTB-2 X mode, DABS format #5, P_T = 250W, DABS PRF = 500/s.

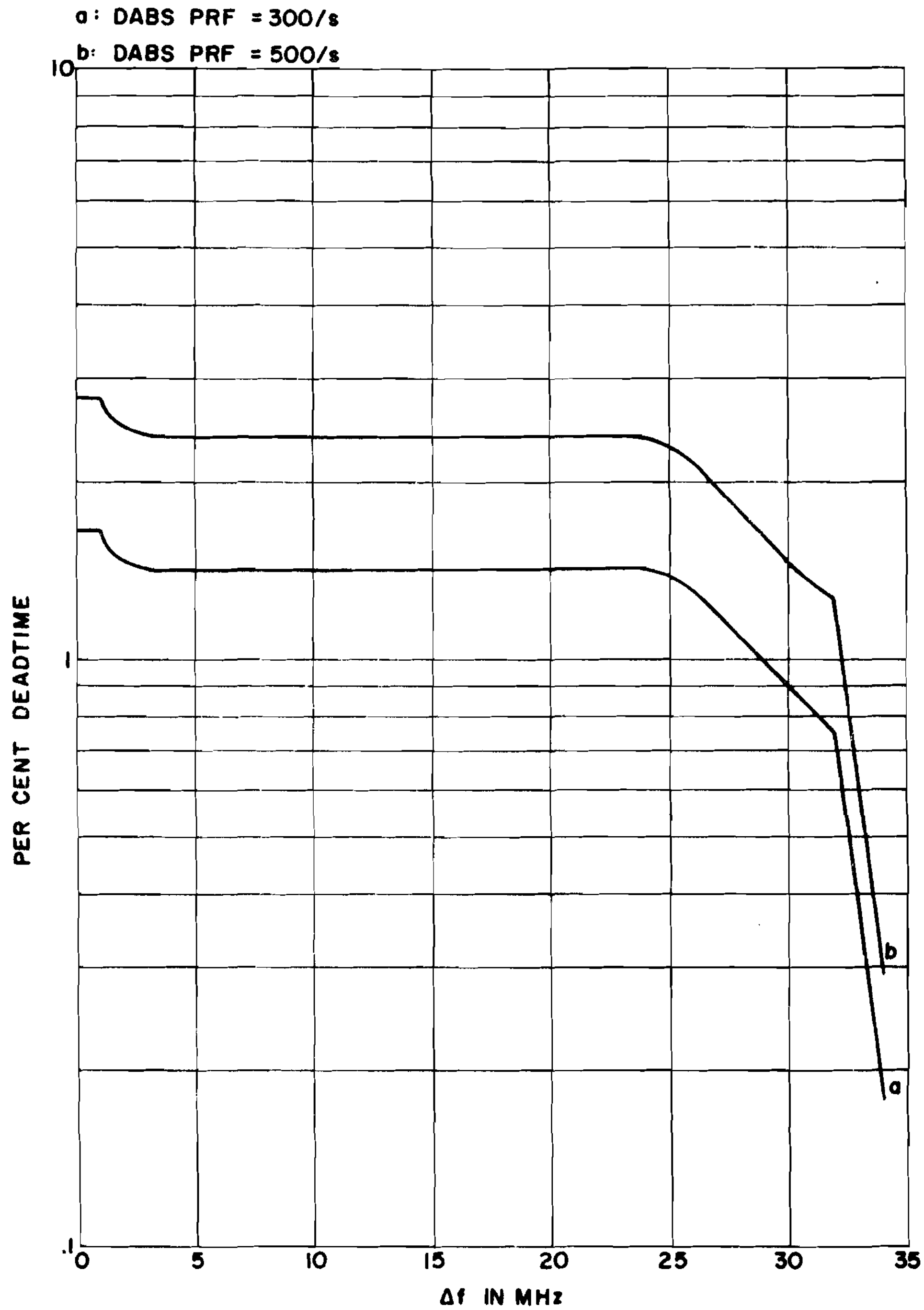


Figure B-20. Percent deadtime vs Δf for RTB-2 X mode, DABS format #5, P_T = 2.5 kW.

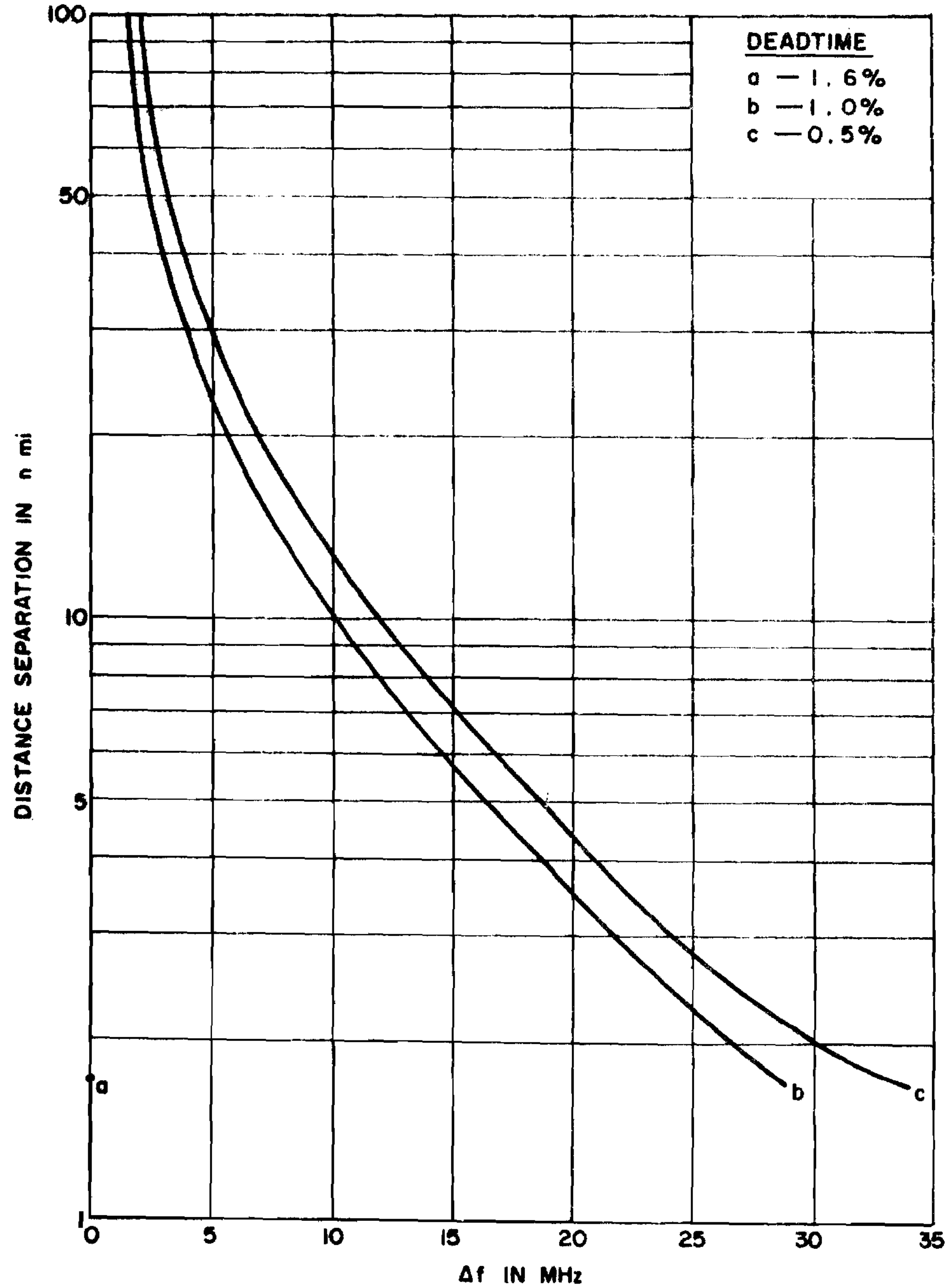


Figure B-21. Distance separation vs Δf for RTB-2 X mode, DABS format #5, P_T = 2.5 kW, DABS PRF = 300/s.

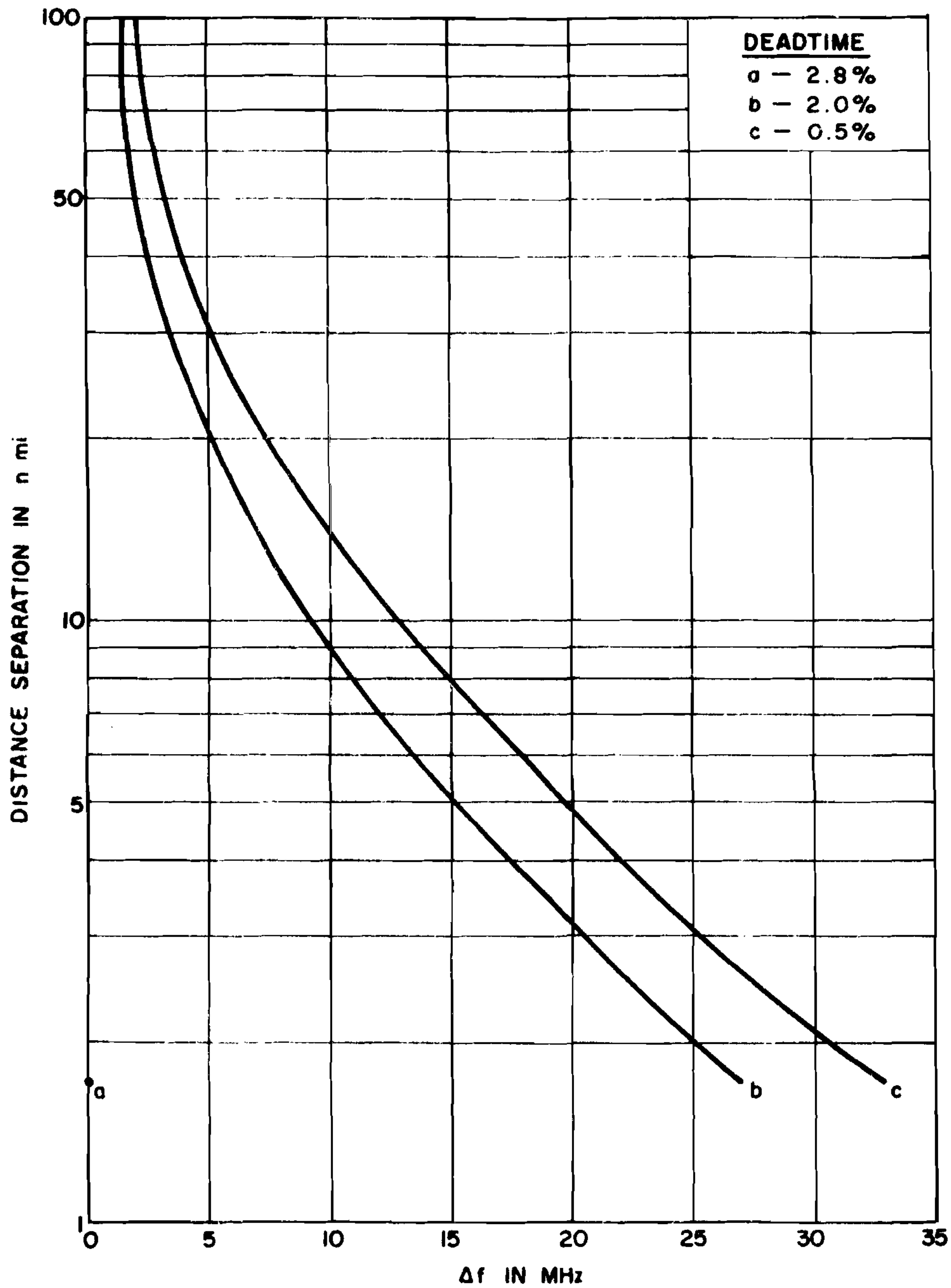


Figure B-22. Distance separation vs Δf for RTB-2 X mode, DABS format #5, P_T = 2.5 kW, DABS PRF = 500/s.

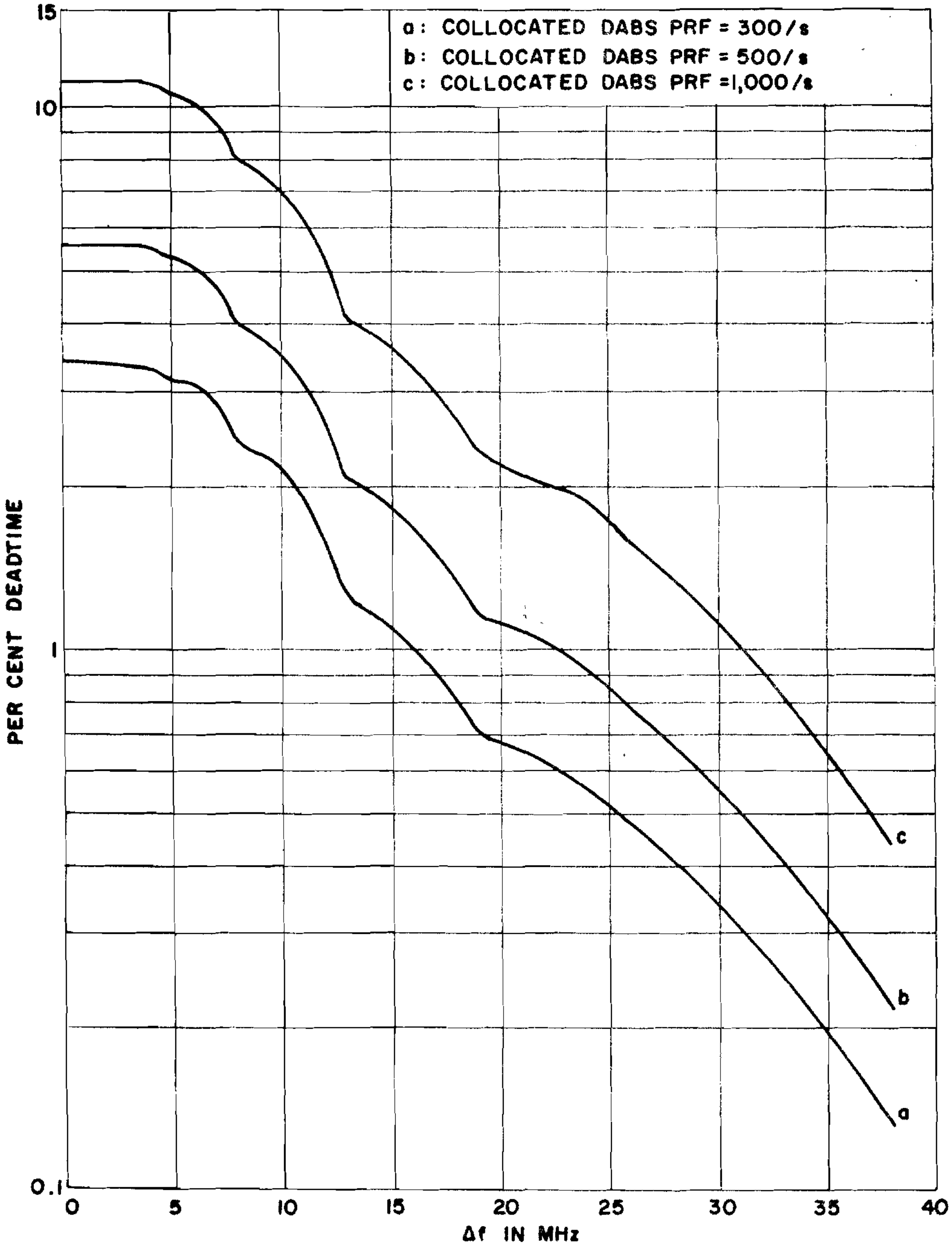


Figure B-23. Percent deadtime vs Δf for RTB-2 Y mode, DABS format #1.

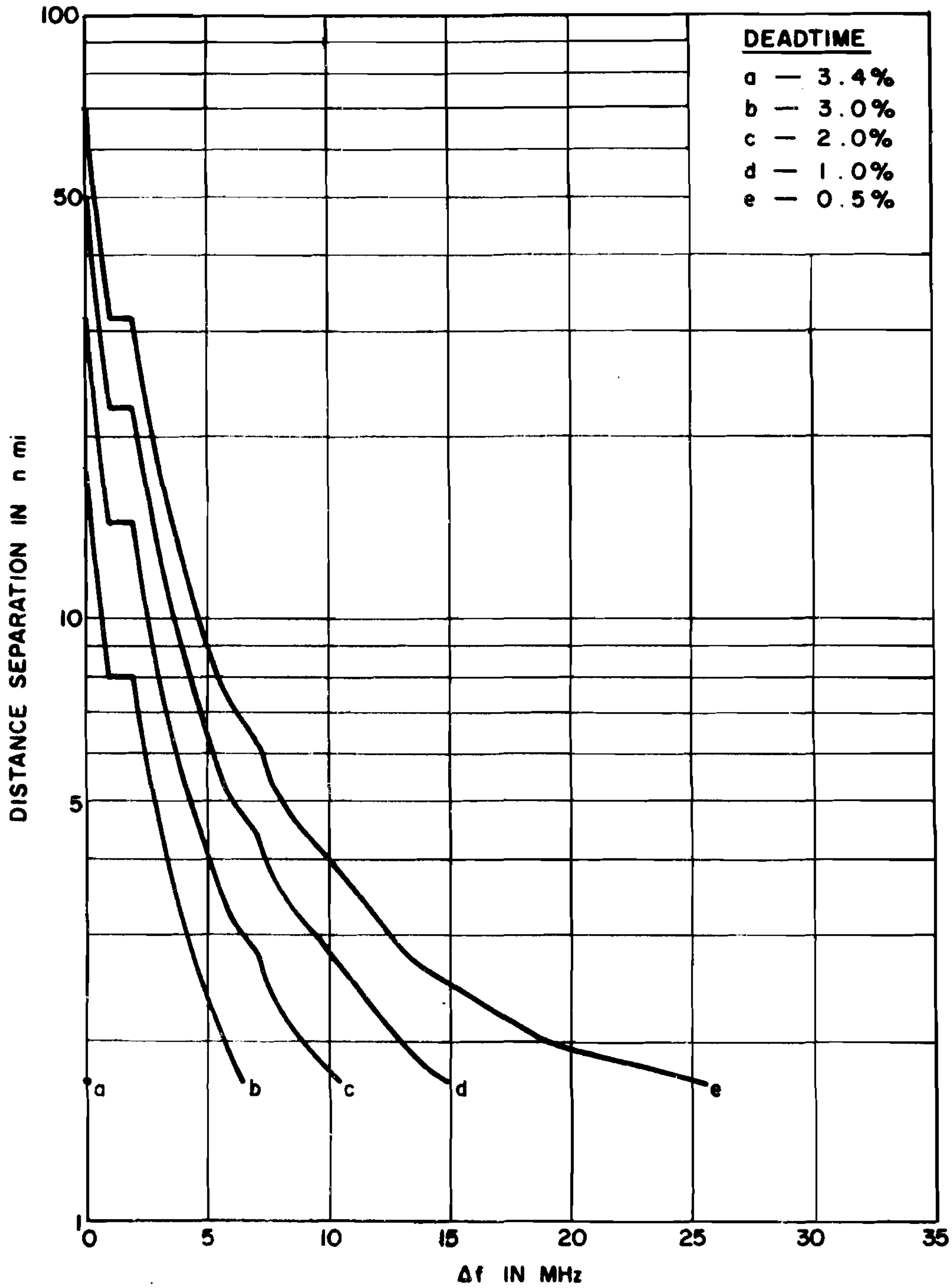


Figure B-24. Distance separation vs Δf for RTB-2 Y mode, DABS format #1, DABS PRF = 300/s.

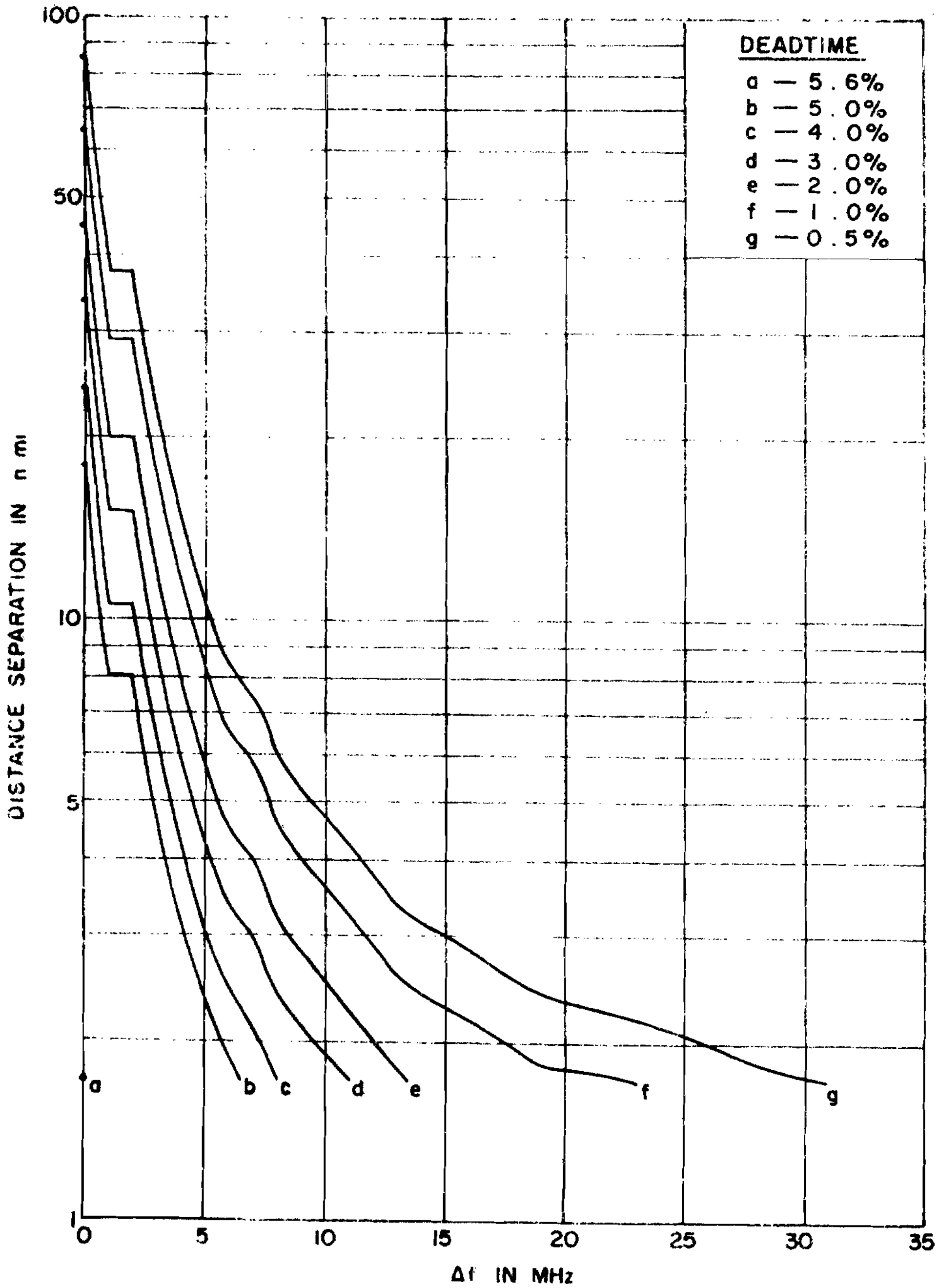


Figure B-25. Distance separation vs Δf for RTB-2 Y mode, DABS format #1, DABS PRF = 500/s.

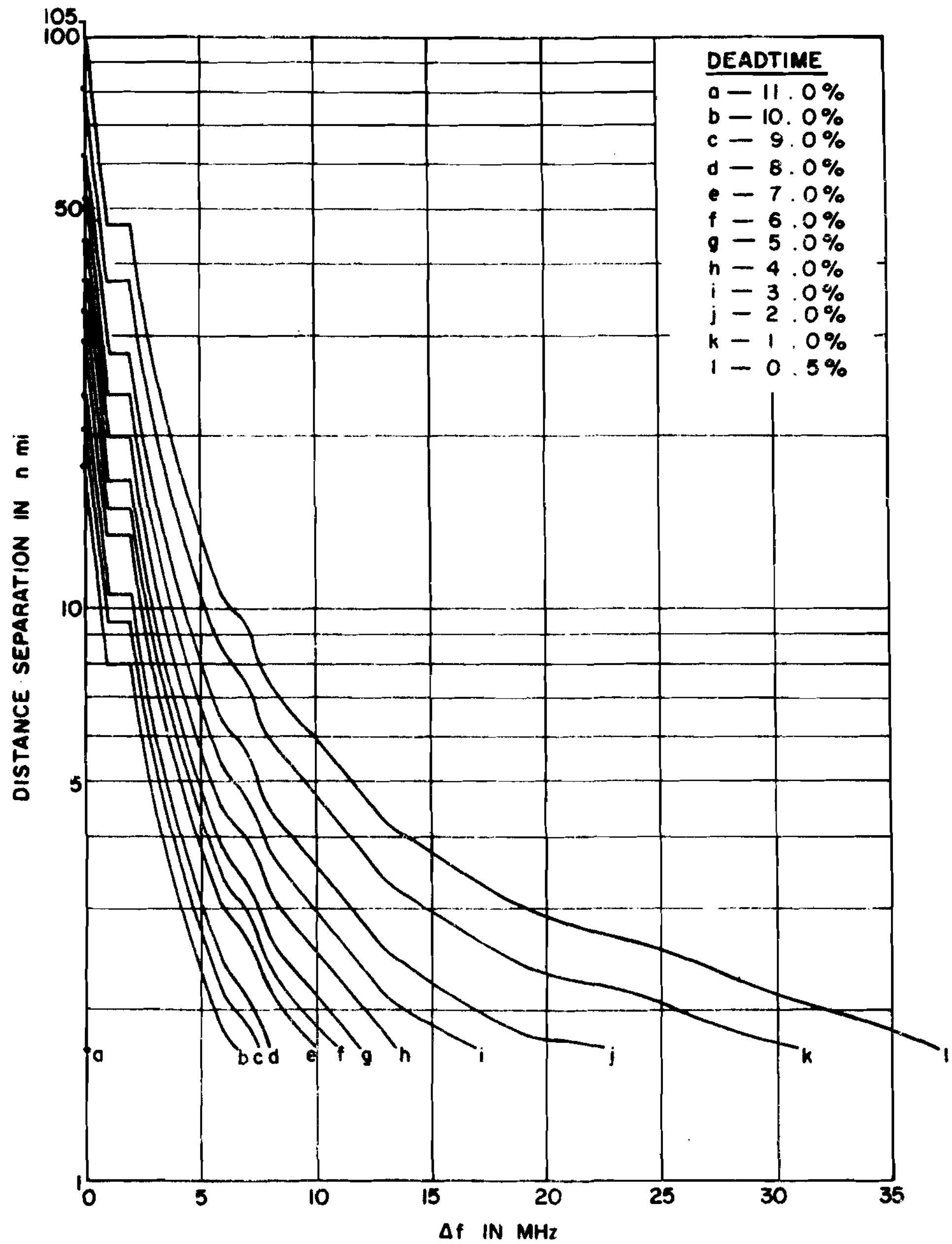


Figure B-26. Distance separation vs Δf for RTB-2 Y mode, DABS format #1, DABS PRF = 1000/s.

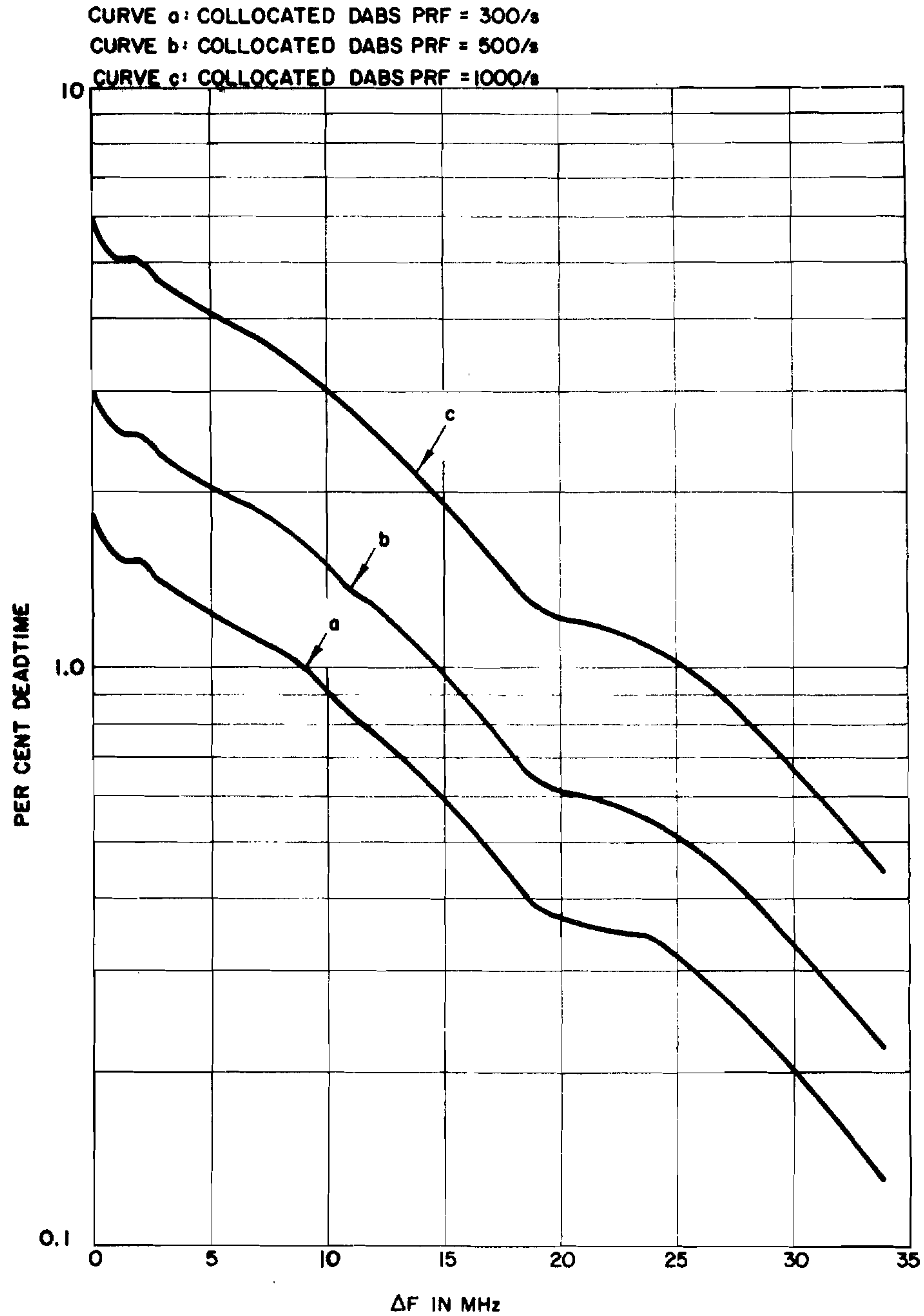


Figure B-27. Percent deadtime vs Δf for RTB-2 Y mode, DABS format #2.

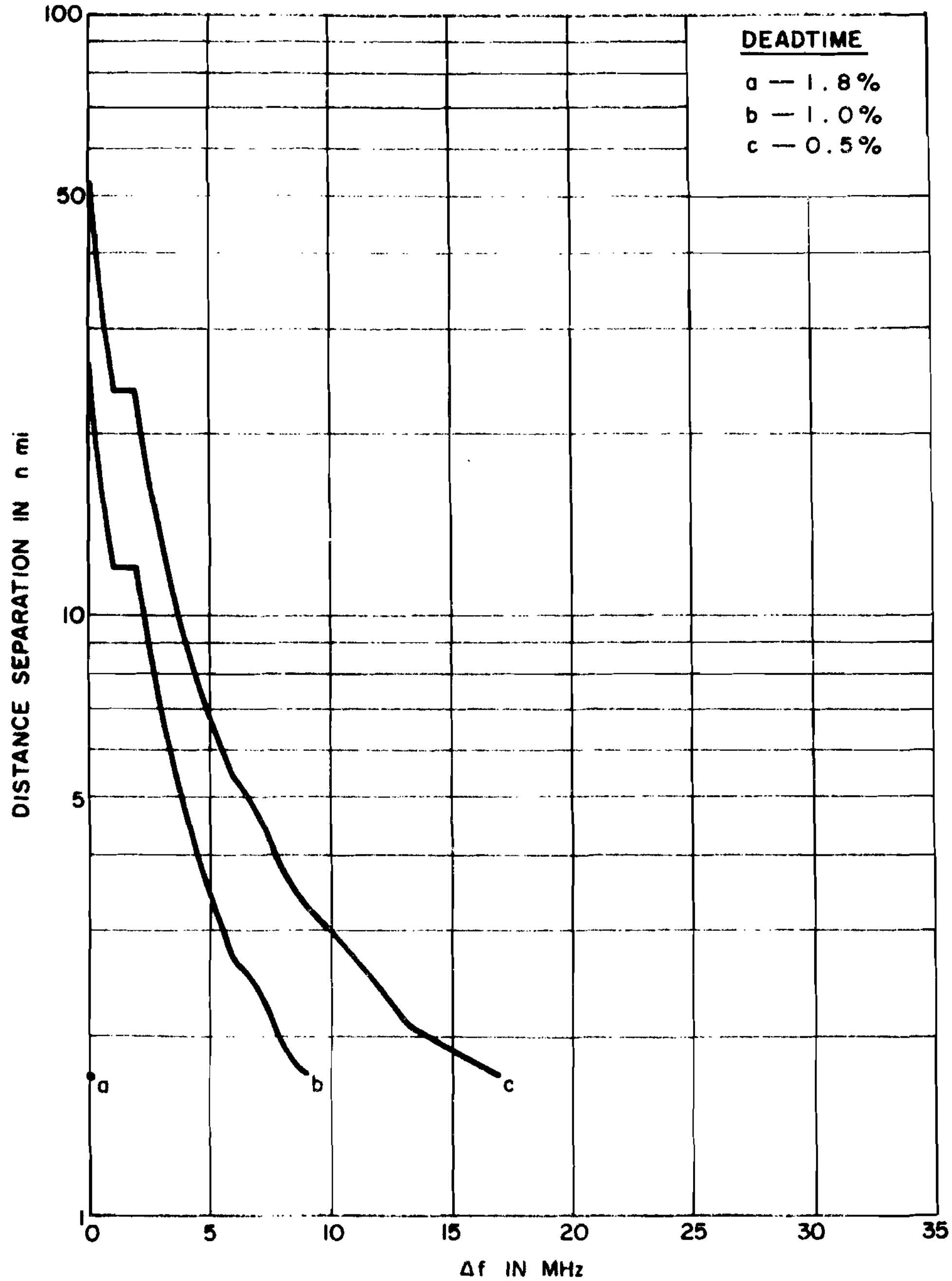


Figure B-28. Distance separation vs Δf for RTB-2 Y mode, DABS format #2, DABS PRF = 300/s.

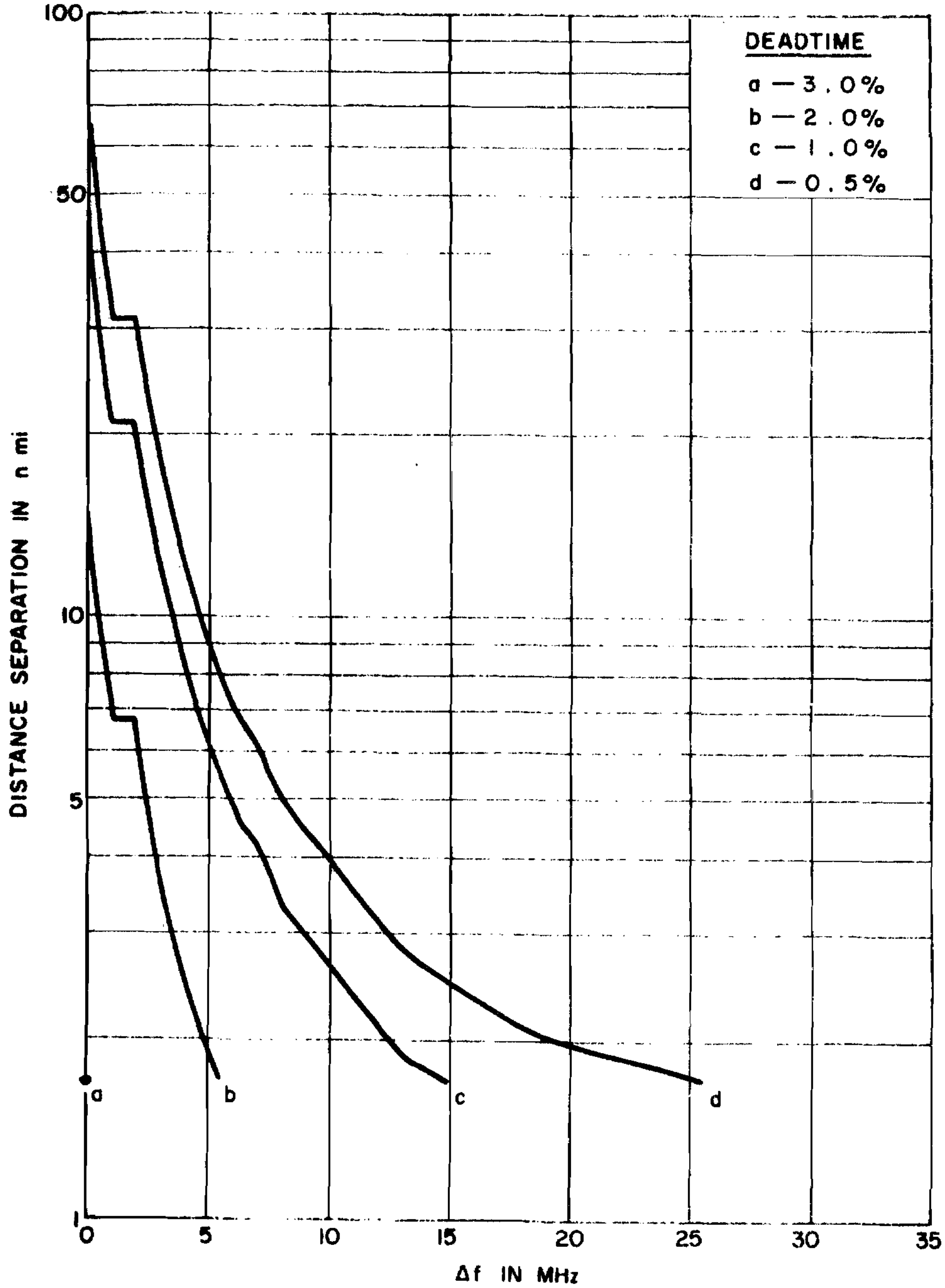


Figure B-29. Distance separation vs Δf for RTB-2 Y mode, DABS format #2, DABS PRF = 500/s.

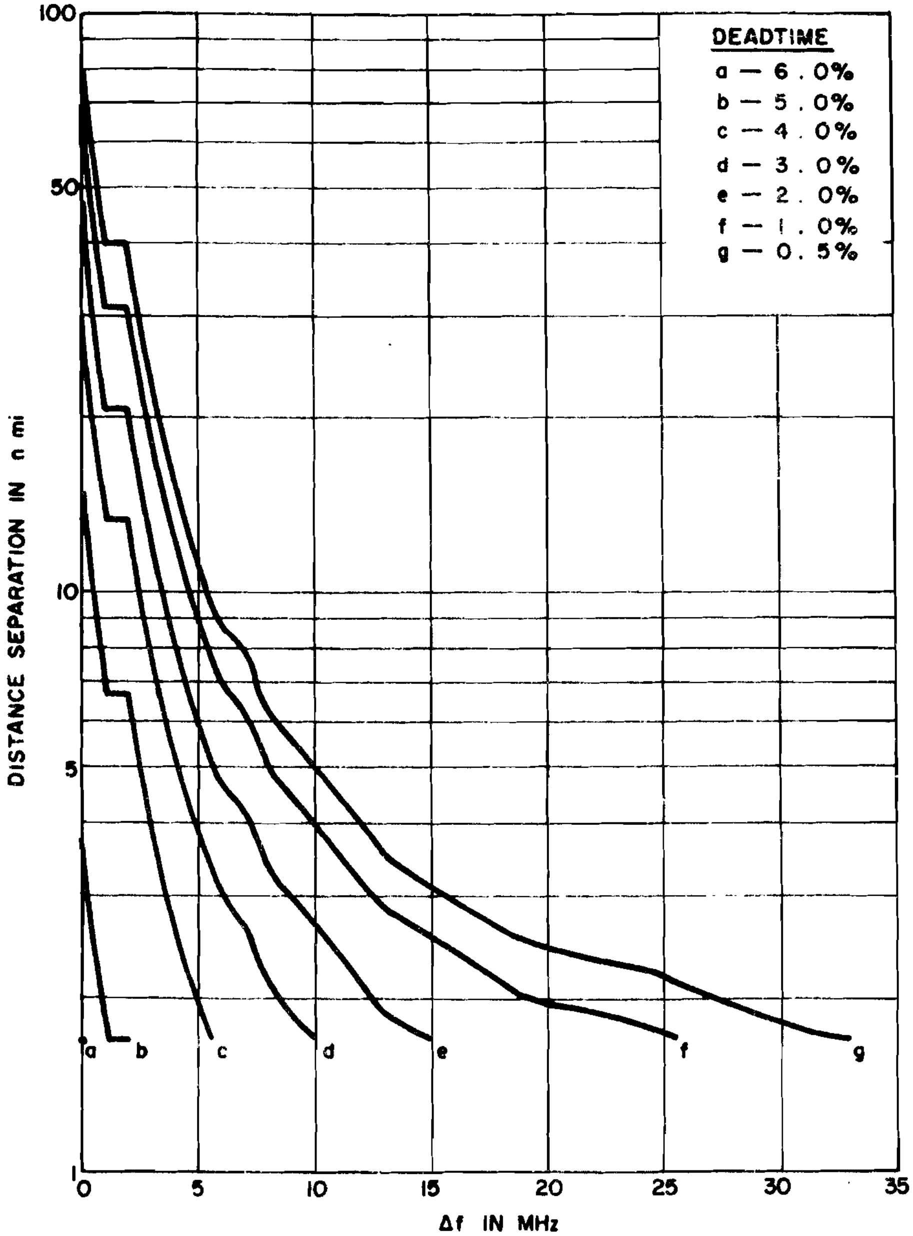


Figure B-30. Distance separation vs Δf for RTB-2 Y mode, DABS format #2, DABS PRF = 1000/s.

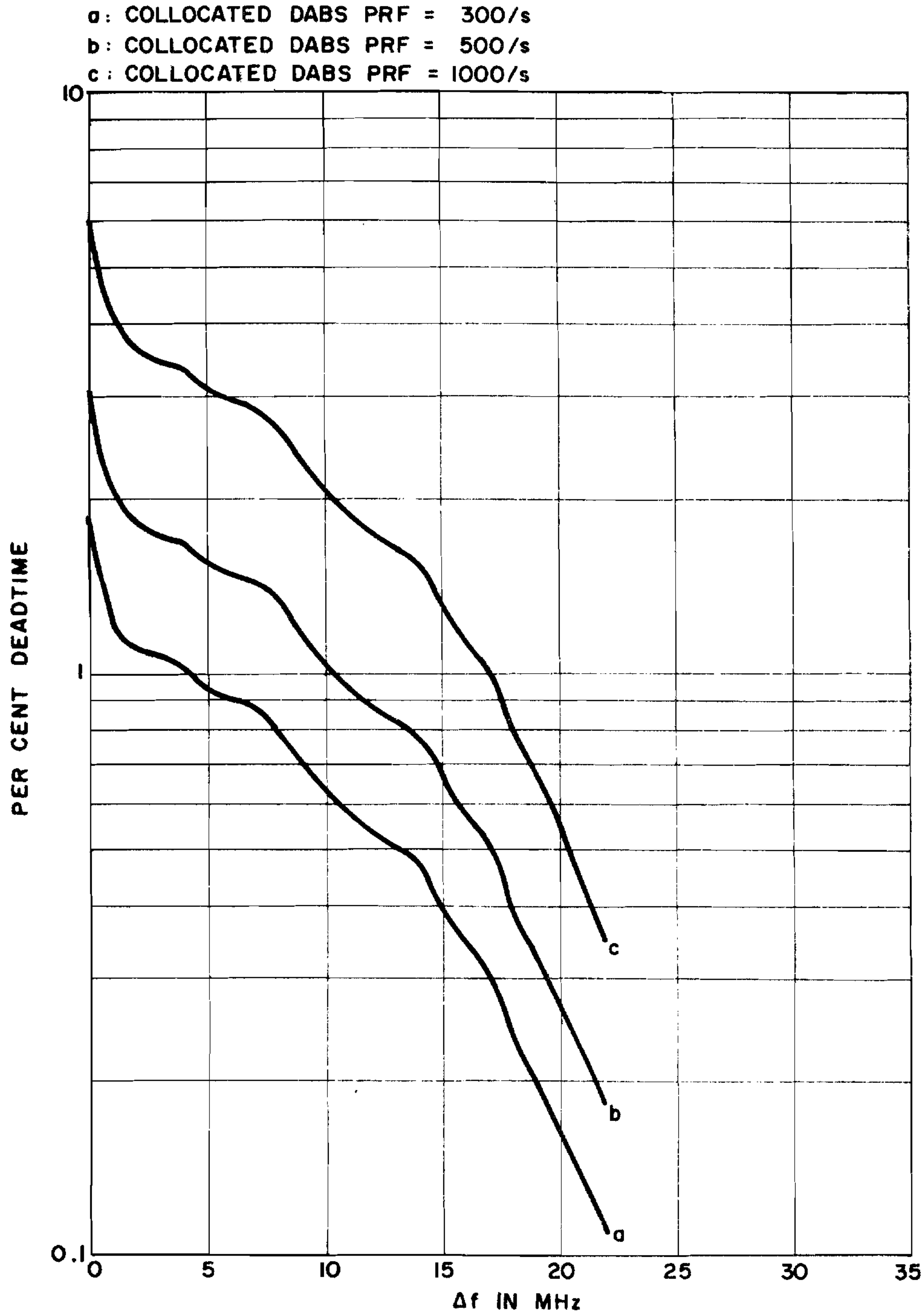


Figure B-31. Percent deadtime vs Δf for RTB-2 Y mode, DABS format #3.

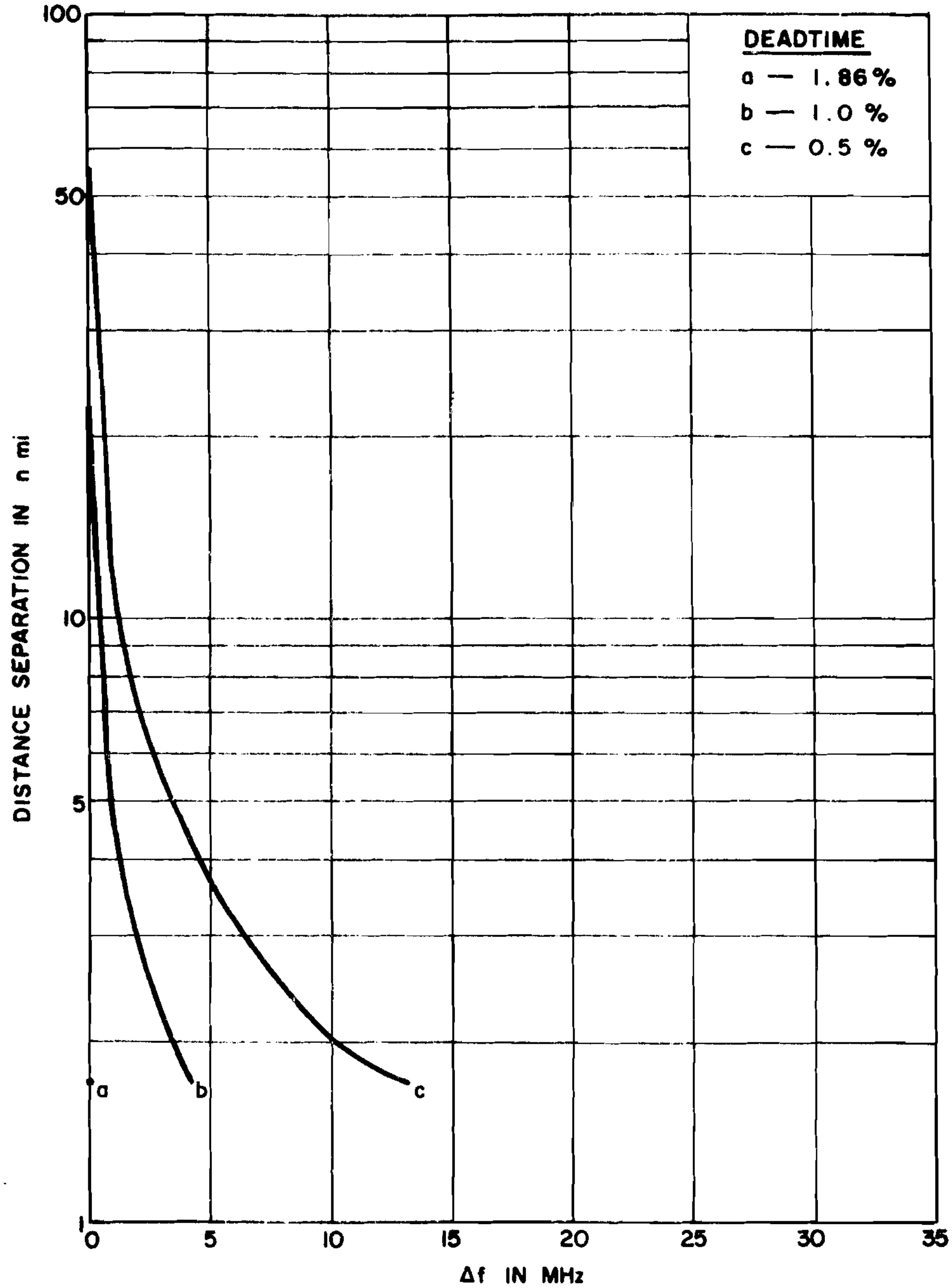


Figure B-32. Distance separation vs Δf for RTB-2 Y mode, DABS format #3, DABS PRF = 300/s.

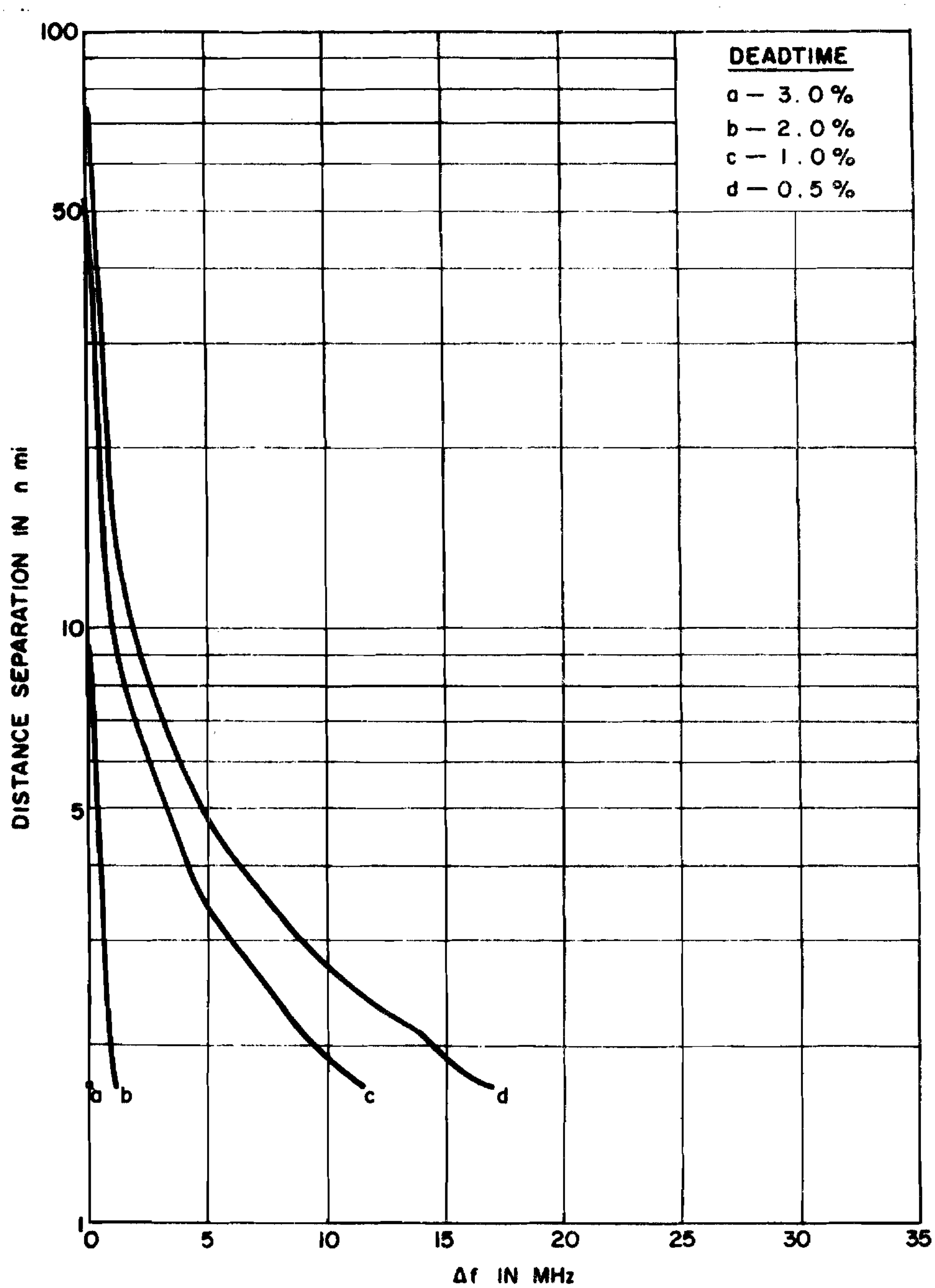


Figure B-33. Distance separation vs Δf for RTB-2 Y mode, DABS format #3, DABS PRF = 500/s.

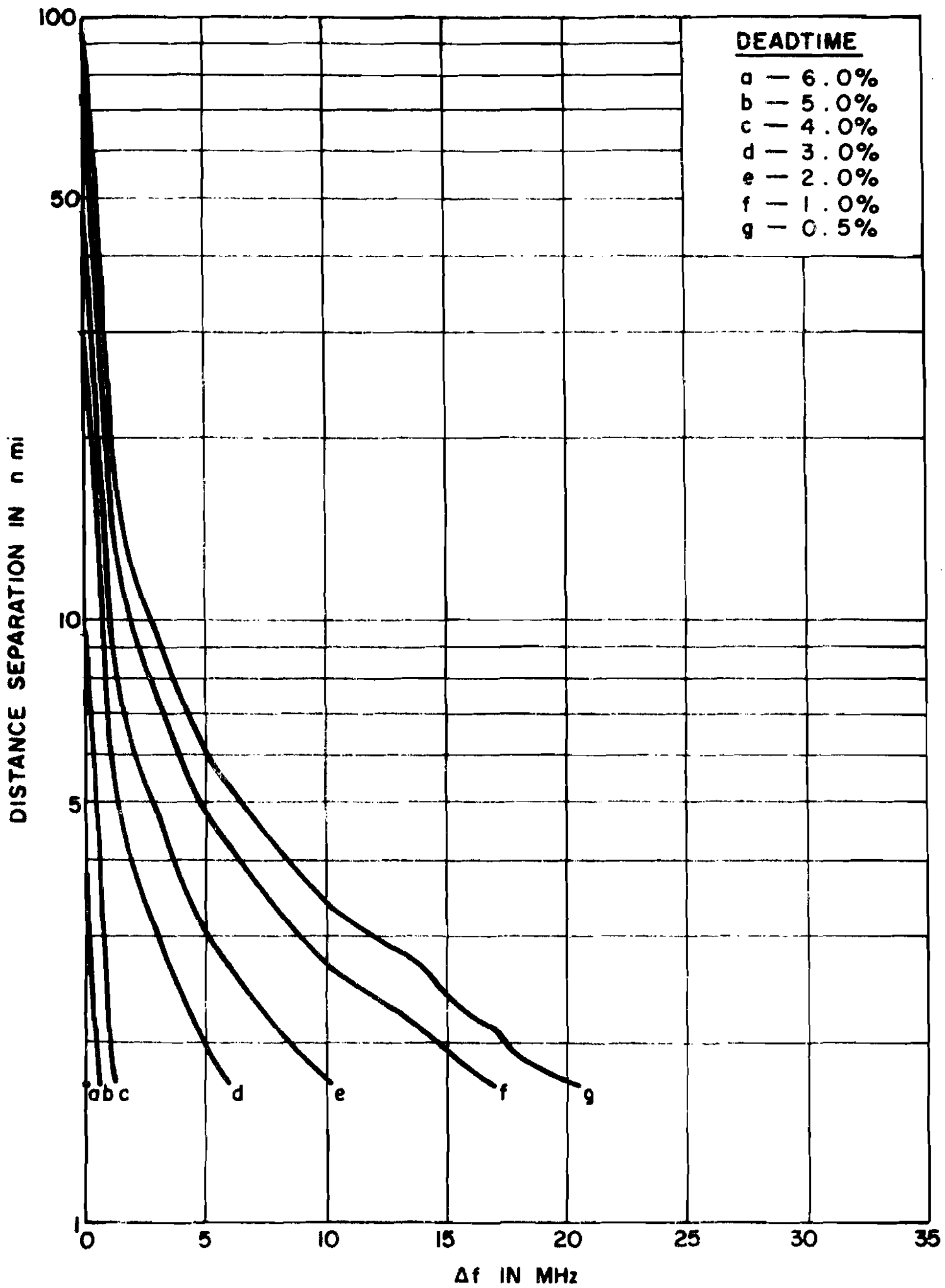


Figure B-34. Distance separation vs Δf for RTB-2 Y mode, DABS format #3, DABS PRF = 1000/s.

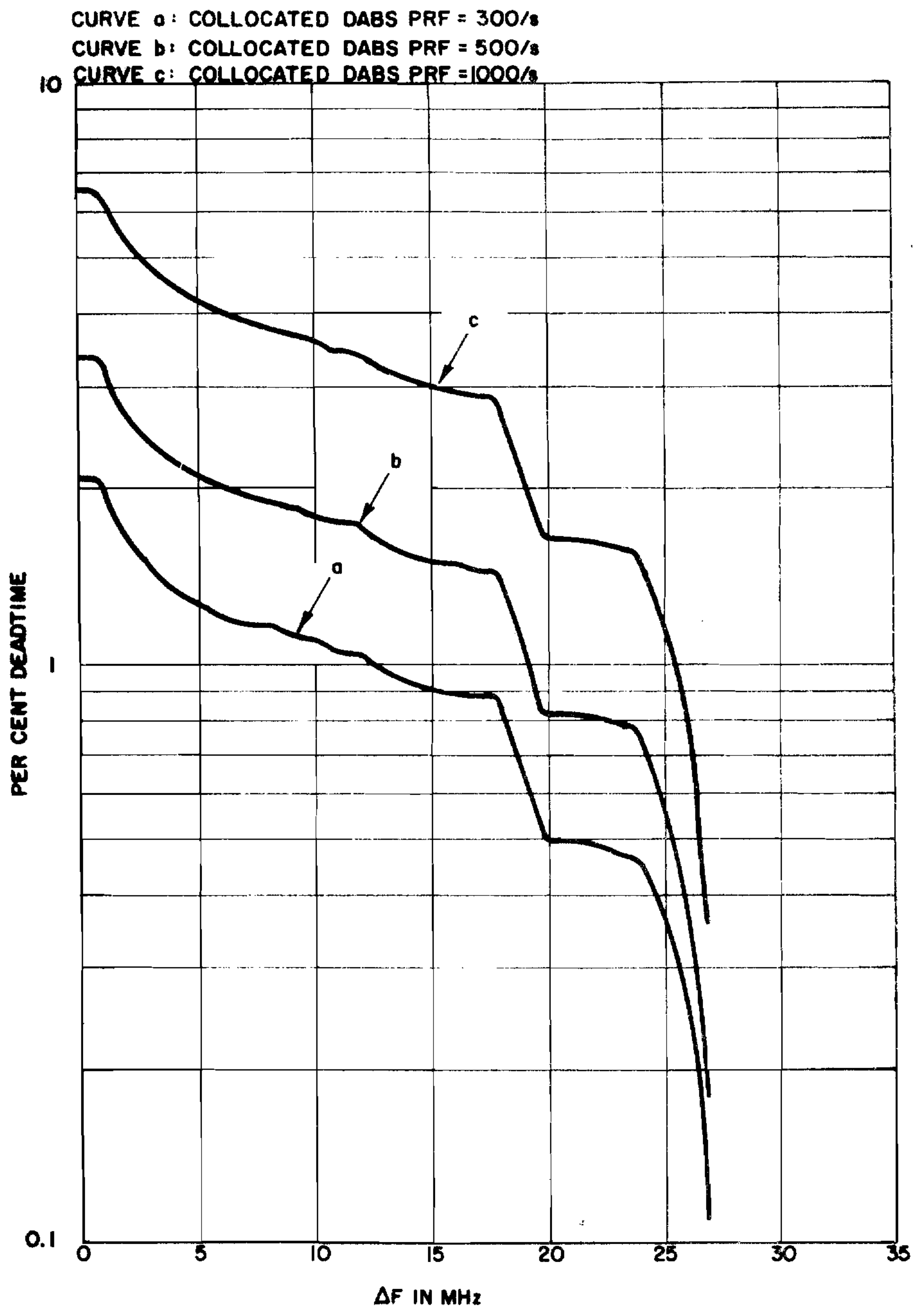


Figure B-35. Percent deadtime vs Δf for RTB-2 Y mode, DABS format #4.

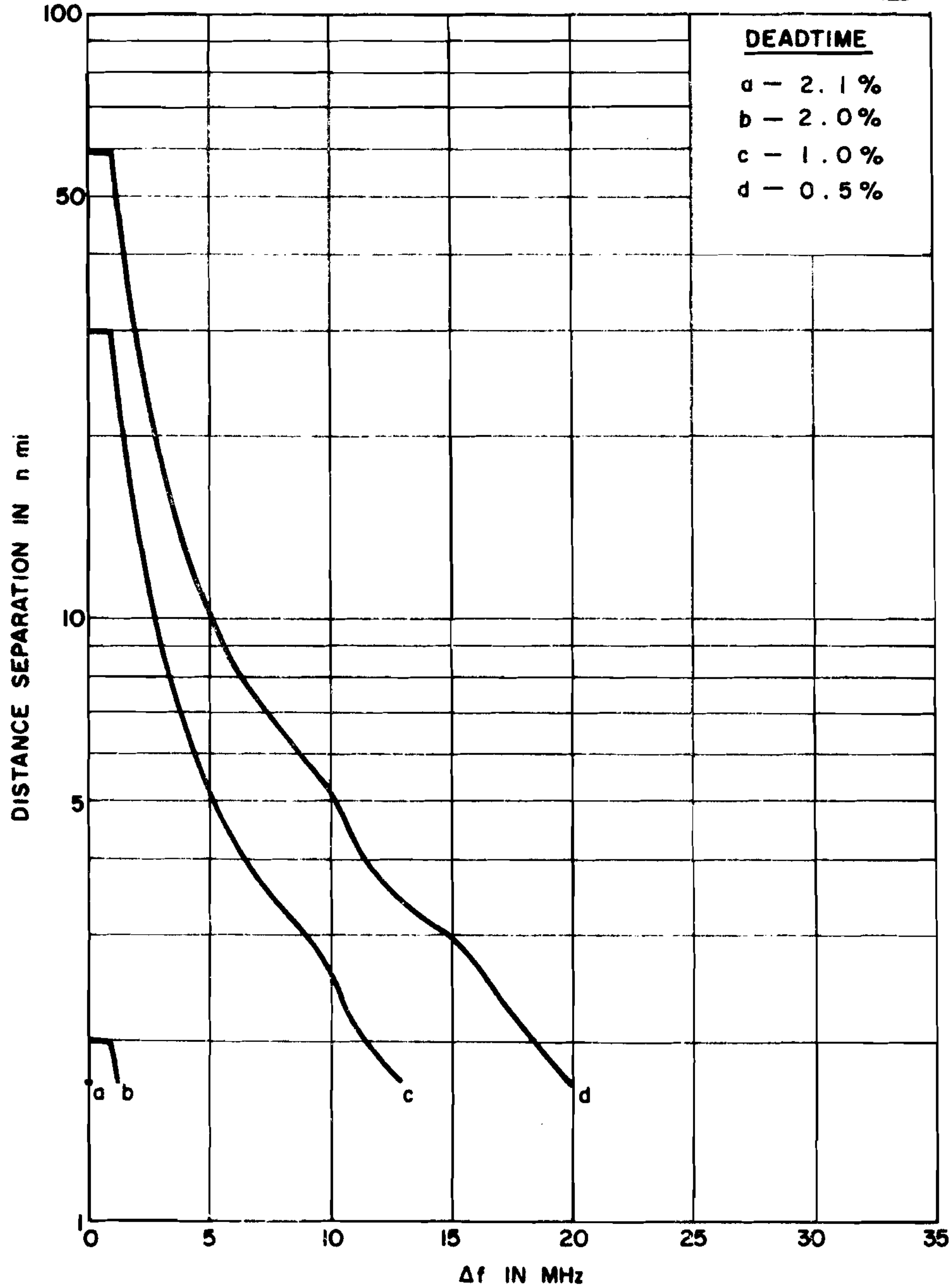


Figure B-36. Distance separation vs Δf for RTB-2 Y mode, DABS format #4, DABS PRF = 300/s.

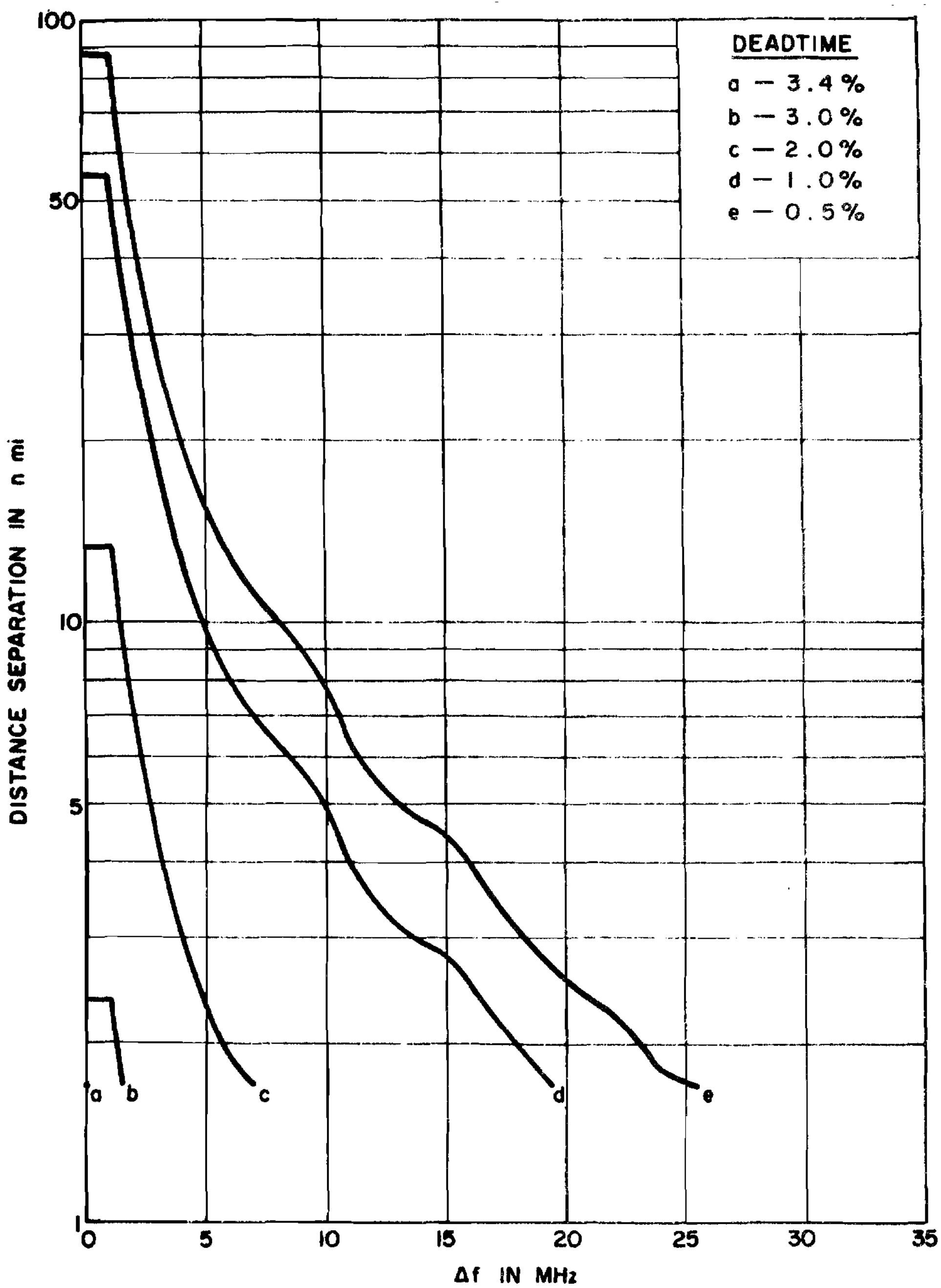


Figure B-37. Distance separation vs Δf for RTB-2 Y mode, DABS format #4, DABS PRF = 500/s.

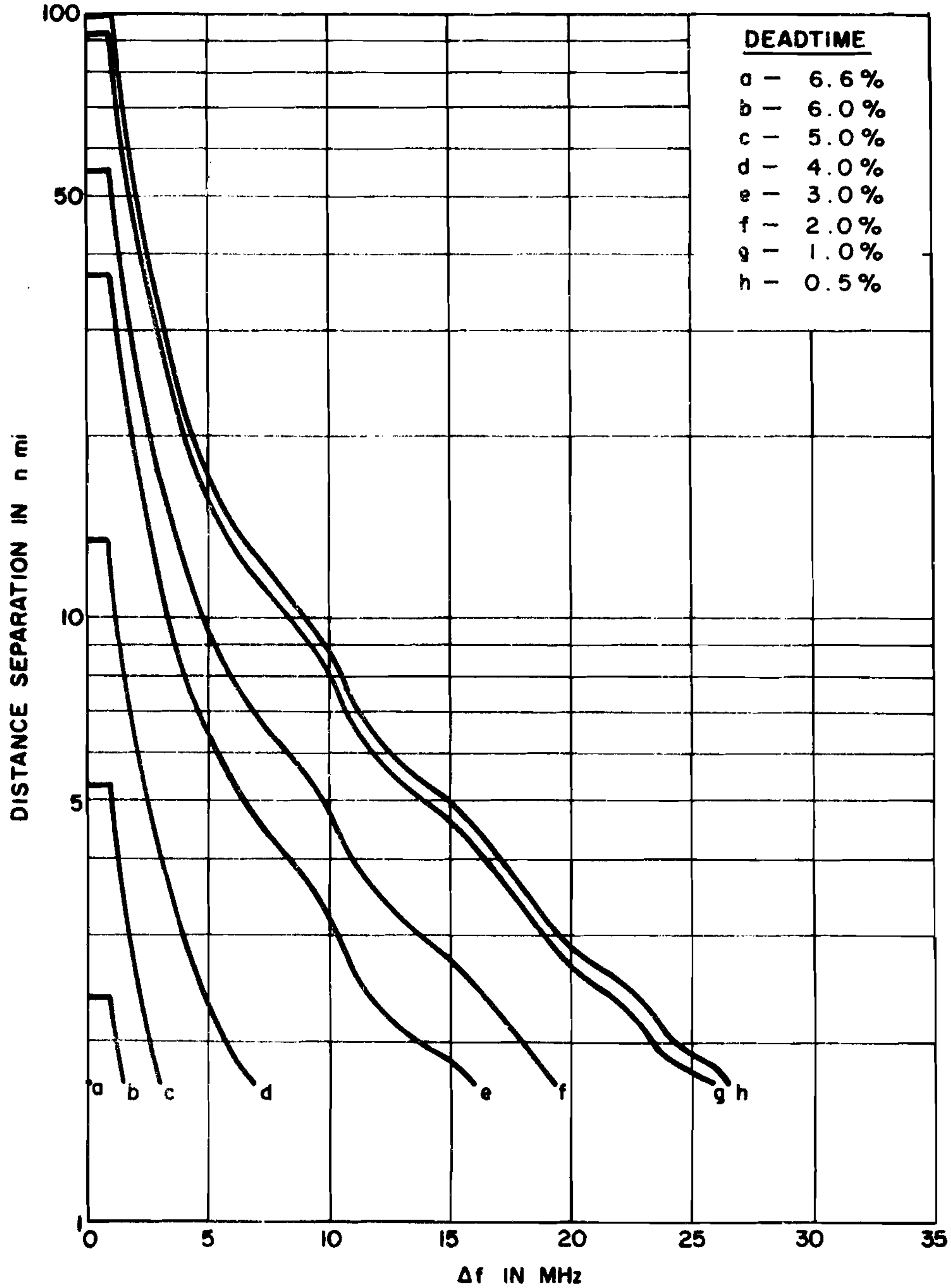


Figure B-38. Distance separation vs Δf for RTB-2 Y mode, DABS format #4, DABS PRF = 1000/s.

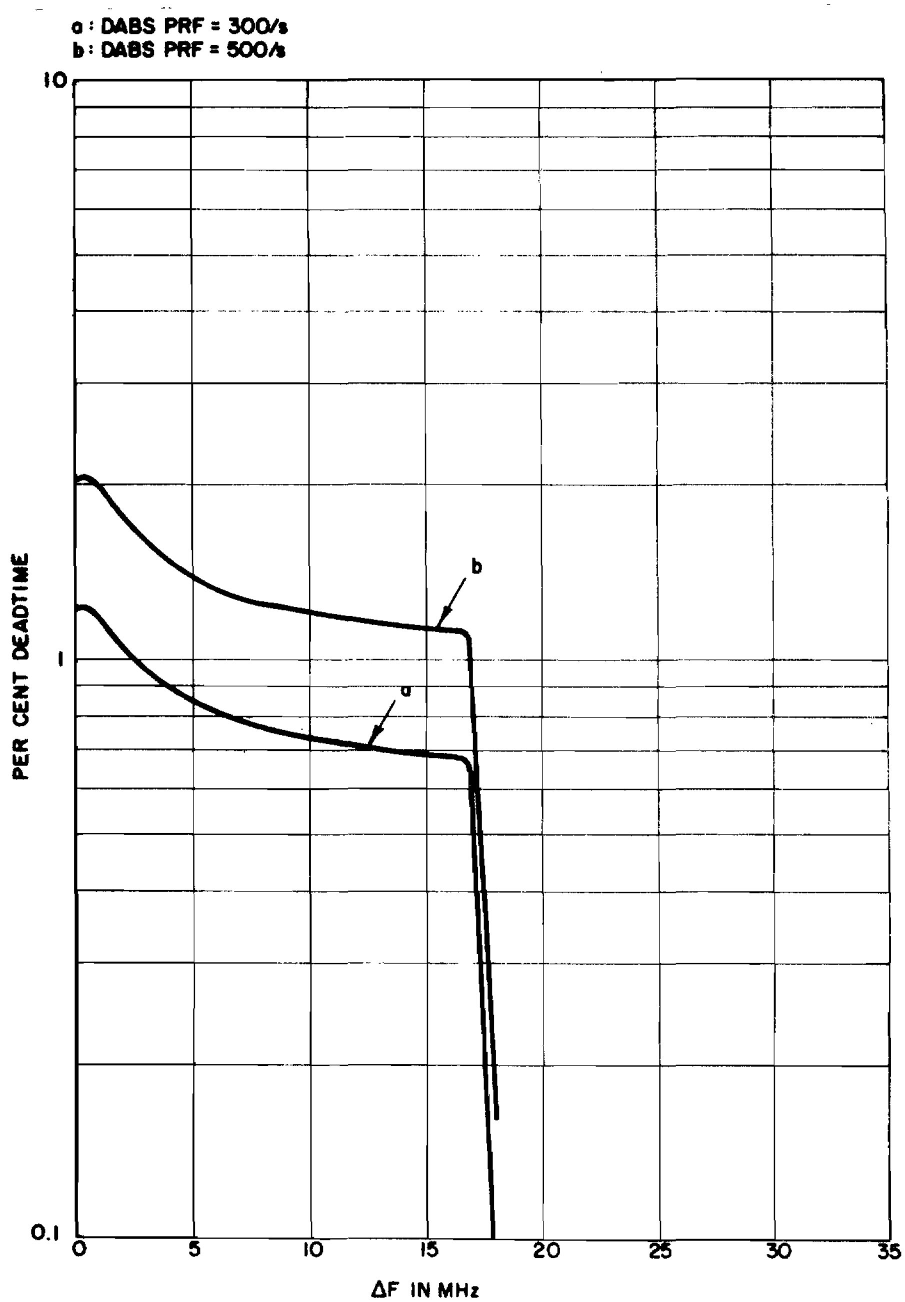


Figure B-39. Percent deadtime vs Δf for RTB-2 Y mode, DABS format #5, P_T = 250W.

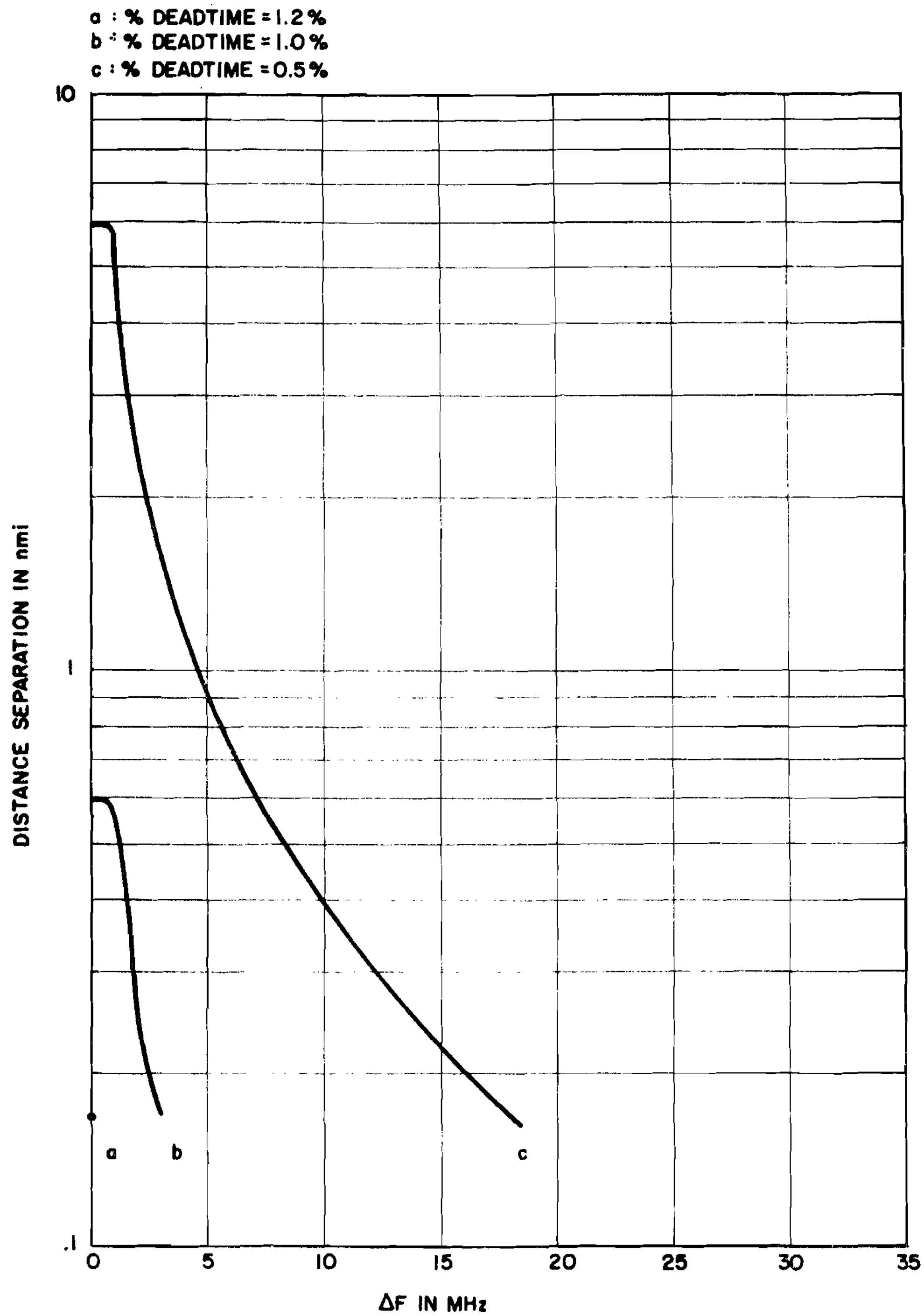


Figure B-40. Distance separation vs Δf for RTB-2 Y mode, DABS format #5, P_T = 250W, DABS PRF = 300/s.

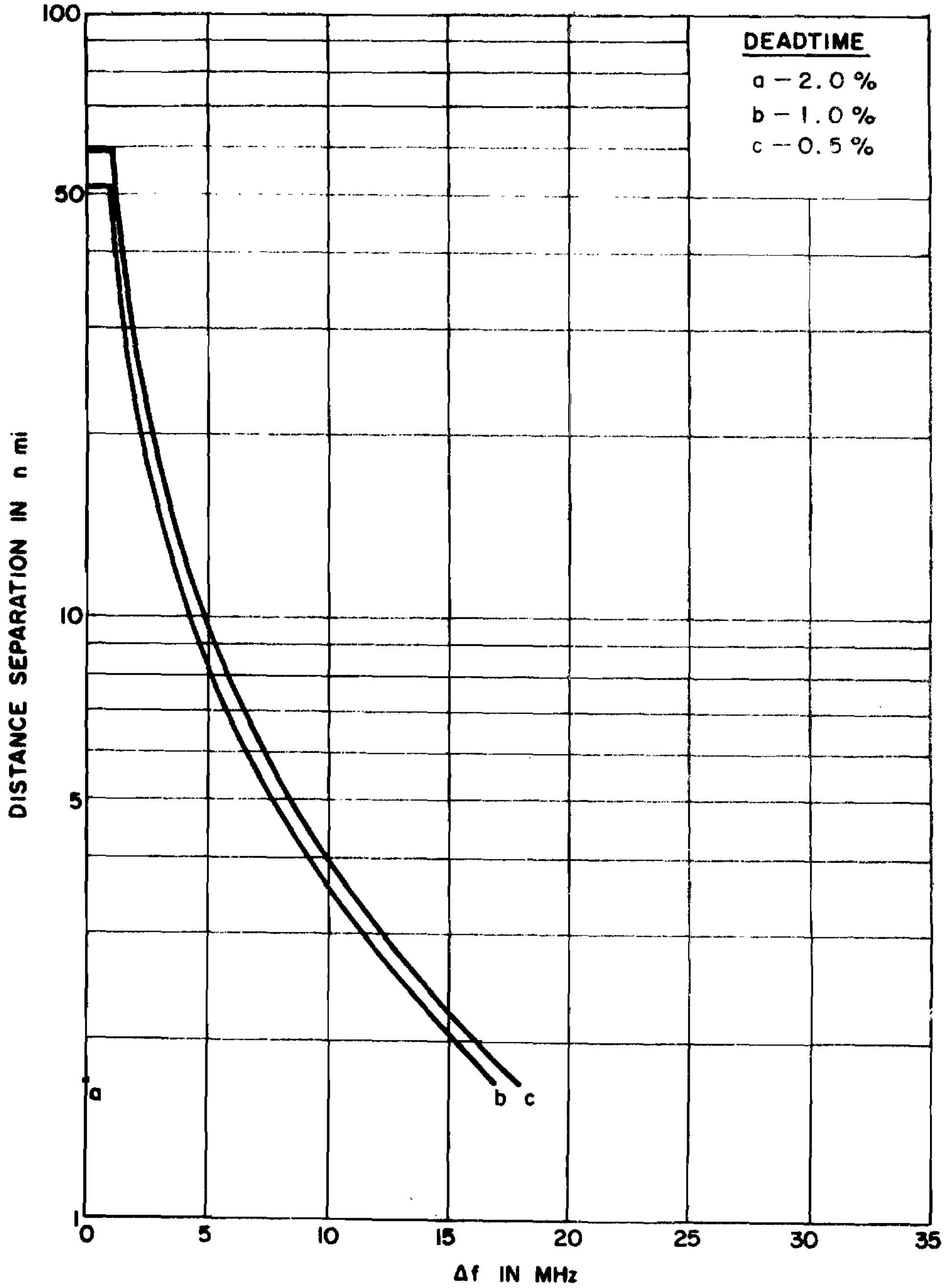


Figure B-41. Distance separation vs Δf for RTB-2 Y mode, DABS format #5, P_T = 250W, DABS PRF = 500/s.

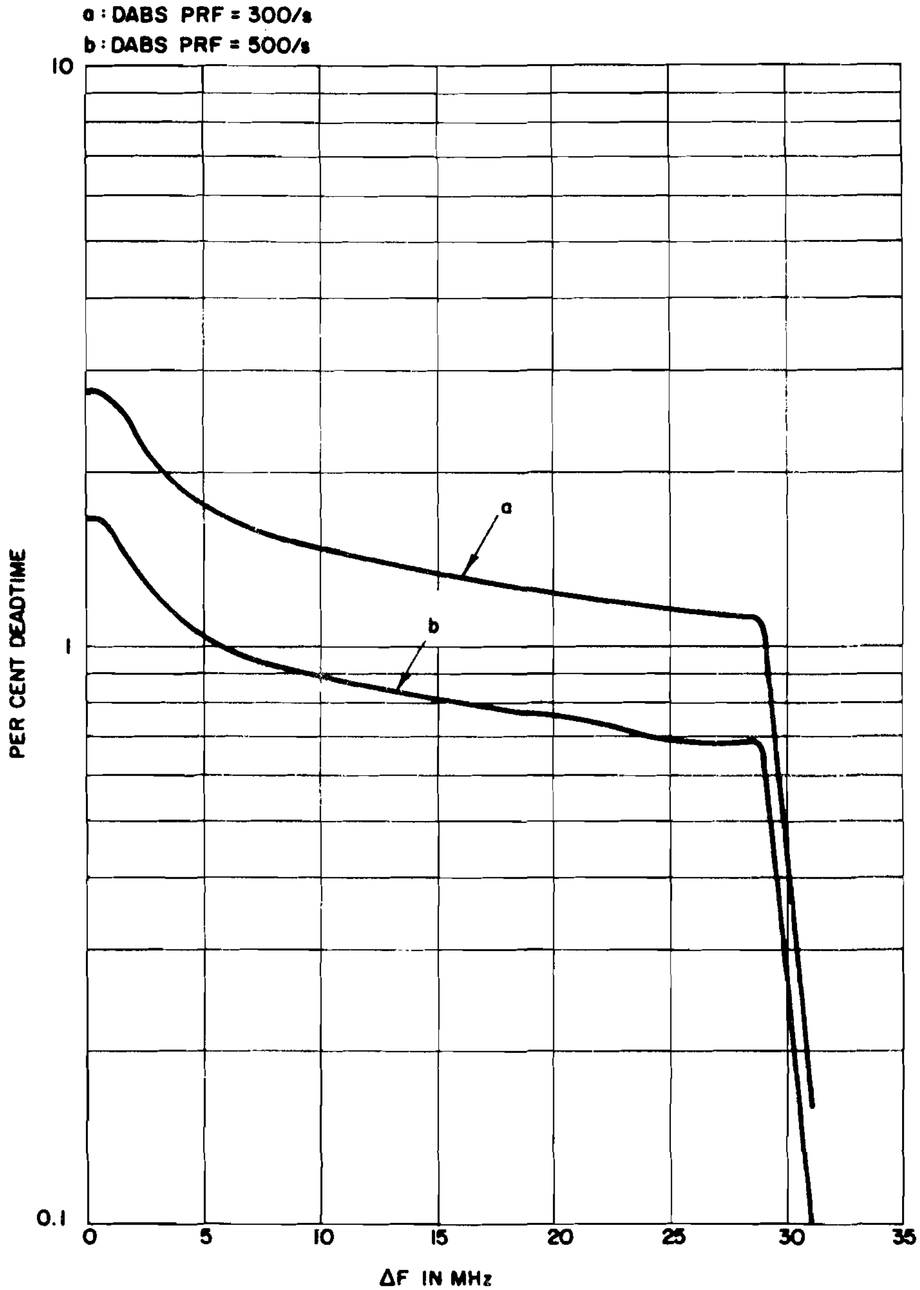


Figure B-42. Percent deadtime vs Δf for RTB-2 Y mode, DABS format #5, P_T = 2.5 kW.

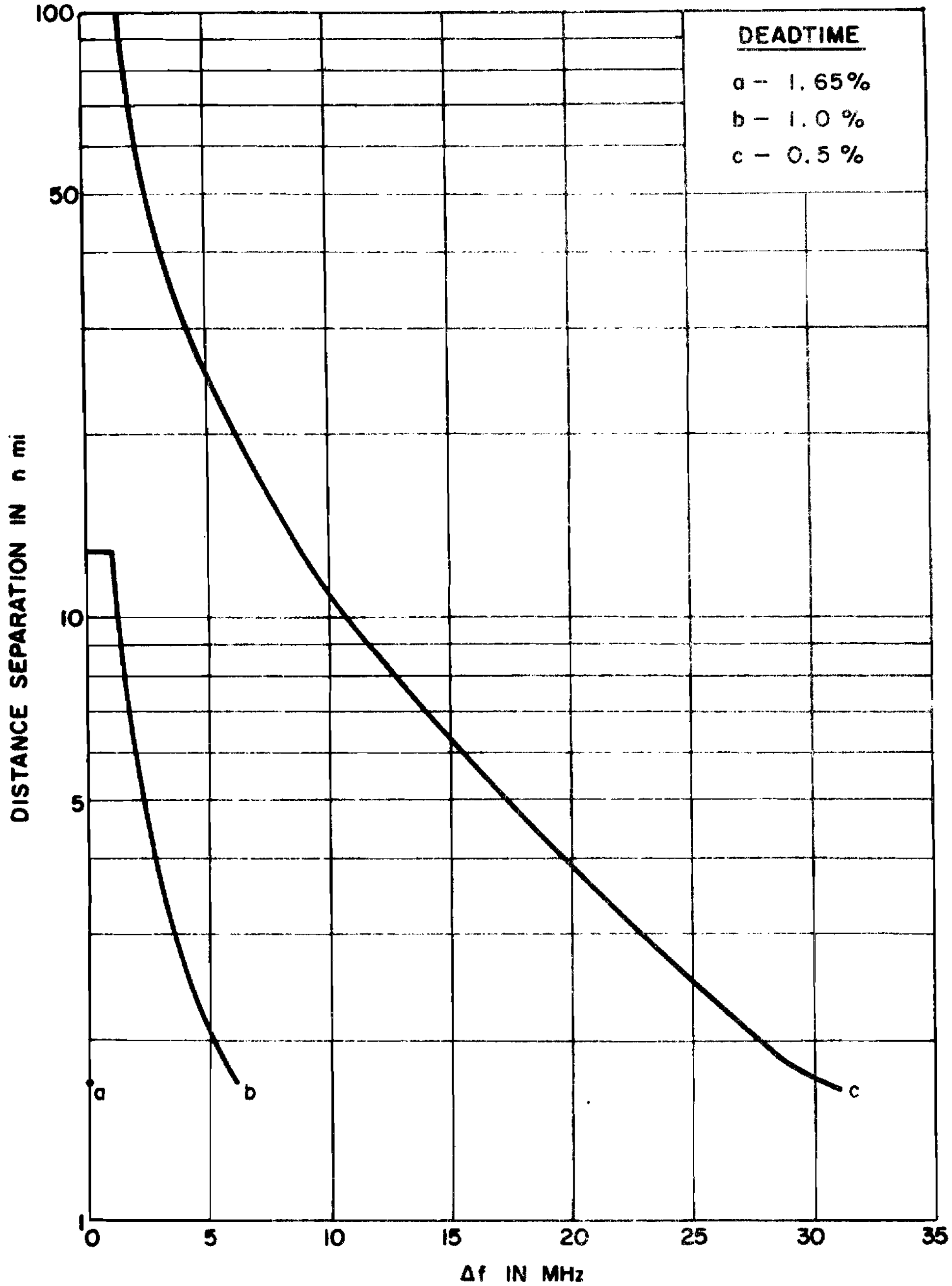


Figure B-43. Distance separation vs Δf for RTB-2 Y mode, DABS format #5, P_T = 2.5 kW, DABS PRF = 300/s.

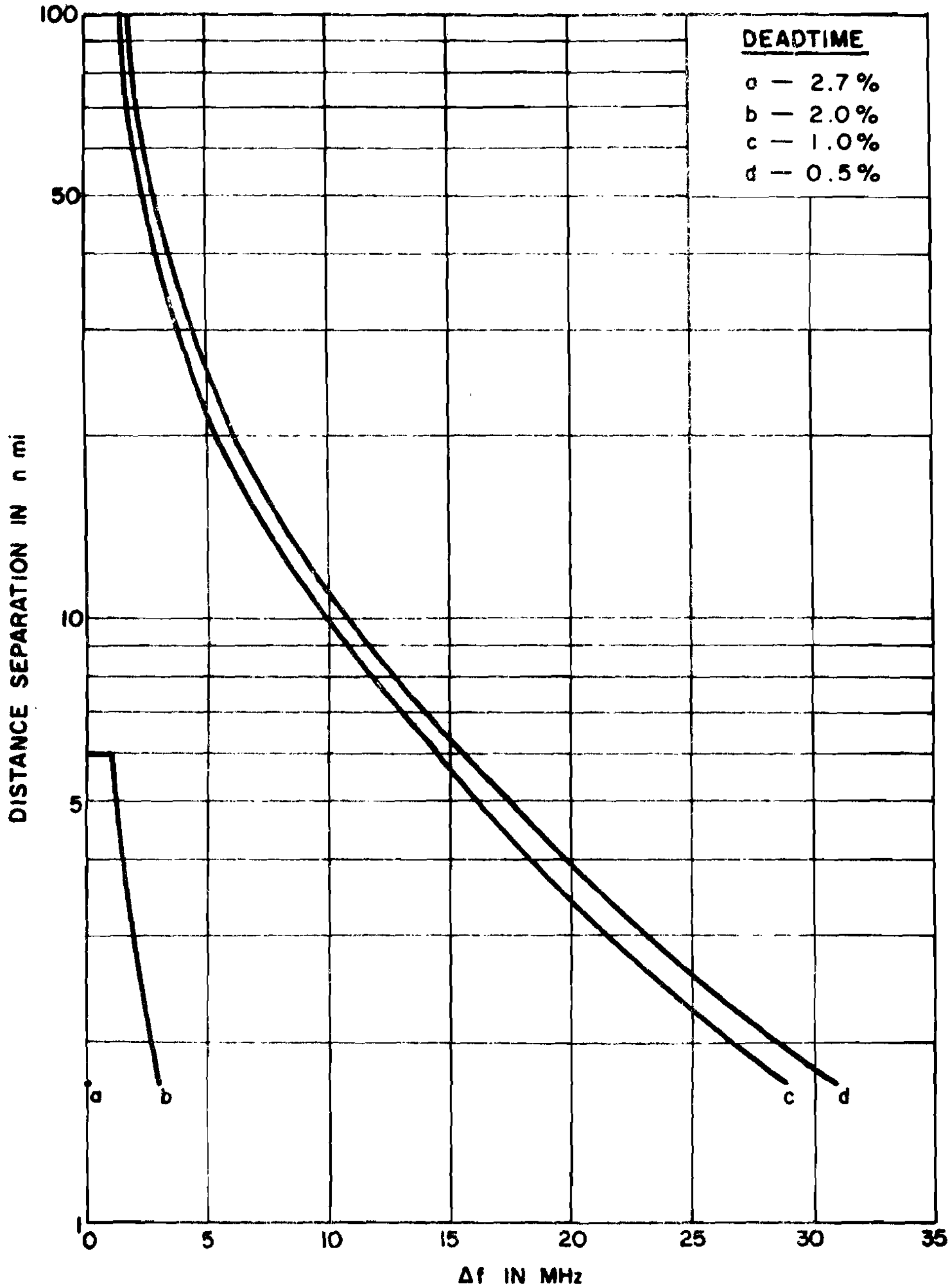


Figure B-44. Distance separation vs Δf for RTB-2 Y mode, DABS format #5, P_T = 2.5 kW, DABS PRF = 500/s.

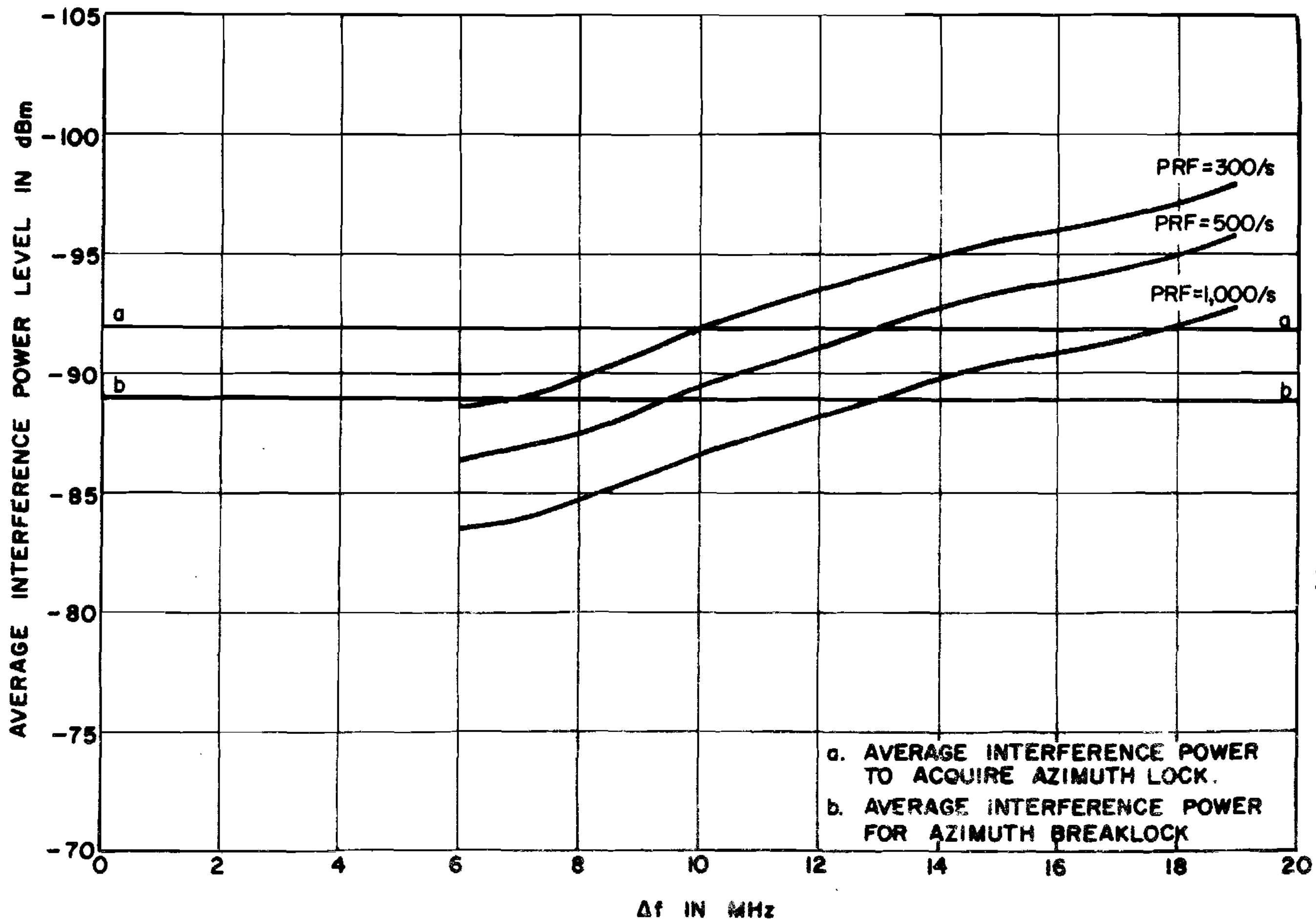


Figure B-45. Interference power level vs Δf for X mode interrogator, DABS format #1, separation = 1 nmi.

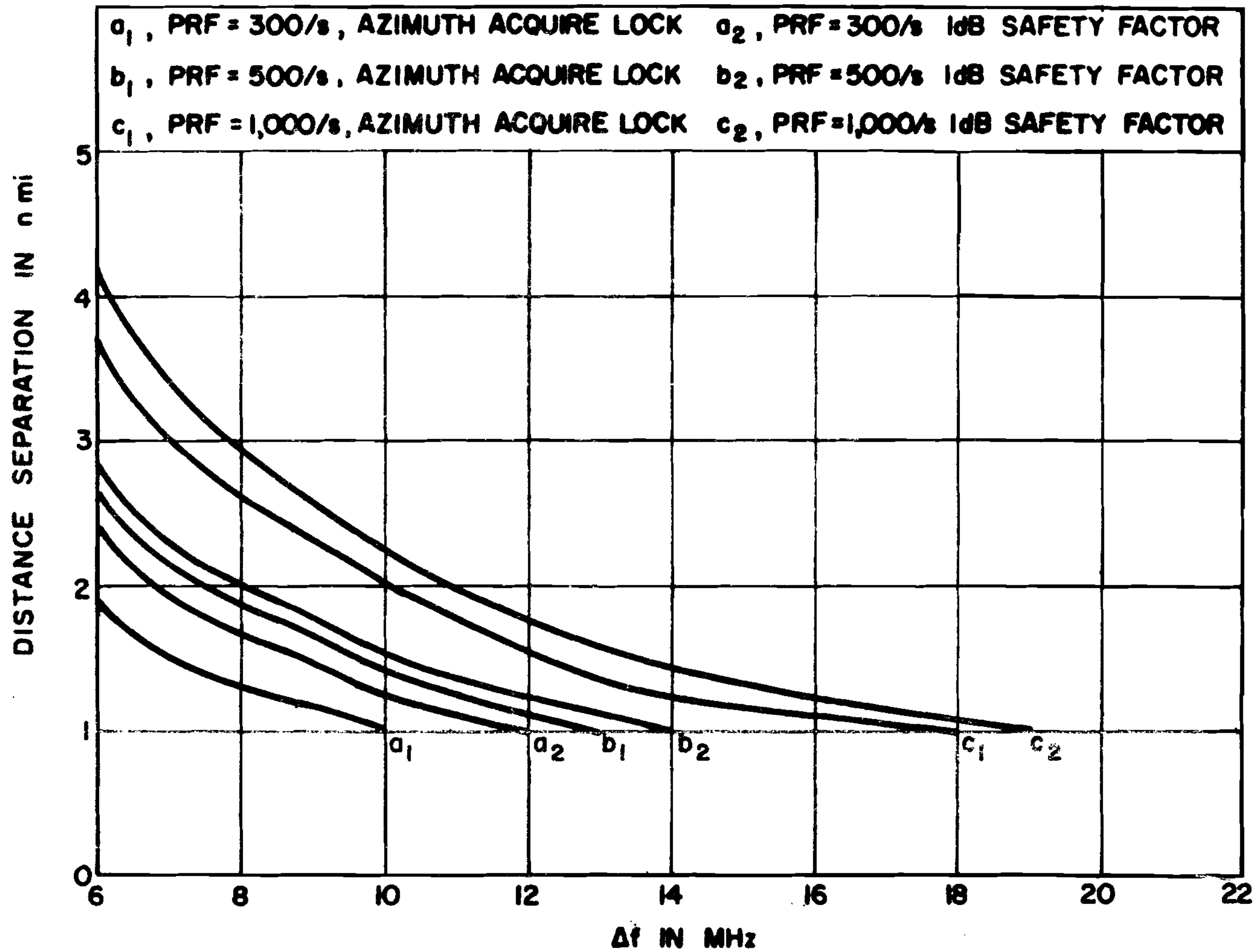


Figure B-46. Distance separation vs Δf for X mode interrogator, DABS format #1.

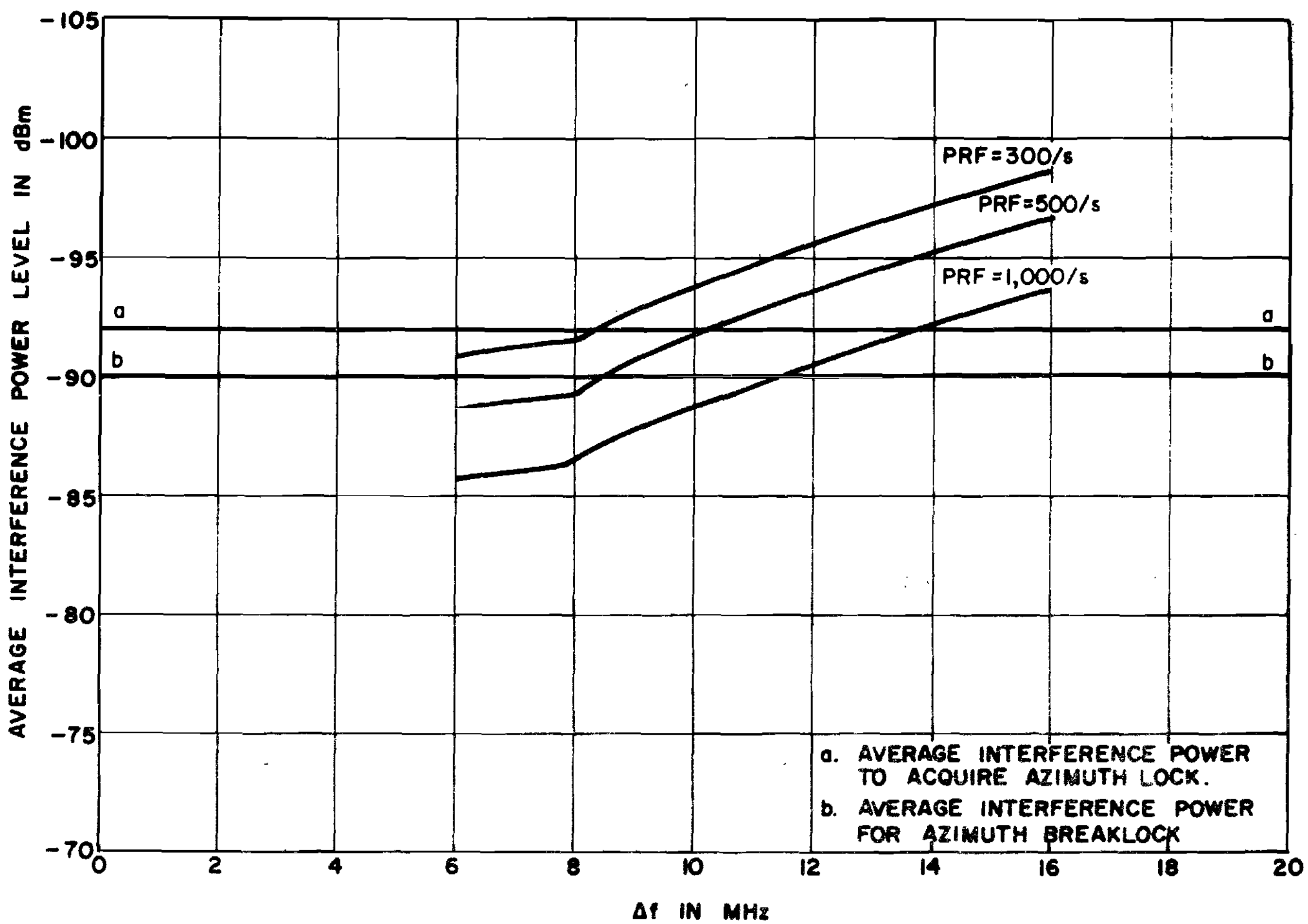


Figure B-47. Interference power level vs Δf for X mode interrogator, DABS format #2, separation = 1 nmi.

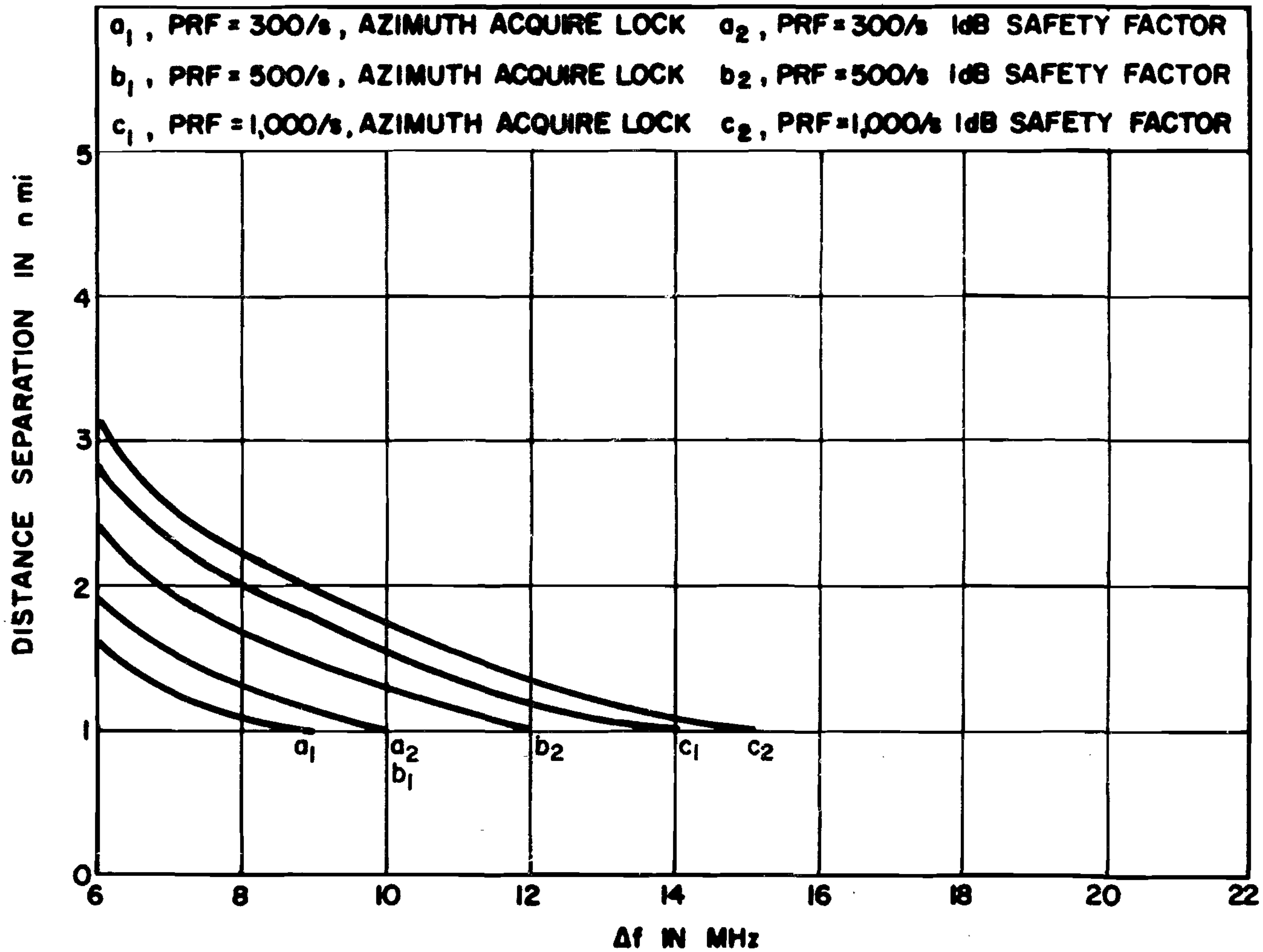


Figure B-48. Distance separation vs Δf for X mode interrogator, DABS format #2.

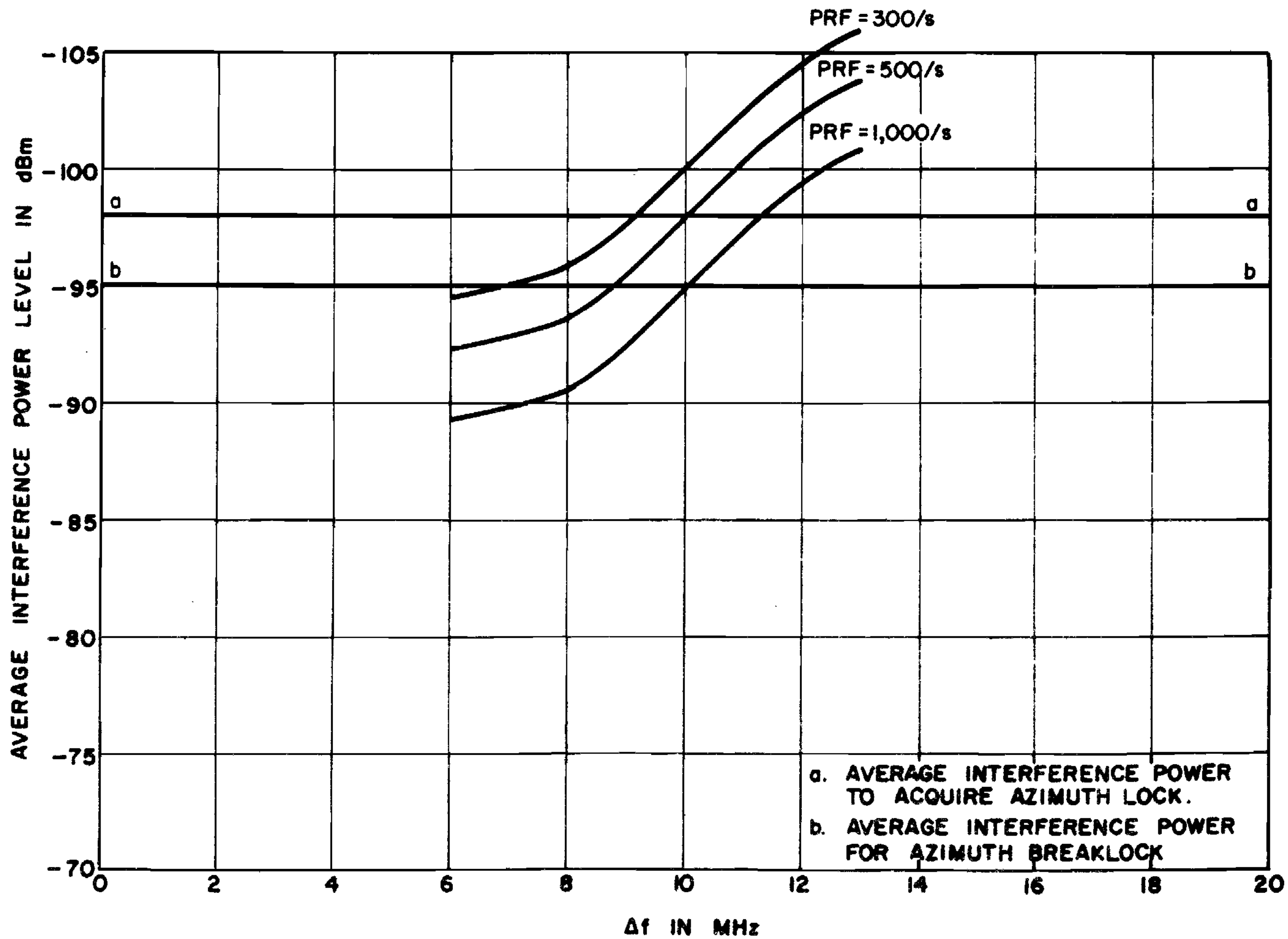


Figure B-49. Interference power level vs Δf for X mode interrogator, DABS format #3, separation = 1 nmi.

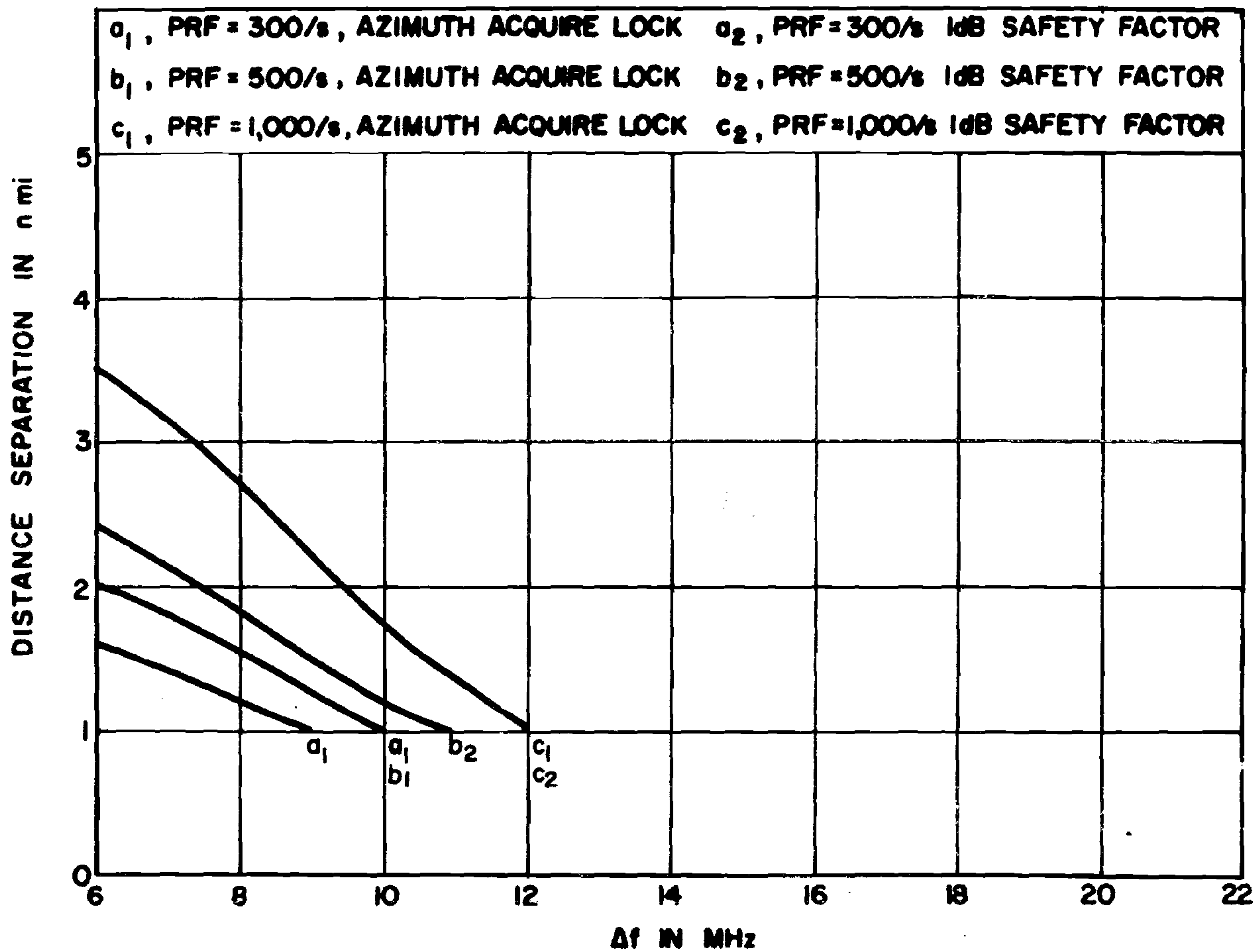


Figure B-50. Distance separation vs Δf for X mode interrogator, DABS format #3.

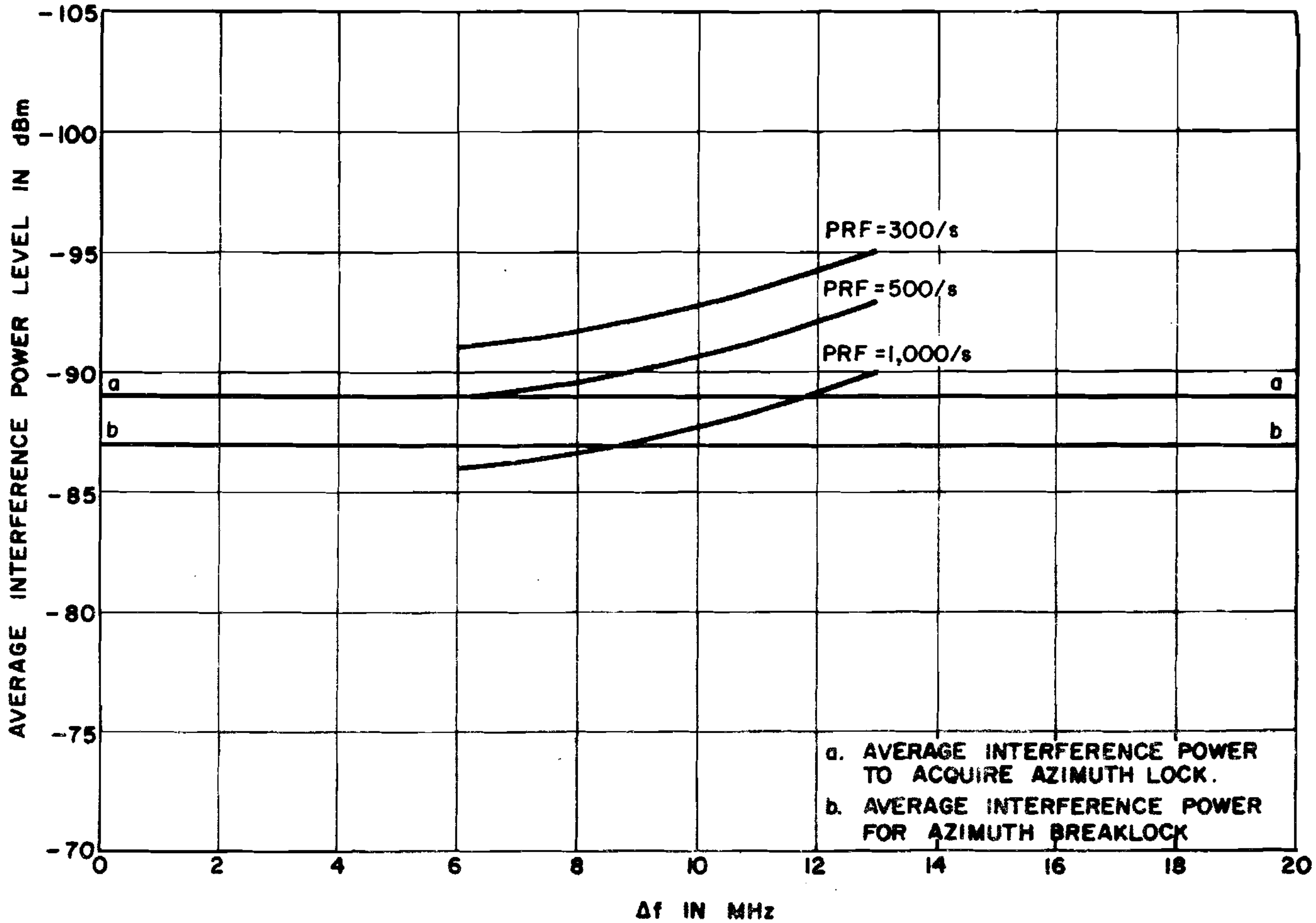


Figure B-51. Interference power level vs Δf for X mode interrogator, DABS format #4, separation = 1 nmi.

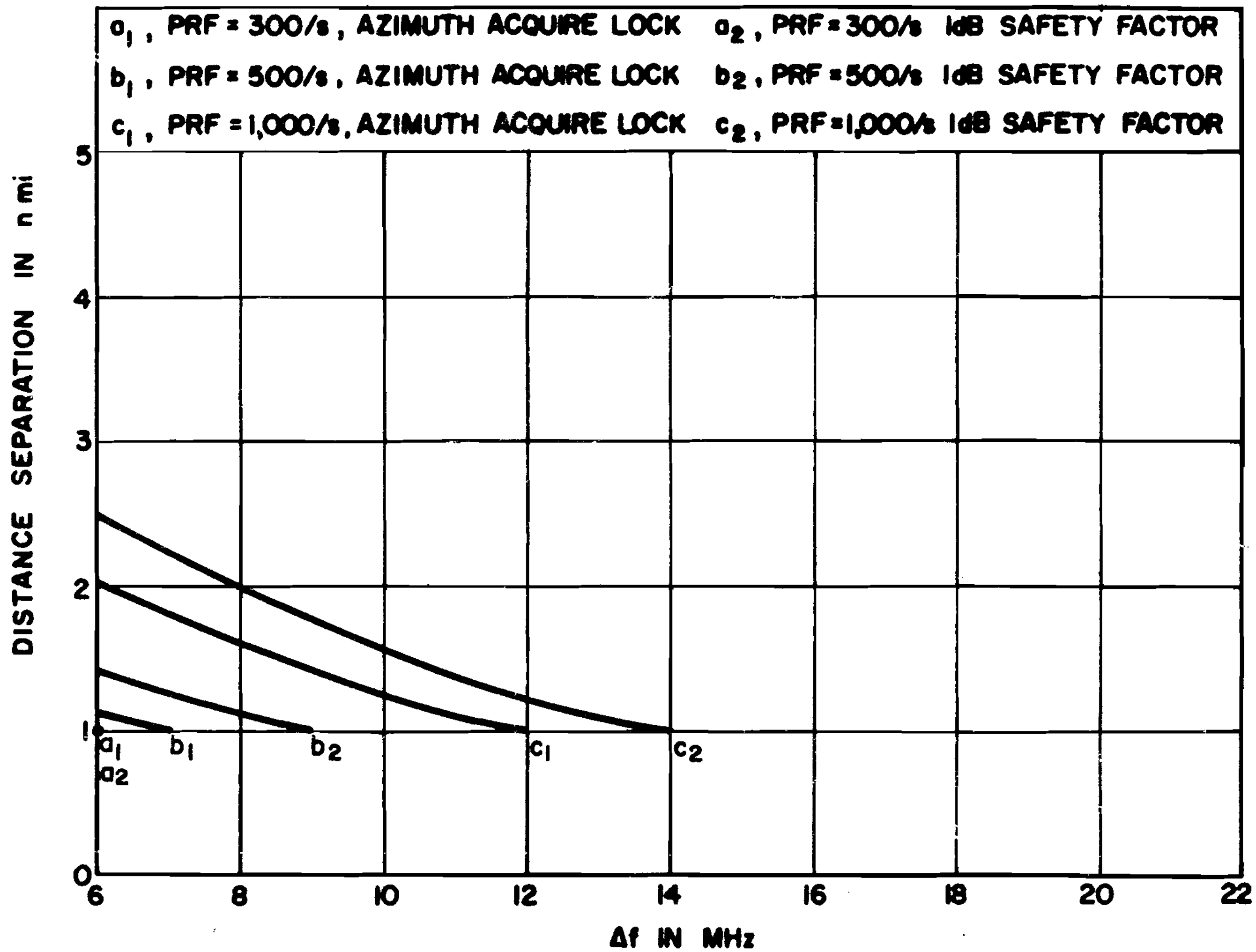


Figure B-52. Distance separation vs Δf for X mode interrogator, DABS format #4.

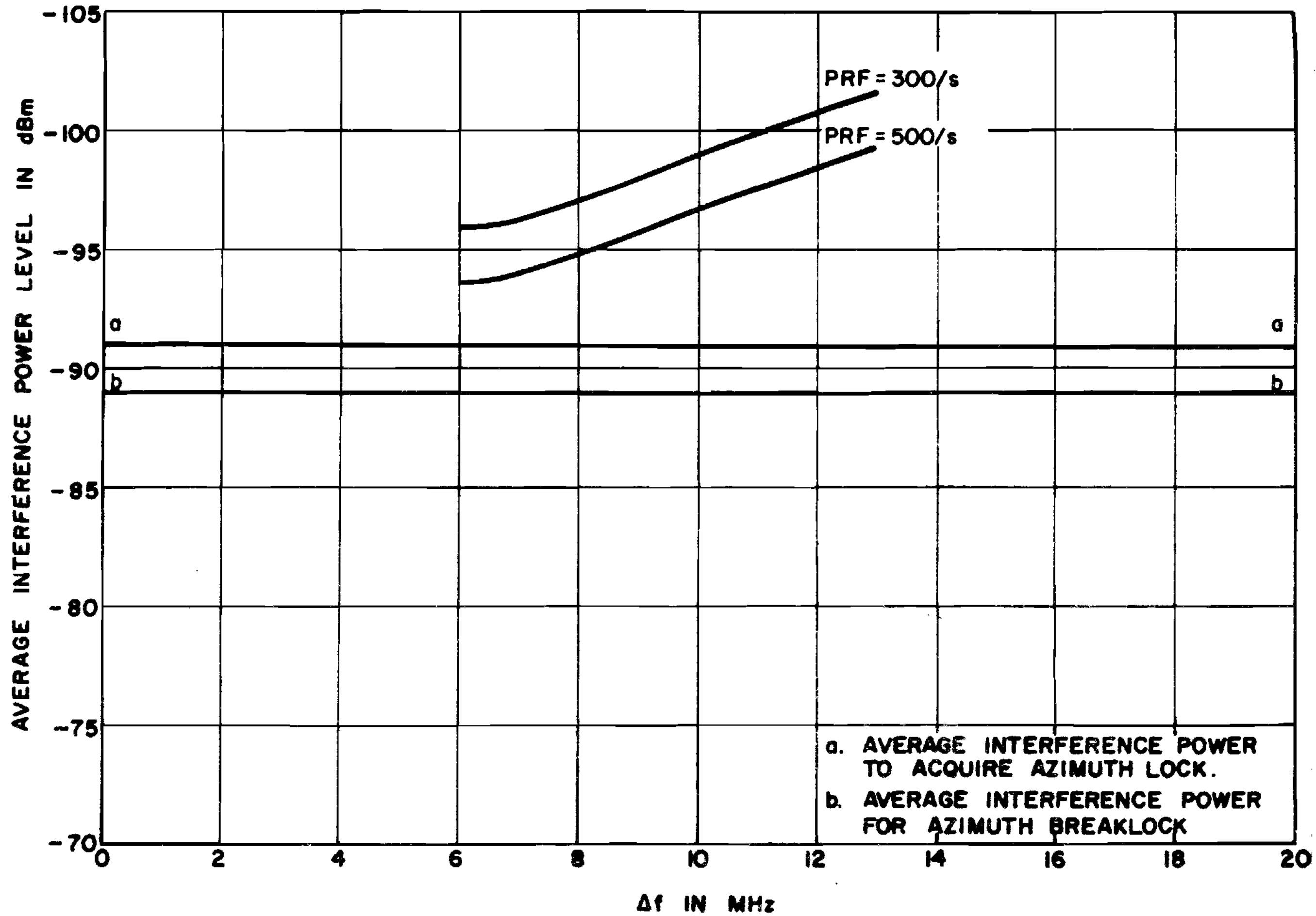


Figure B-53. Interference power level vs Δf for X mode interrogator, DABS format #5, P_T = 250W, separations = 1 nmi.

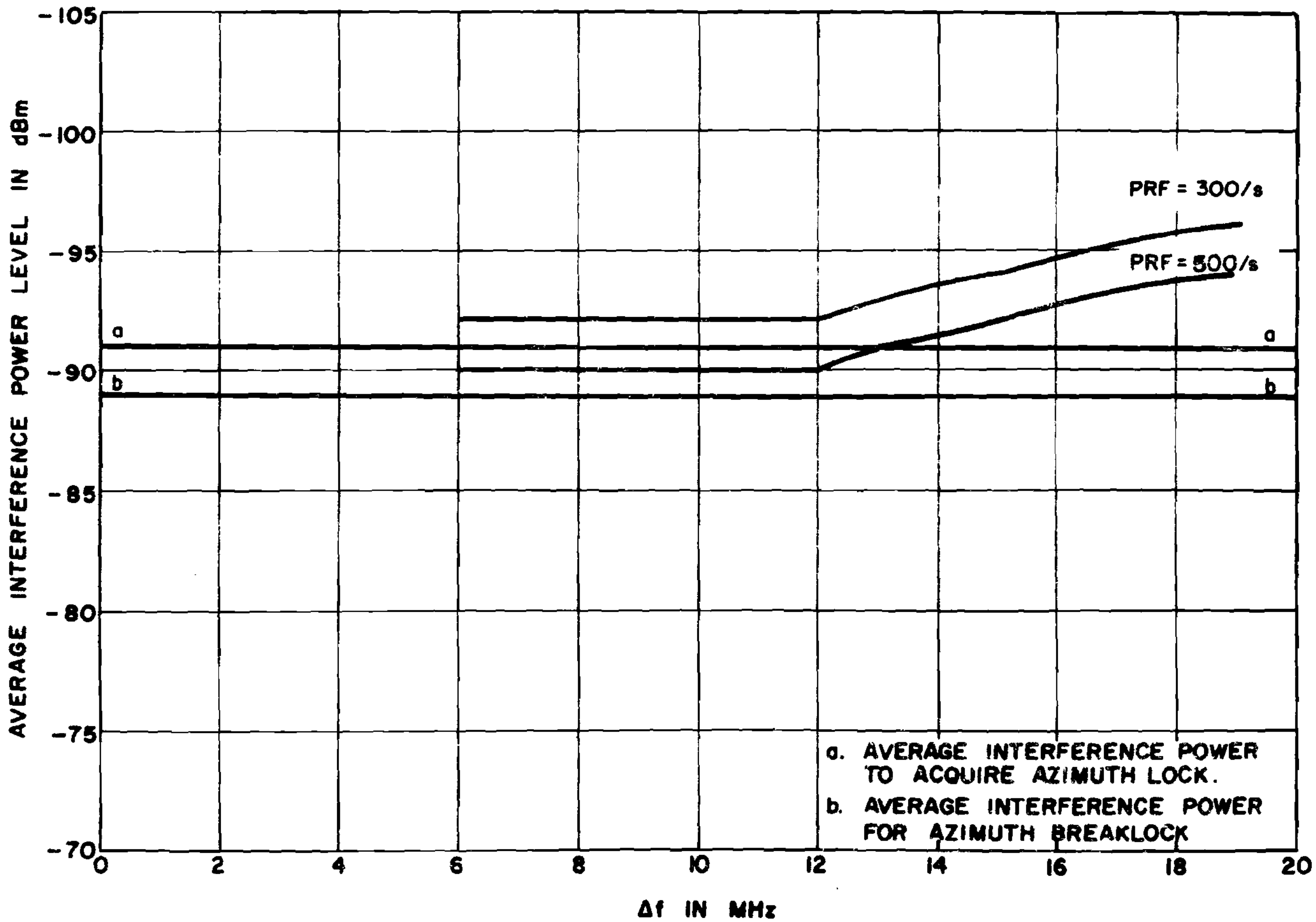


Figure B-54. Interference power level vs Δf for X mode interrogator, DABS format #5, P_T = 2.5 kW, separations = 1 nmi.

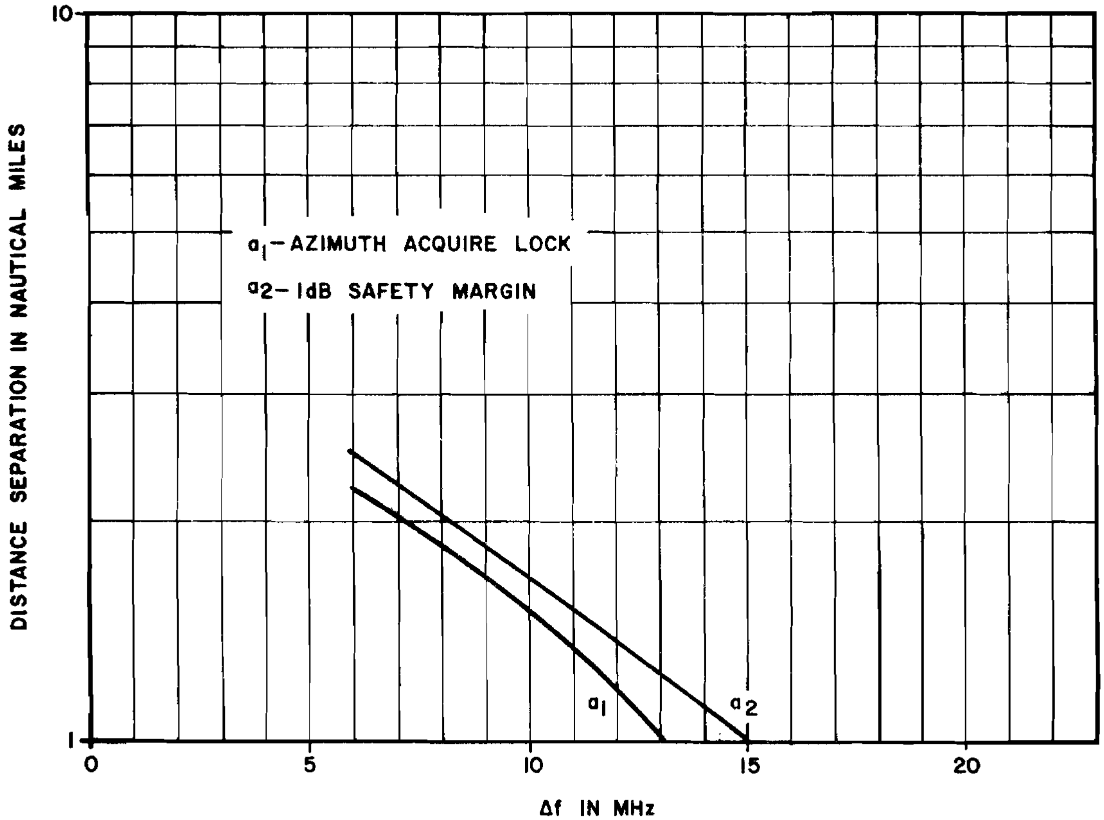


Figure B-55. Distance separation vs Δf for X mode interrogator, DABS format #5, P_T = 2.5 kW, DABS PRF = 500/s.

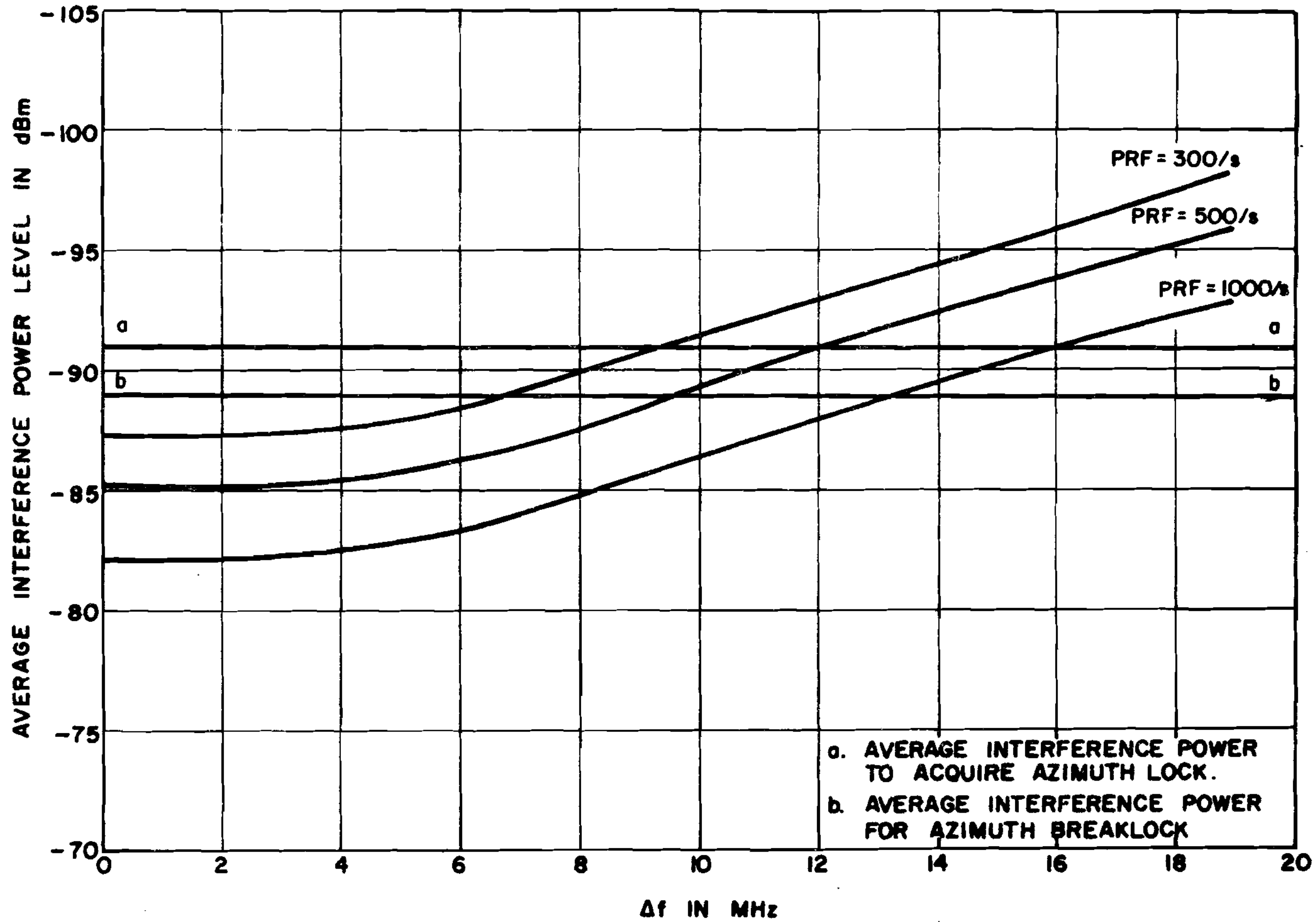


Figure B-56. Interference power level vs Δf for Y mode interrogator, DABS format #1, separation = 1 nmi.

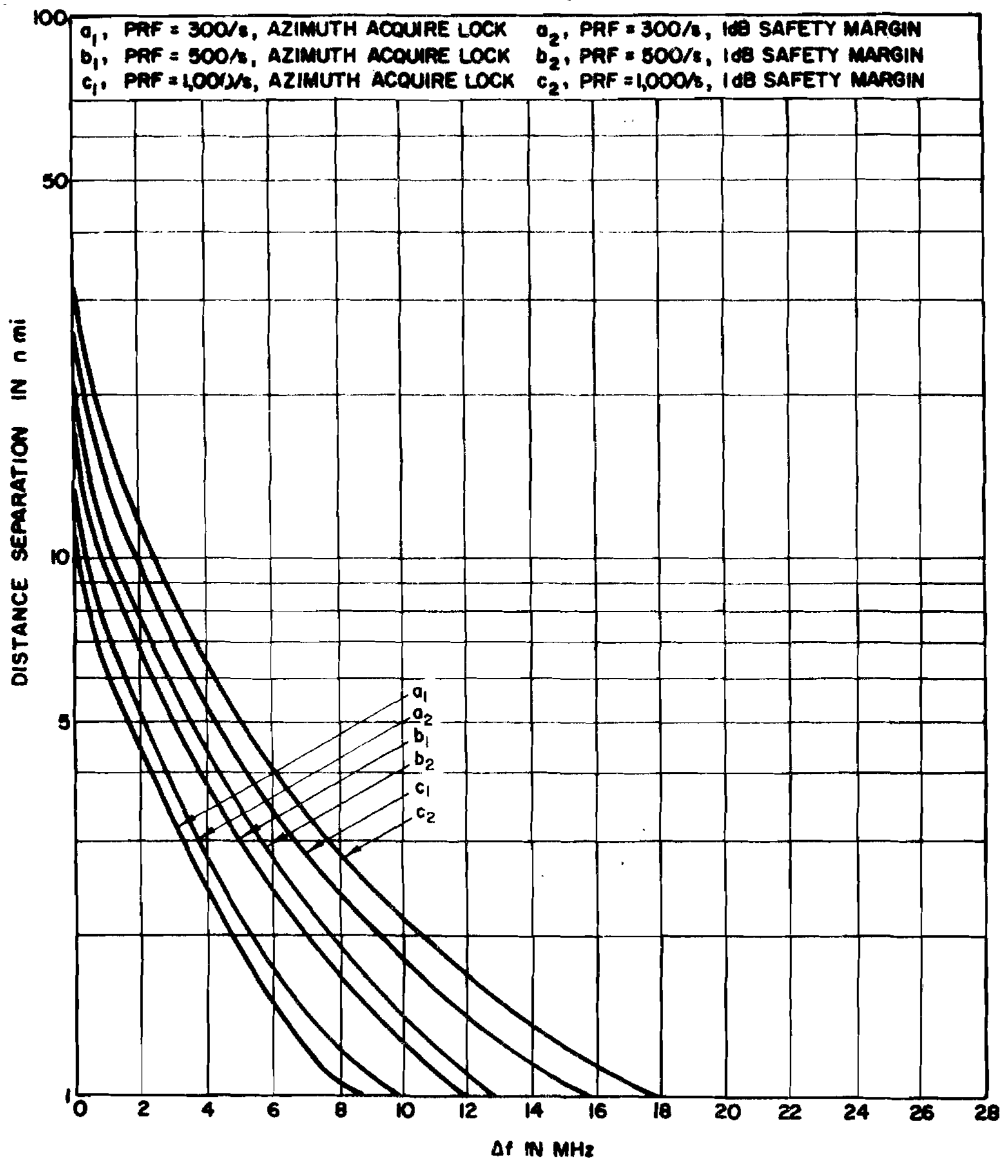


Figure B-57. Distance separation vs Δf for Y mode interrogator, DABS format #1, separation = 1 nmi.

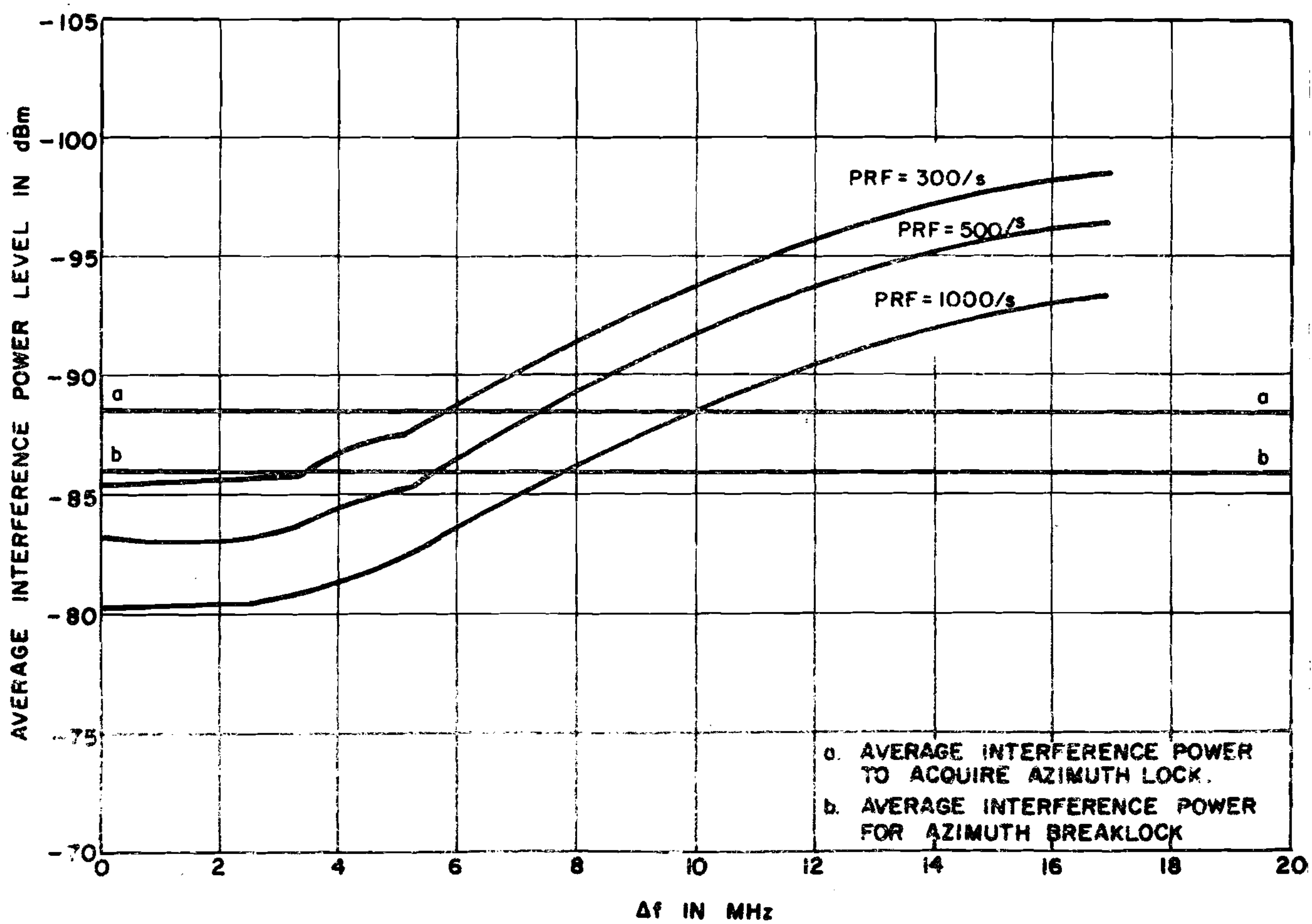


Figure B-58. Interference power level vs Δf for Y mode interrogator, DABS format #2, separation = 1 nmi.

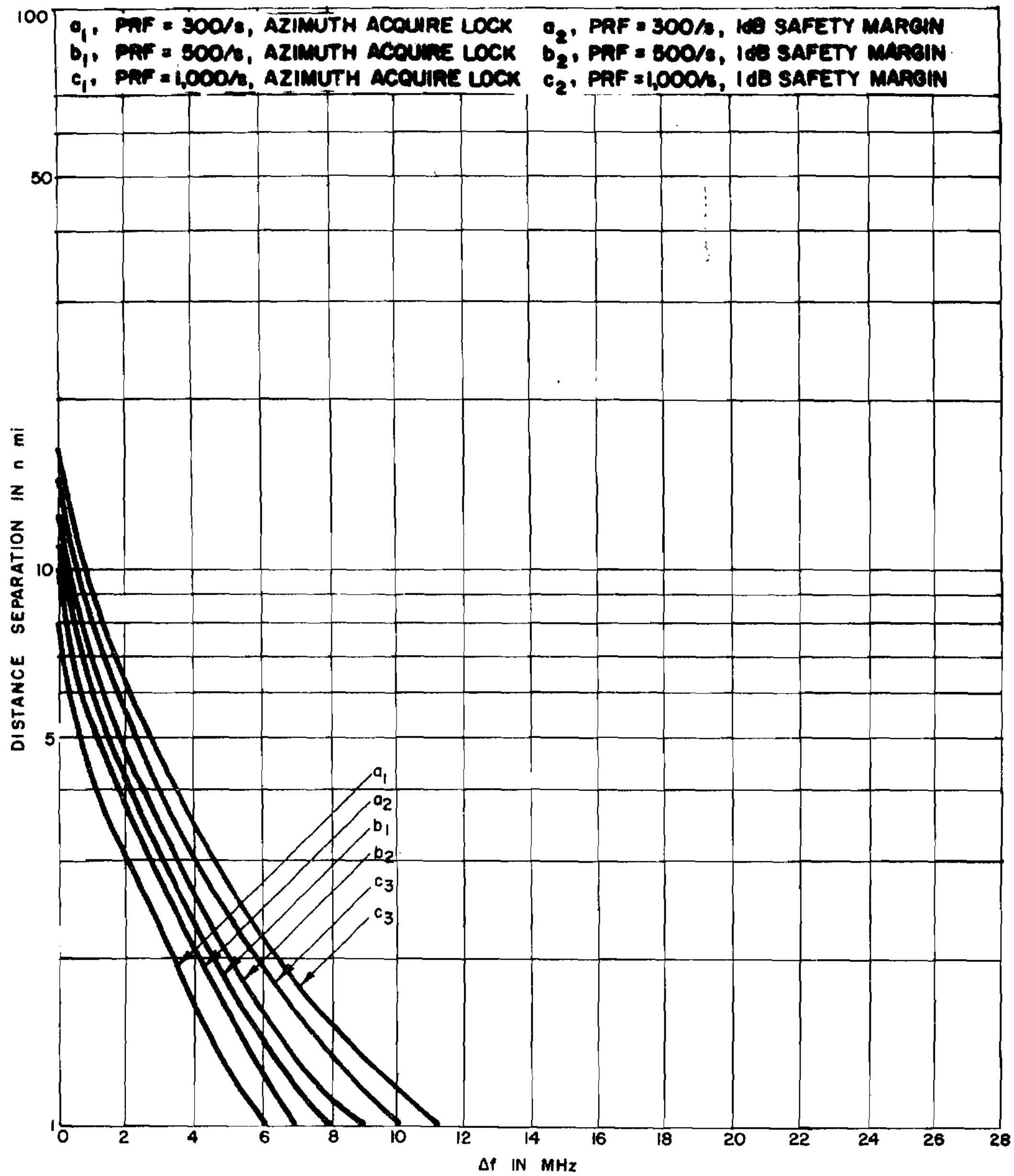


Figure B-59. Distance separation vs Δf for Y mode interrogator, DABS format #2, separation = 1 nmi.

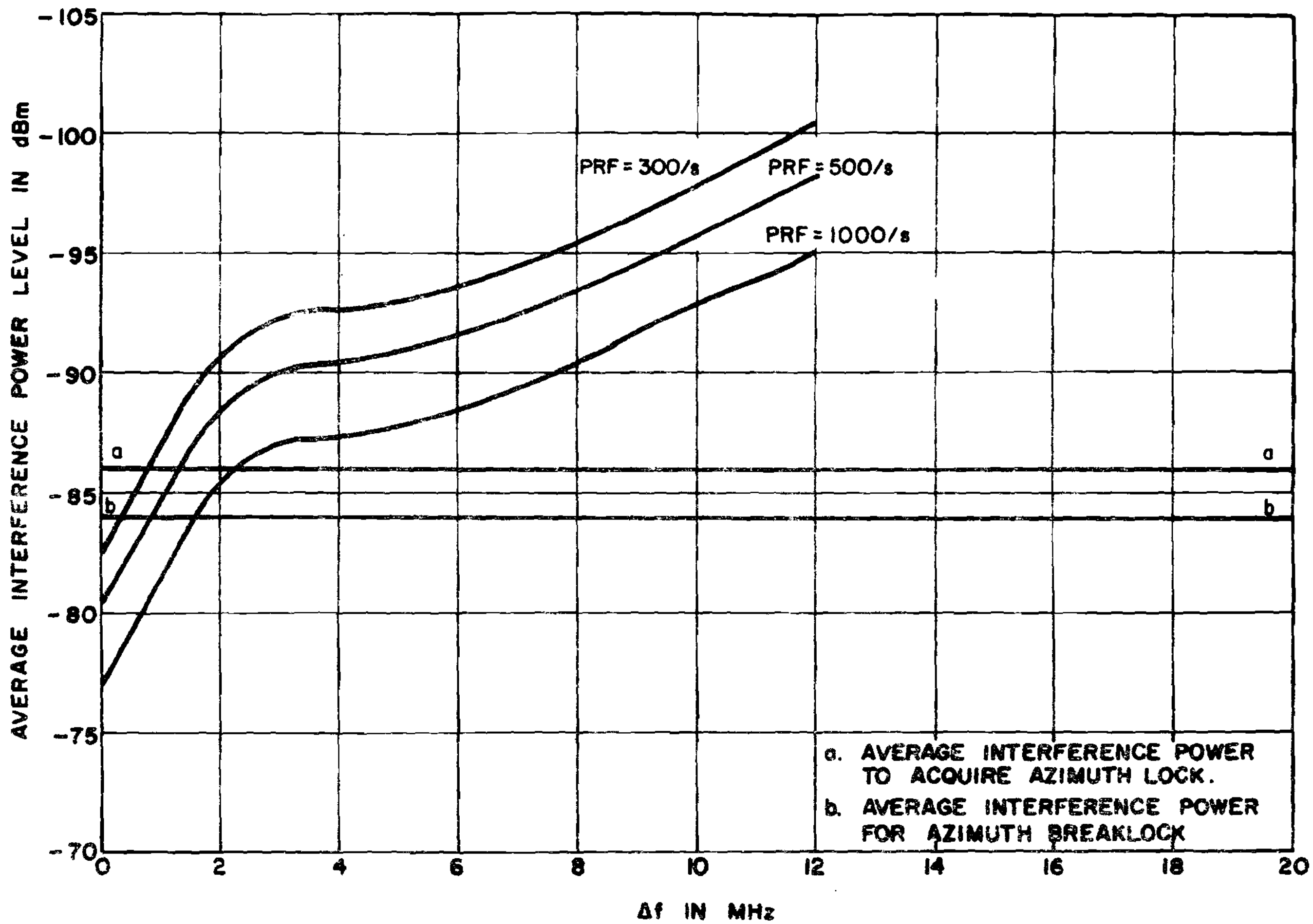


Figure B-60. Interference power level vs Δf for Y mode interrogator, DABS format #3, separation = 1nmi.

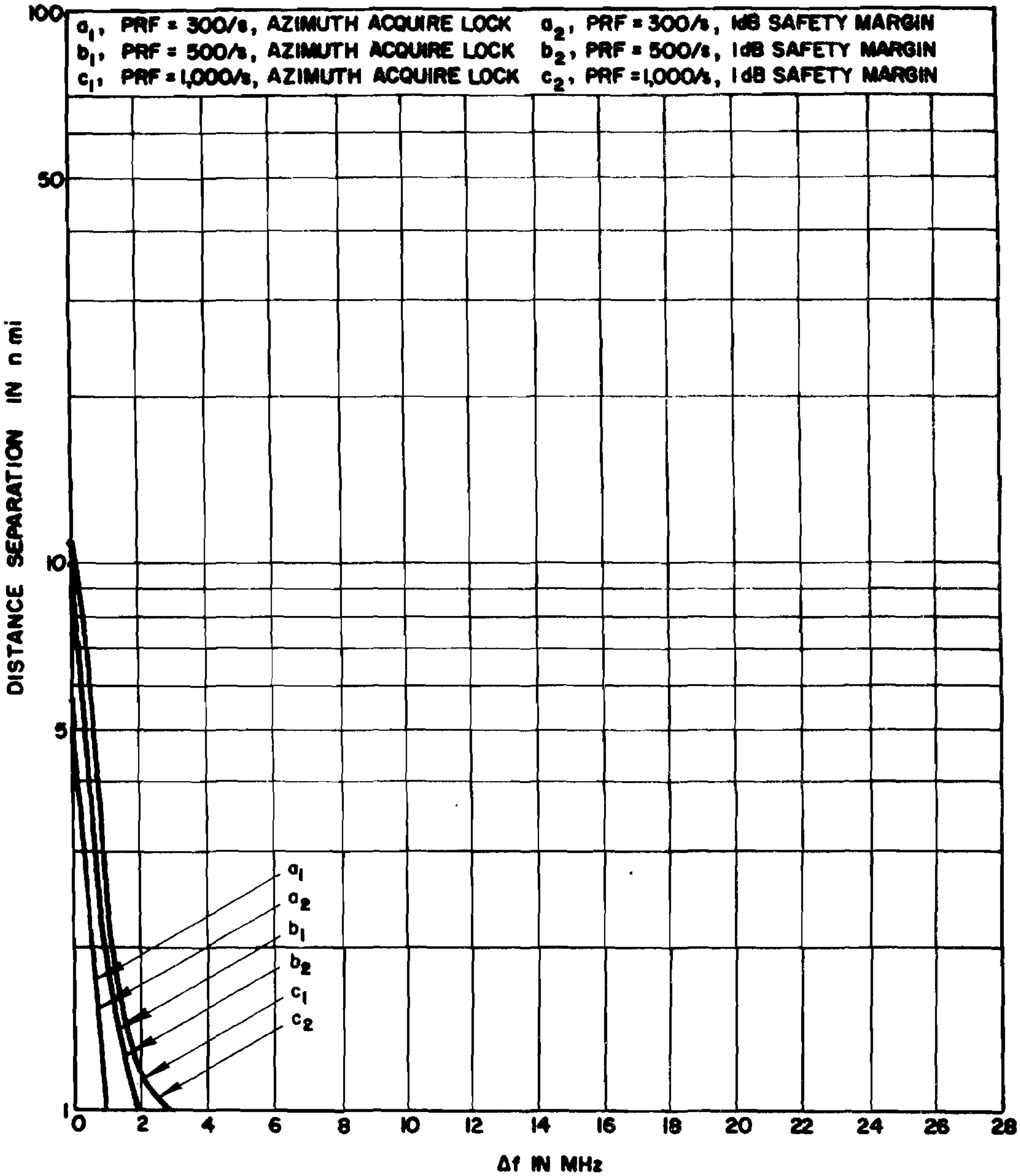


Figure B-61. Distance separation vs Δf for Y mode interrogator, DABS format #3, separation = 1 nmi.

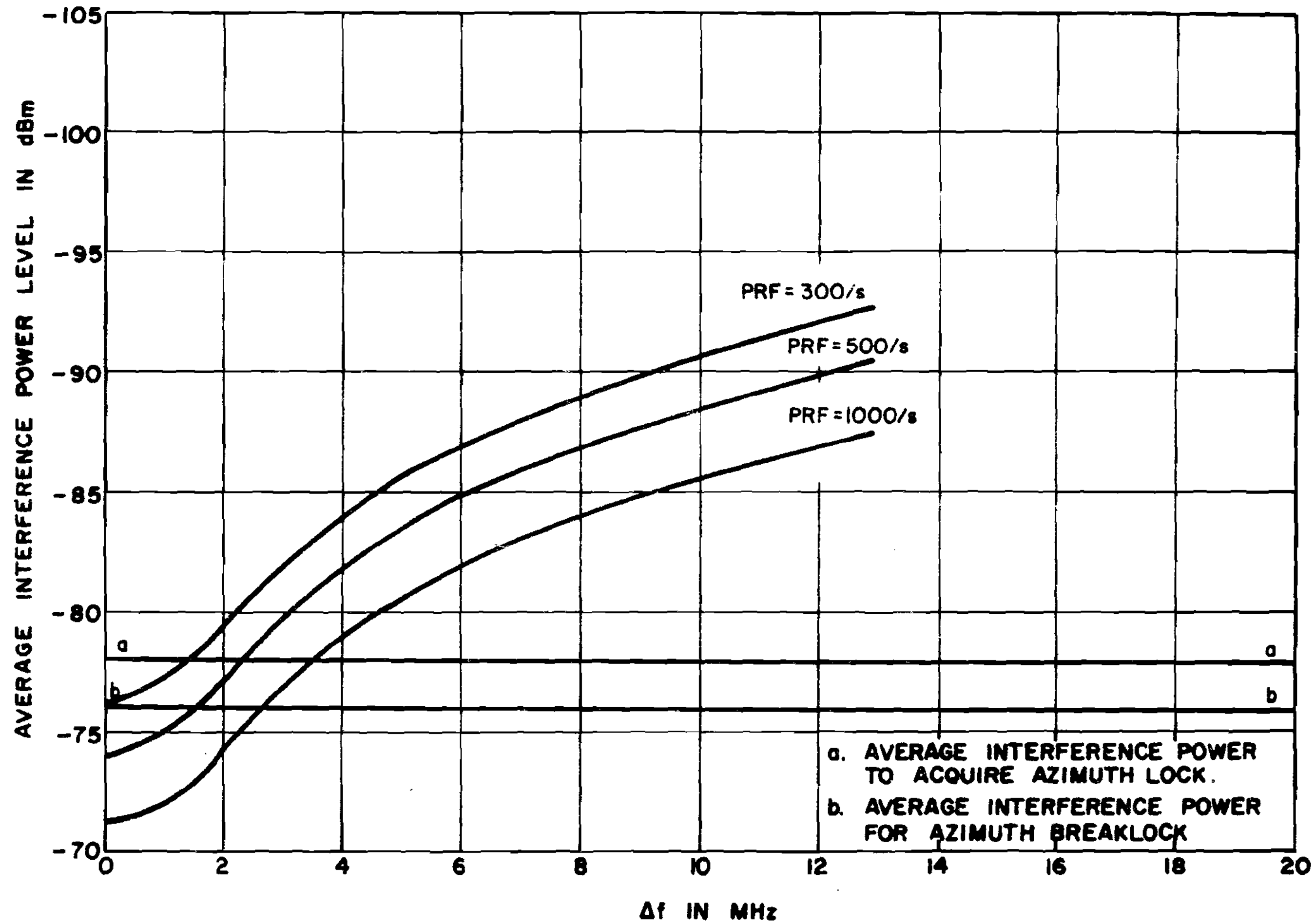


Figure B-62. Interference power level vs Δf for Y mode interrogator, DABS format #4, separation = 1 nmi.

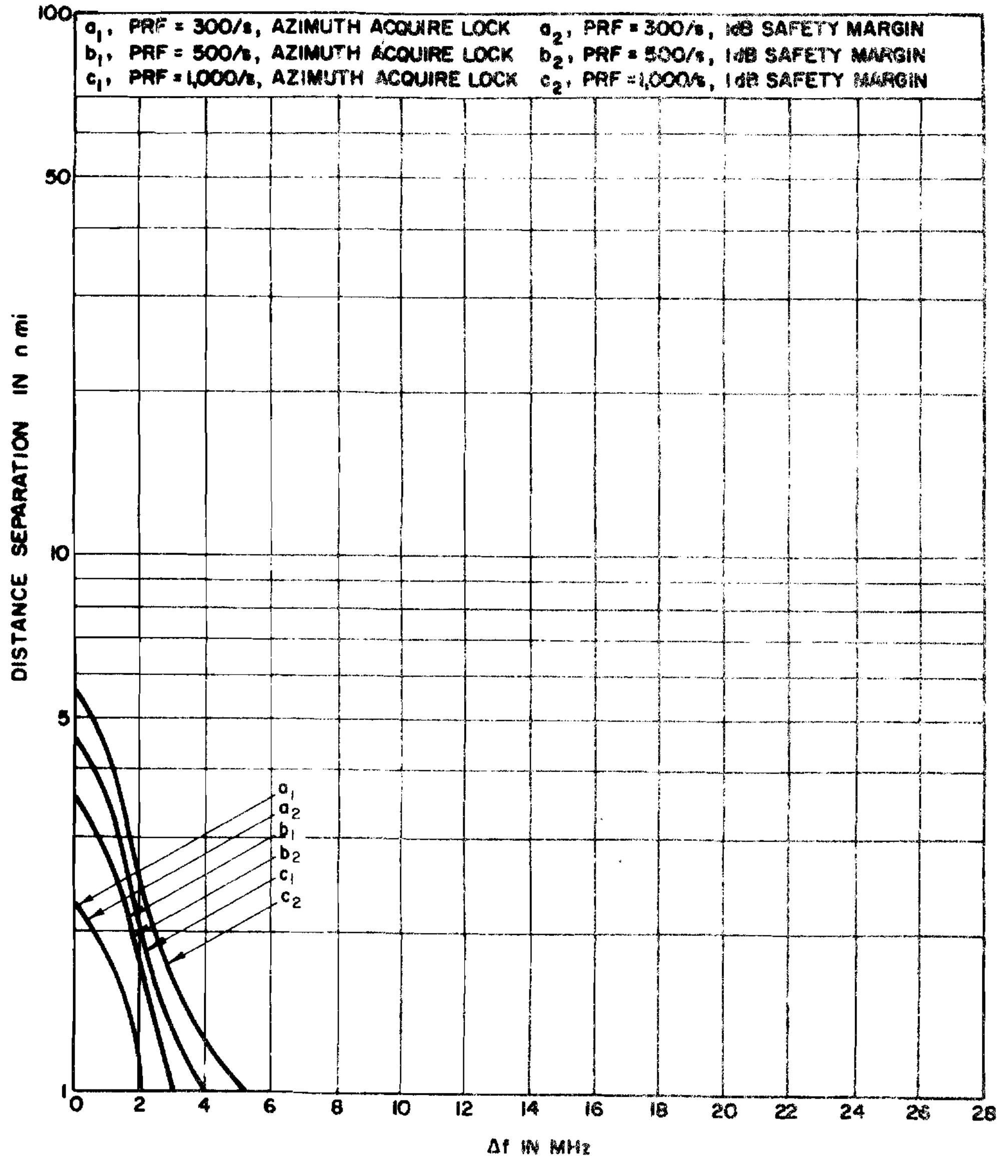


Figure B-63. Distance separation vs Δf for Y mode interrogator, DABS format #4, separation = 1 nmi.

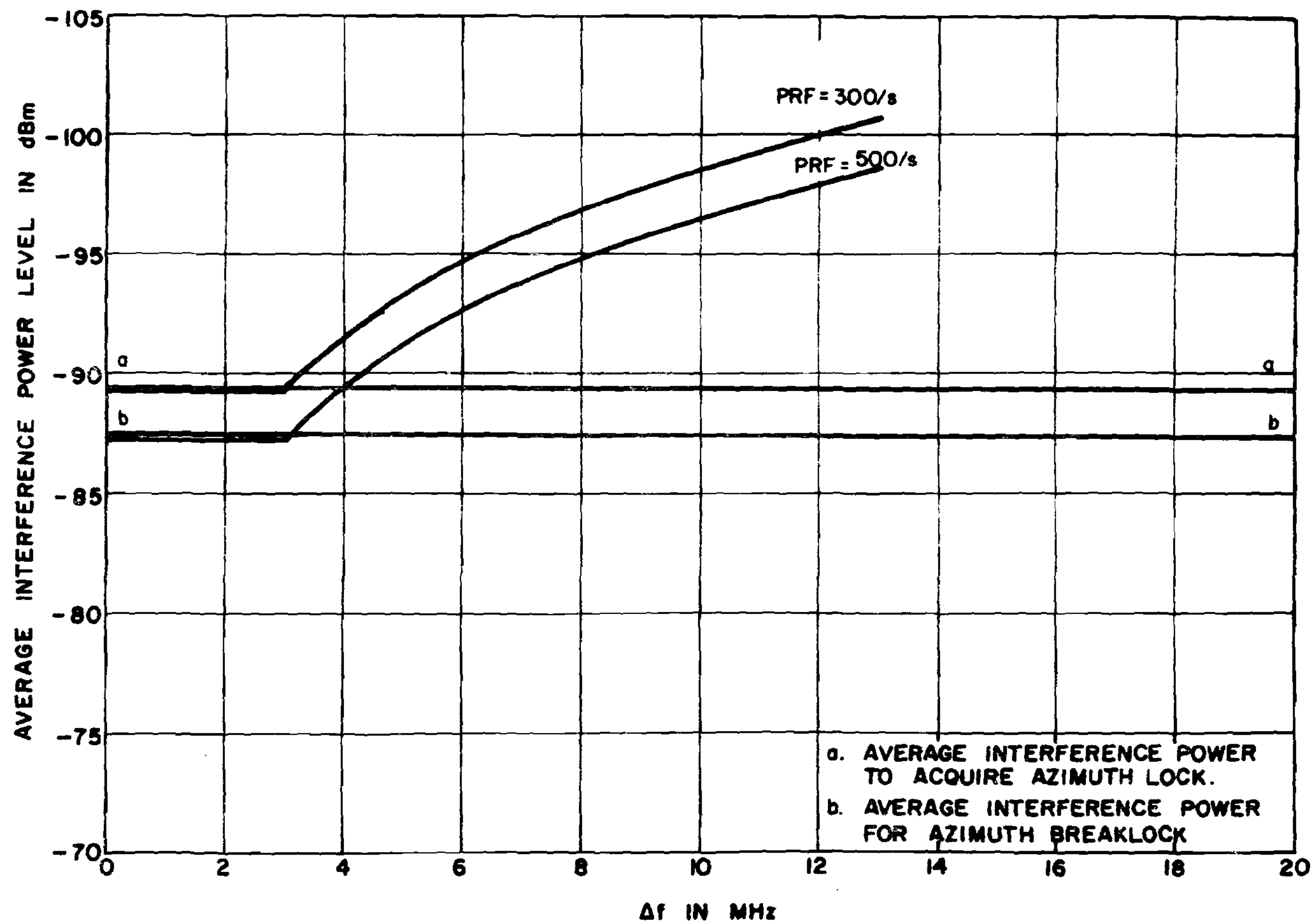


Figure B-64. Interference power level vs Δf for Y mode interrogator, DABS format #5, P_T = 250 W, separation = 1 nmi.

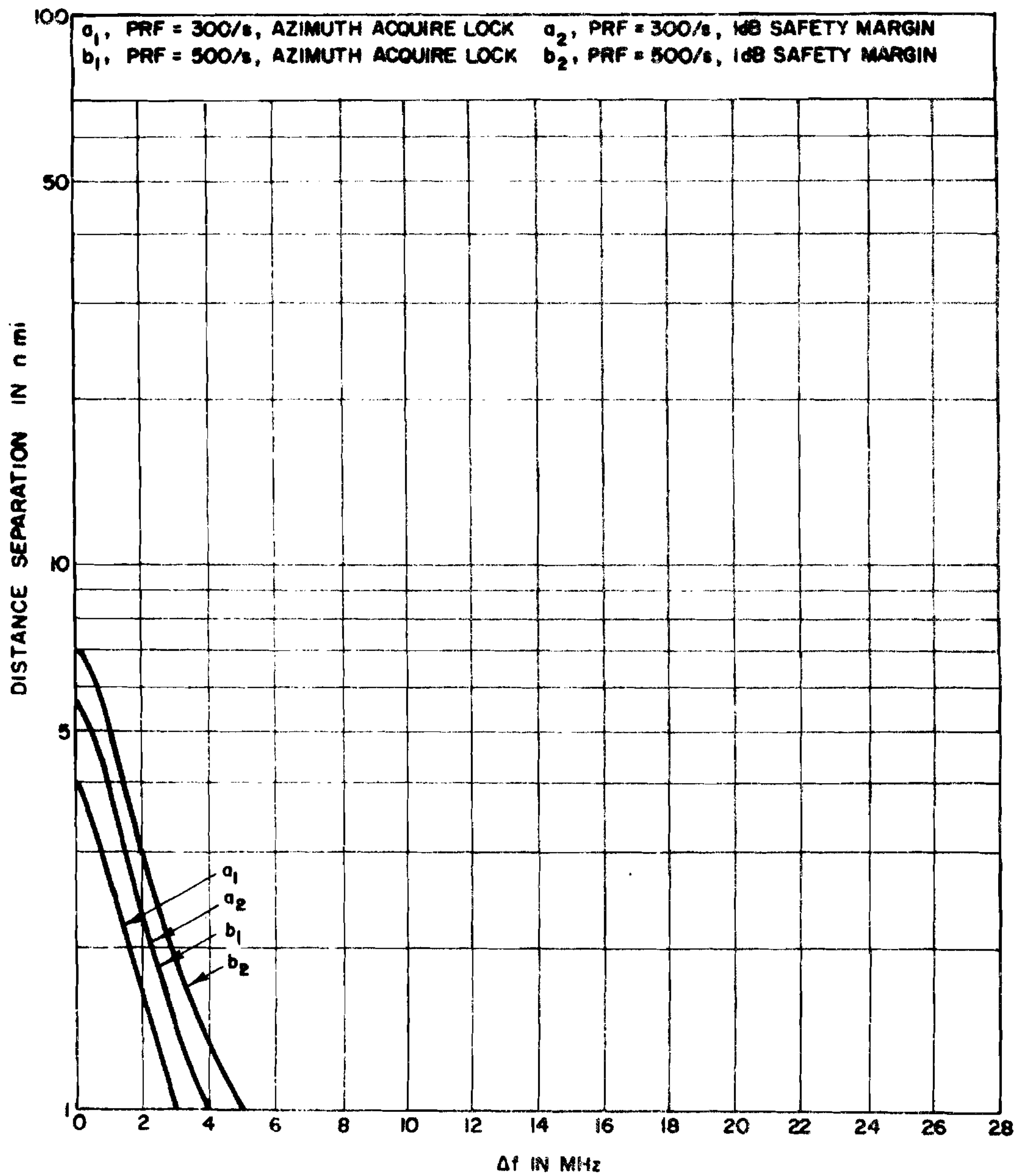


Figure B-65. Distance separation vs Δf for Y mode interrogator, DABS format #5, P_T = 250W, separations = 1 nmi.

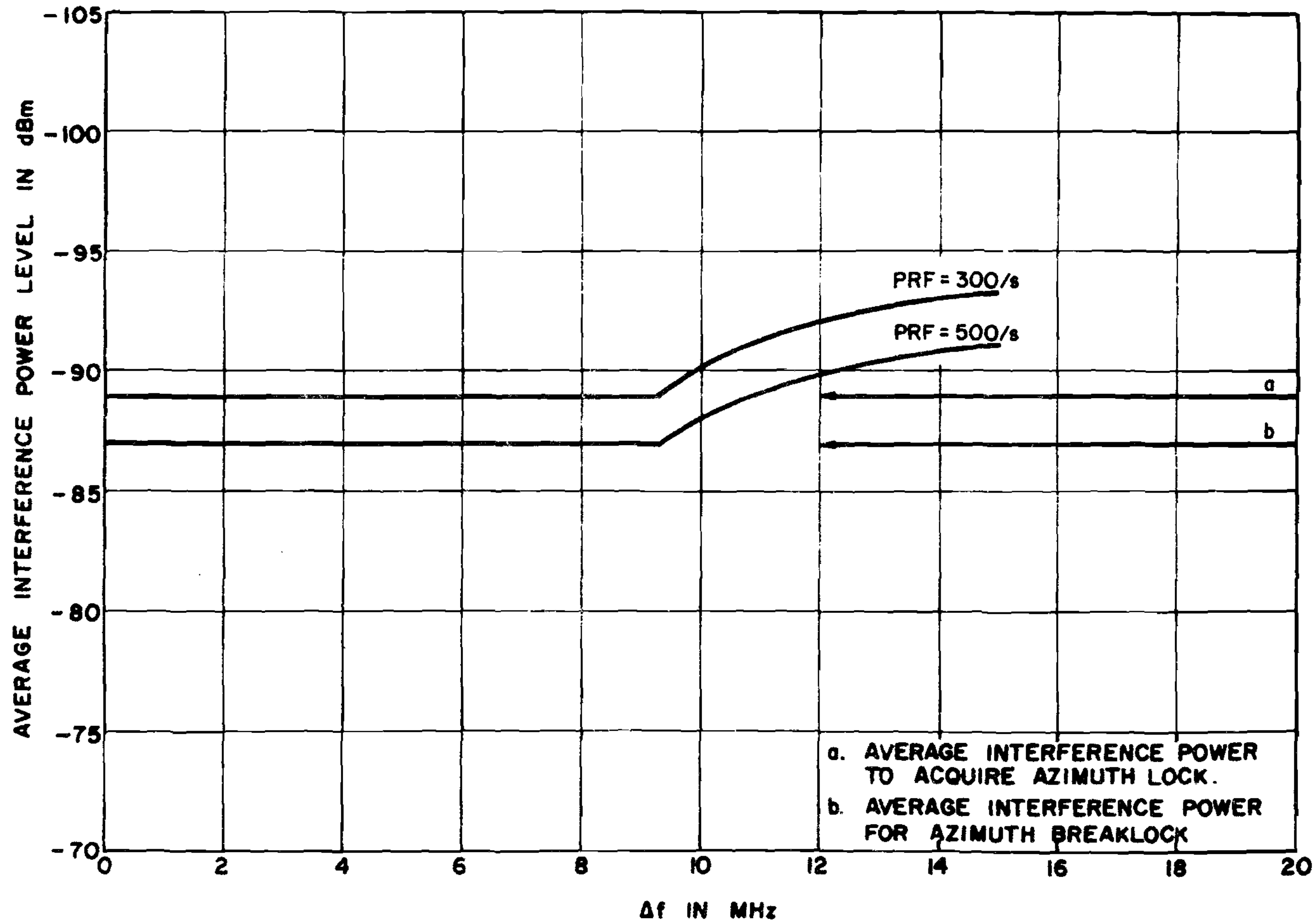


Figure B-66. Interference power level vs Δf for Y mode interrogator, DABS format #5, P_T = 2.5 kW, separation = 1 nmi.

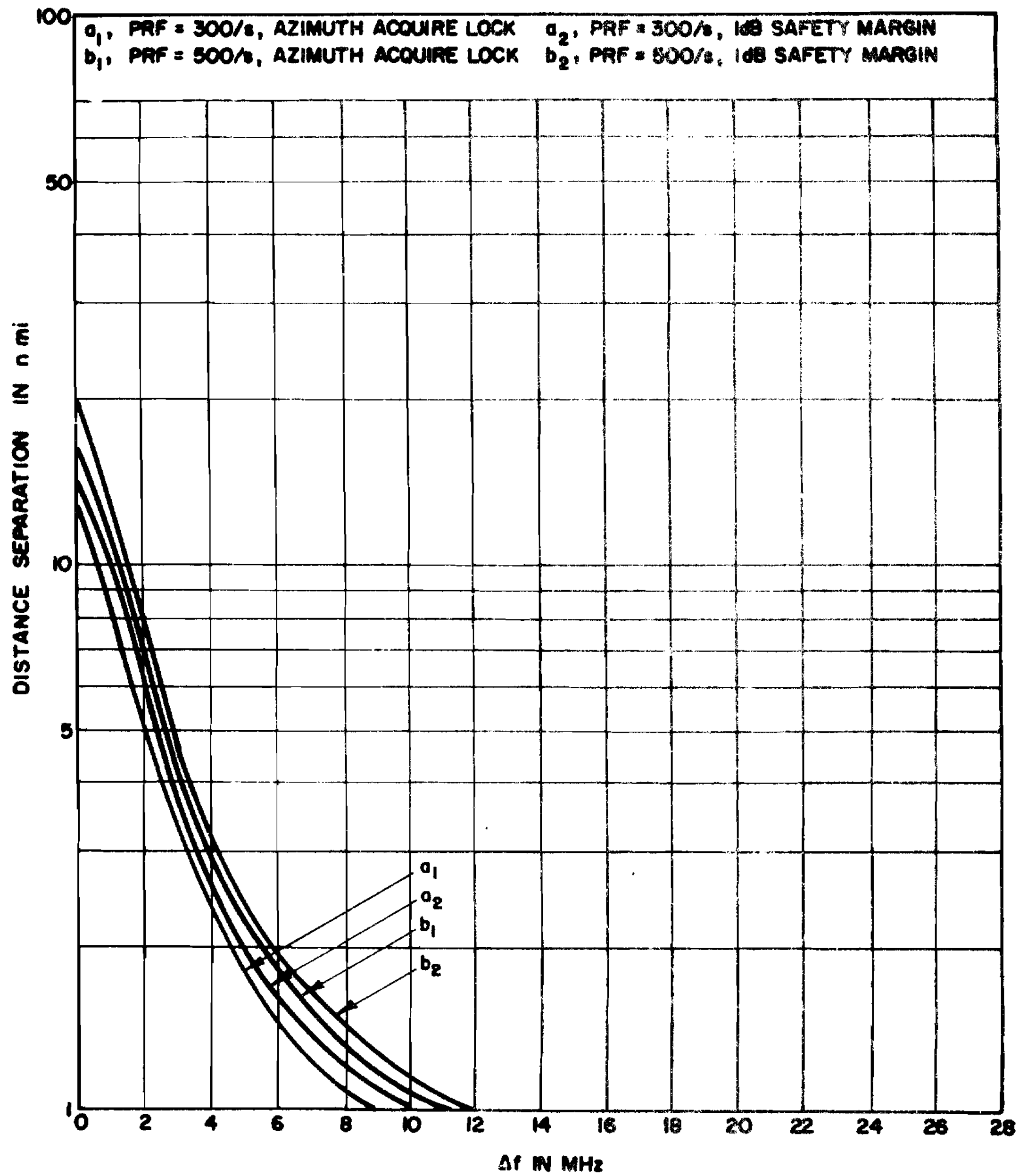


Figure B-67. Distance separation vs Δf for Y mode interrogator, DABS format #5, P_T = 2.5 kW, separation = 1 nmi.

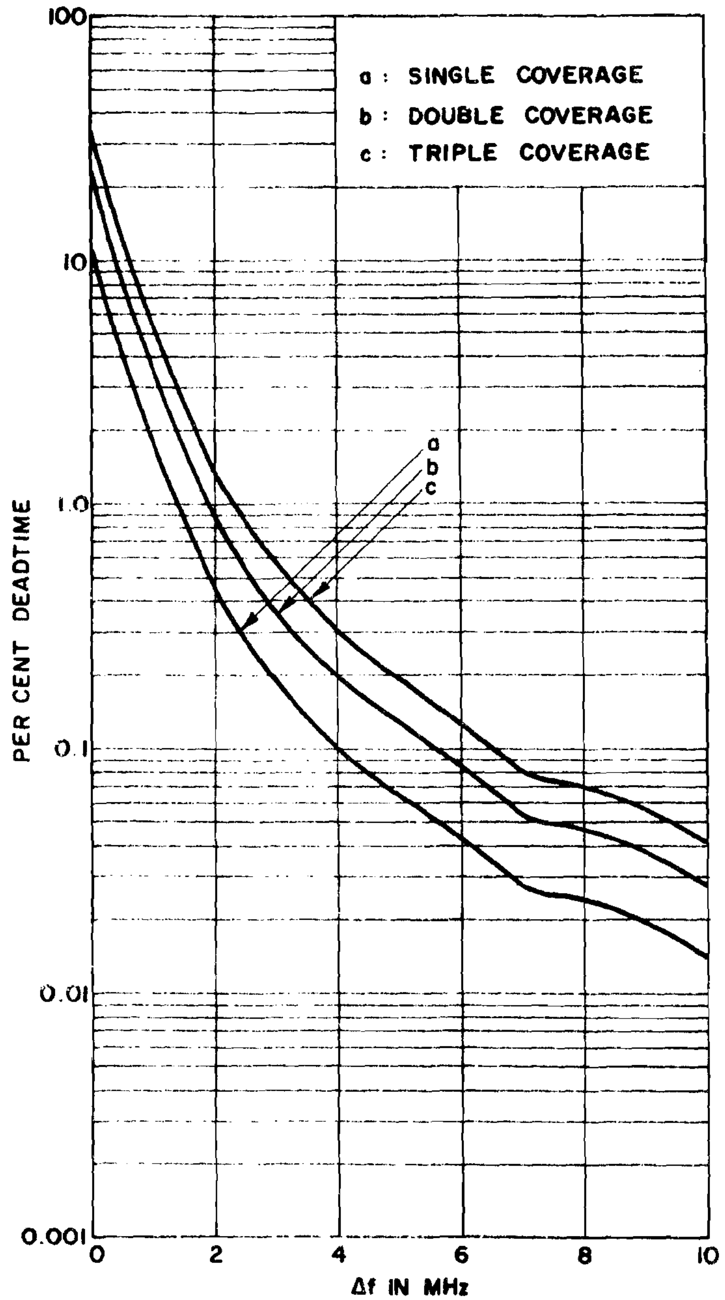


Figure B-68. Percent deadtime vs Δf for RTB-2 X mode, DABS format #6, downlink freq. = 1090 MHz.

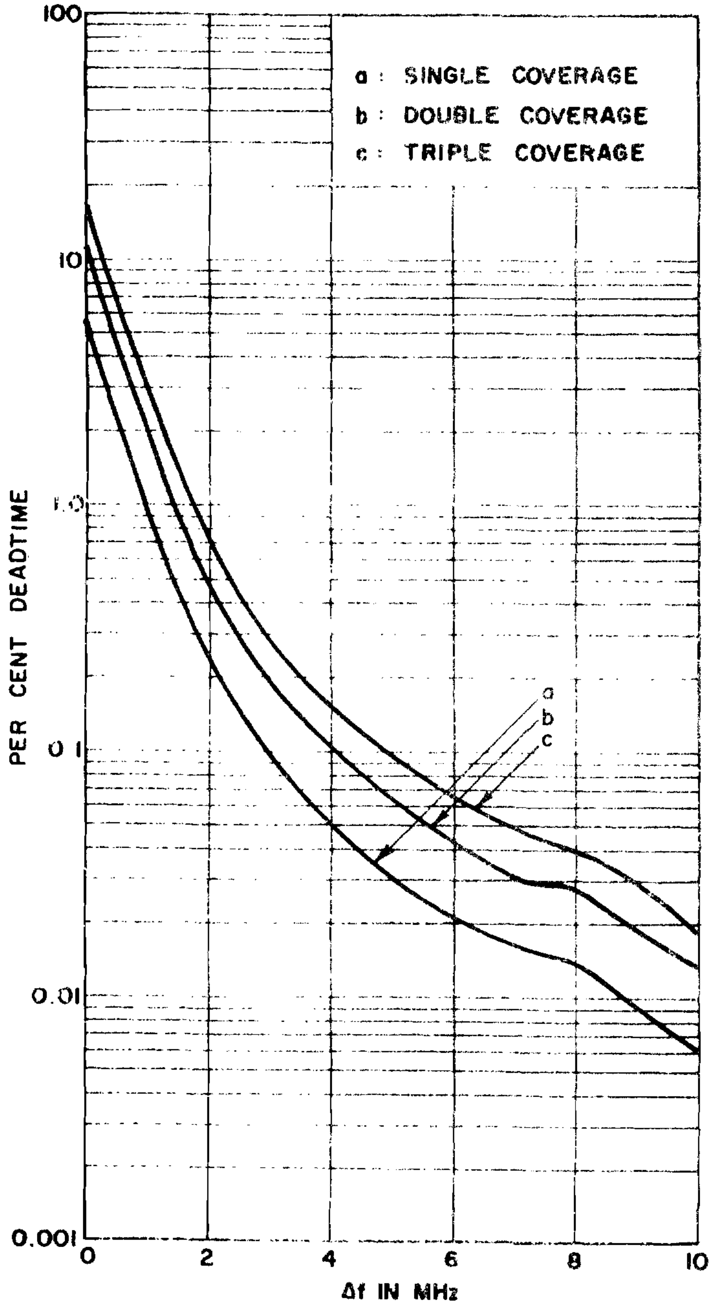


Figure B-69. Percent deadtime vs Δf for RTB-2 X mode, DABS format #7, downlink freq. = 1090 MHz.

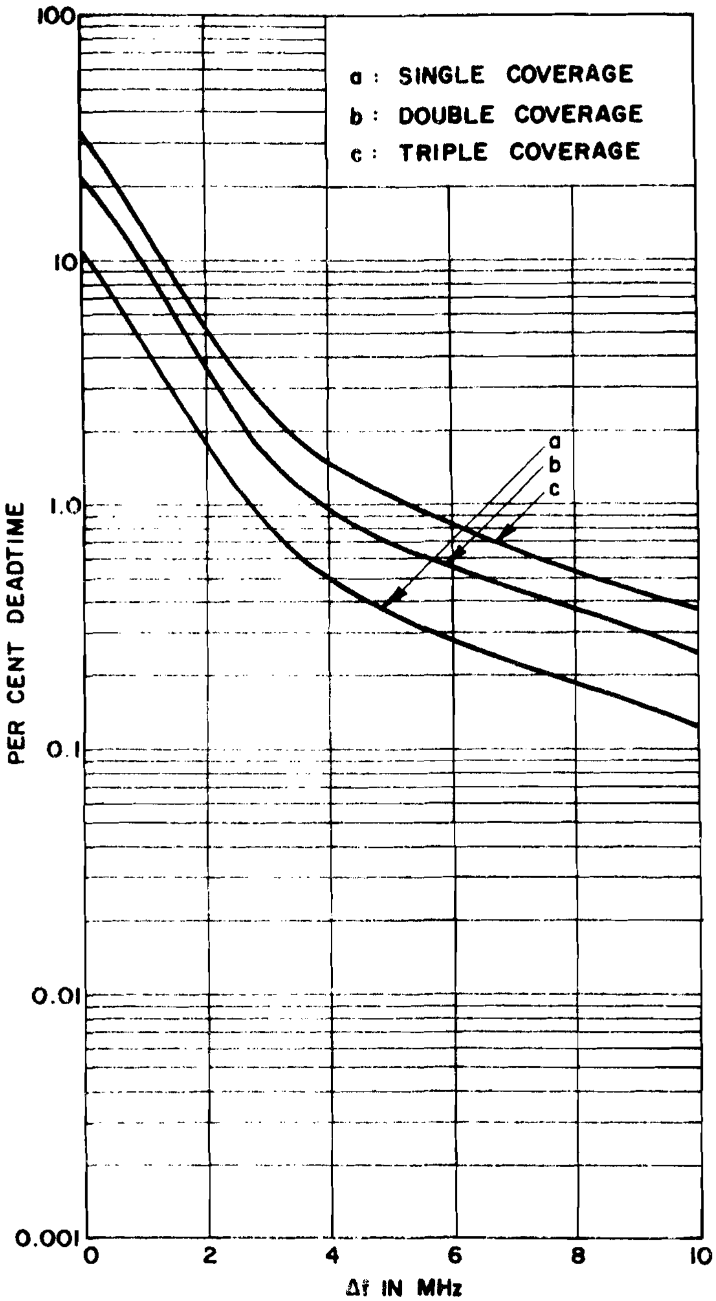


Figure B-70. Percent deadtime vs Δf for RTB-2 X mode, DABS format #8, downlink freq. = 1090 MHz.

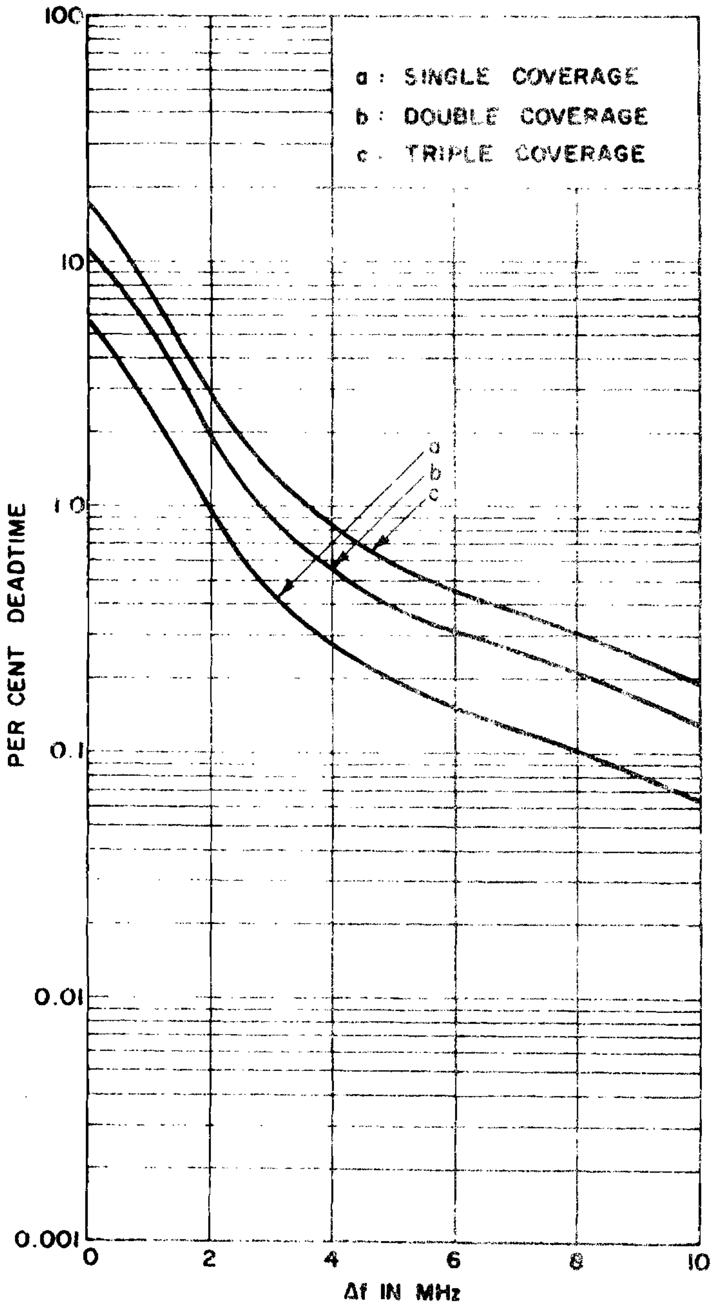


Figure B-71. Percent deadtime vs Δf for RTB-2 X mode, DABS format #9, downlink freq. = 1090 MHz.

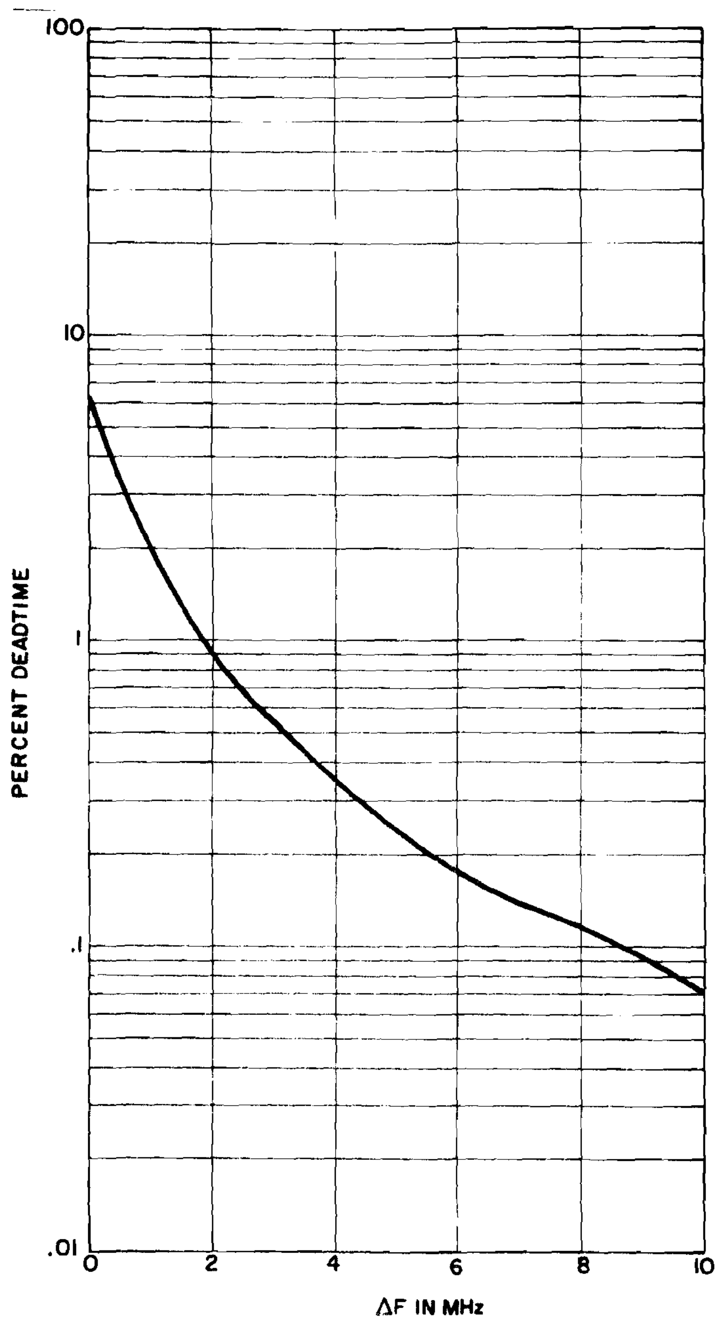


Figure B-72. Percent deadtime vs Δf for RTB-2 X mode, DABS format #10, downlink freq. = 1090 MHz.

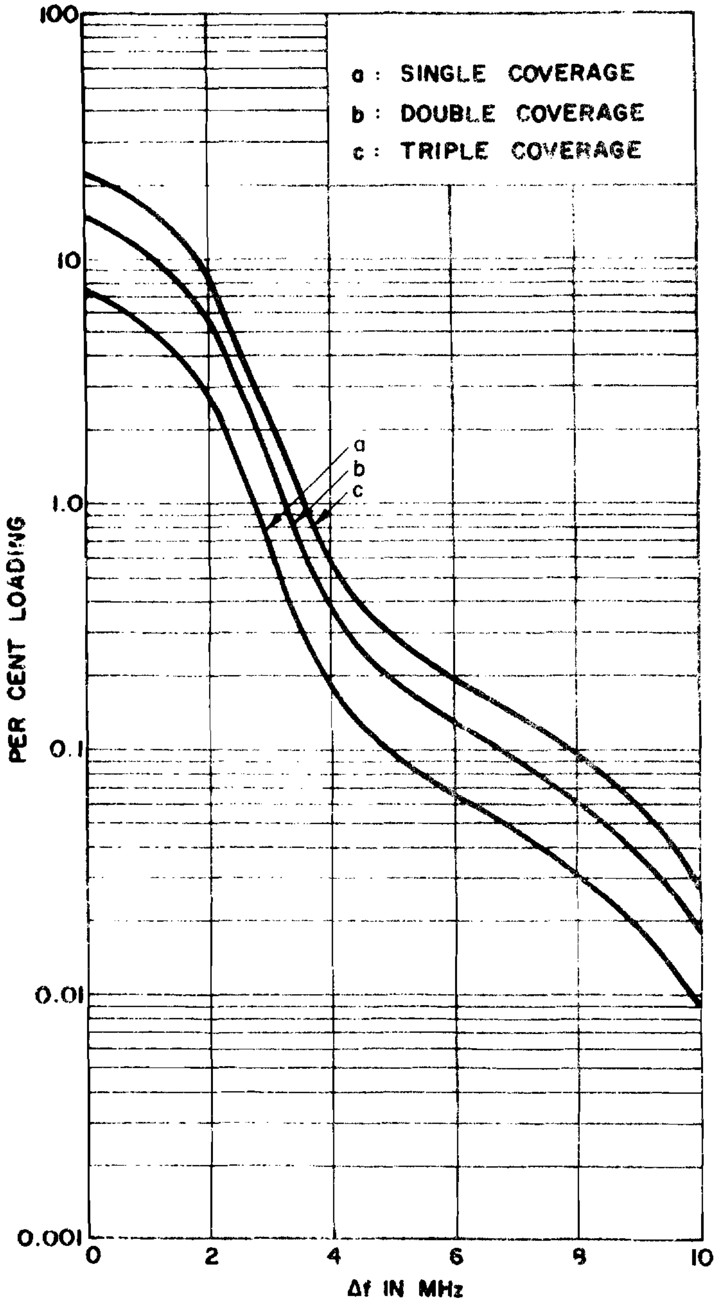


Figure B-73. Percent loading vs Δf for RTB-2 X mode beacon, DABS format #6, downlink freq. = 1090 ± 3 MHz.

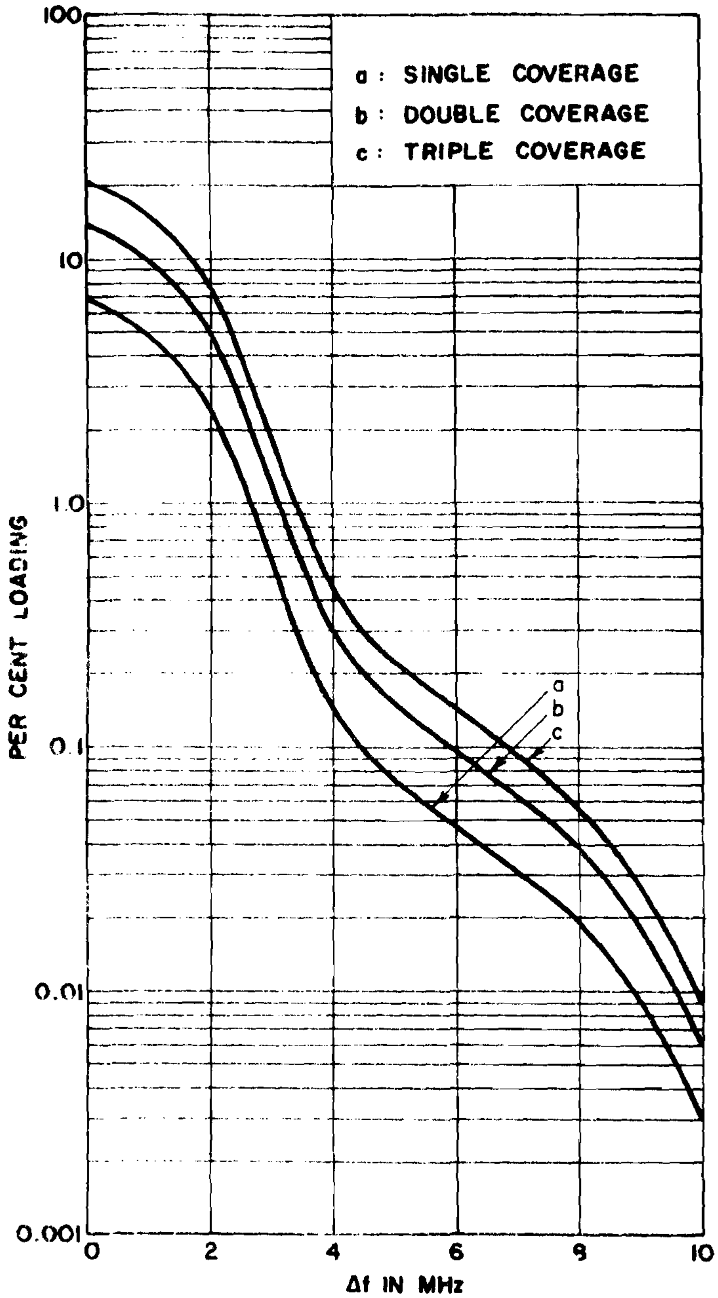


Figure B-74. Percent loading vs Δf for RTB-2 X mode beacon DABS format #7, downlink freq. = 1090 ± 3 MHz.

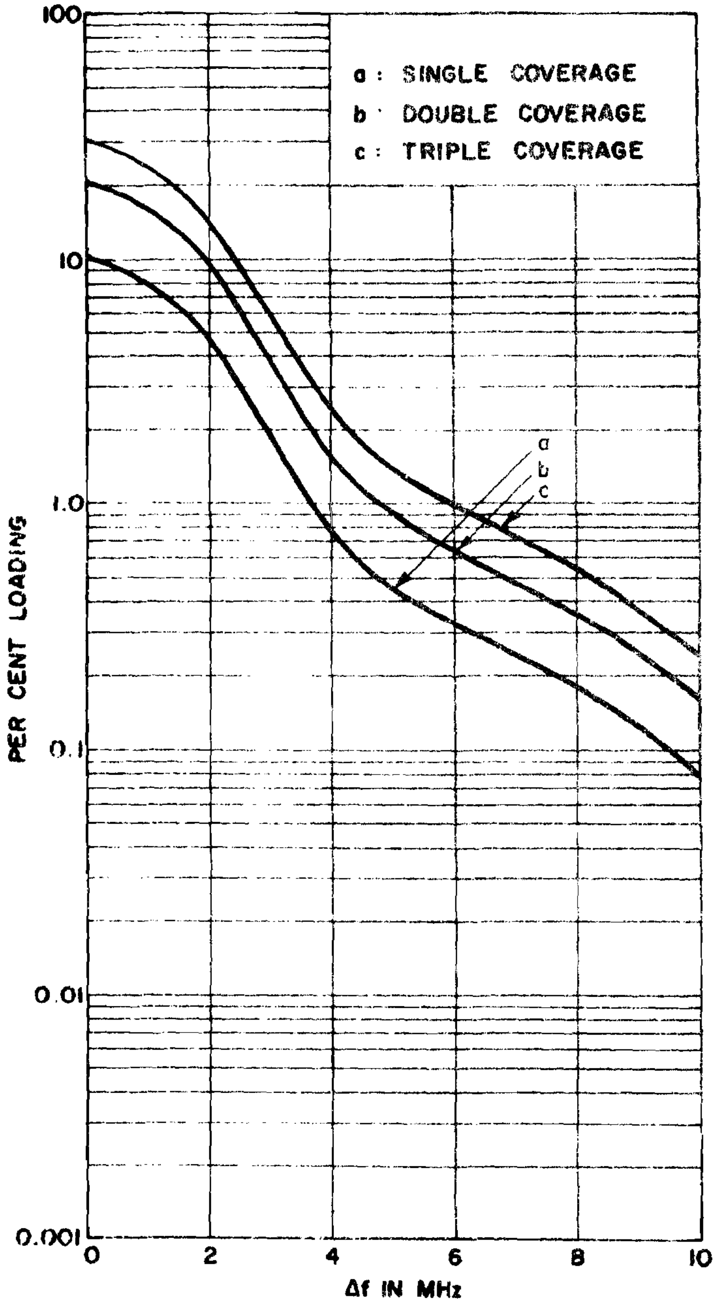


Figure B-75. Percent loading vs Δf for RTB-2 X mode beacon DABS formats 8 and 9, downlink freq. = 1090 ± 3 MHz.

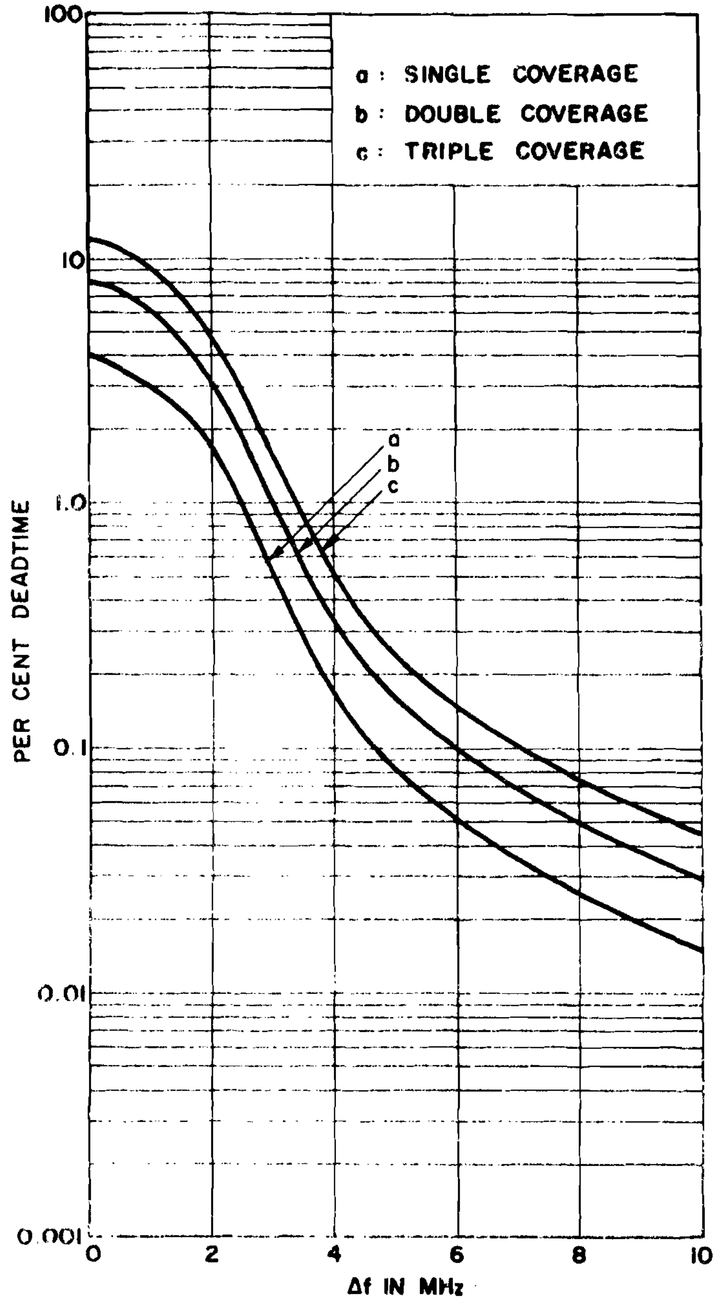


Figure B-76. Percent deadtime vs Δf for RTB-2 X mode beacon DABS format #6, downlink freq. = 1090 ± 3 MHz.

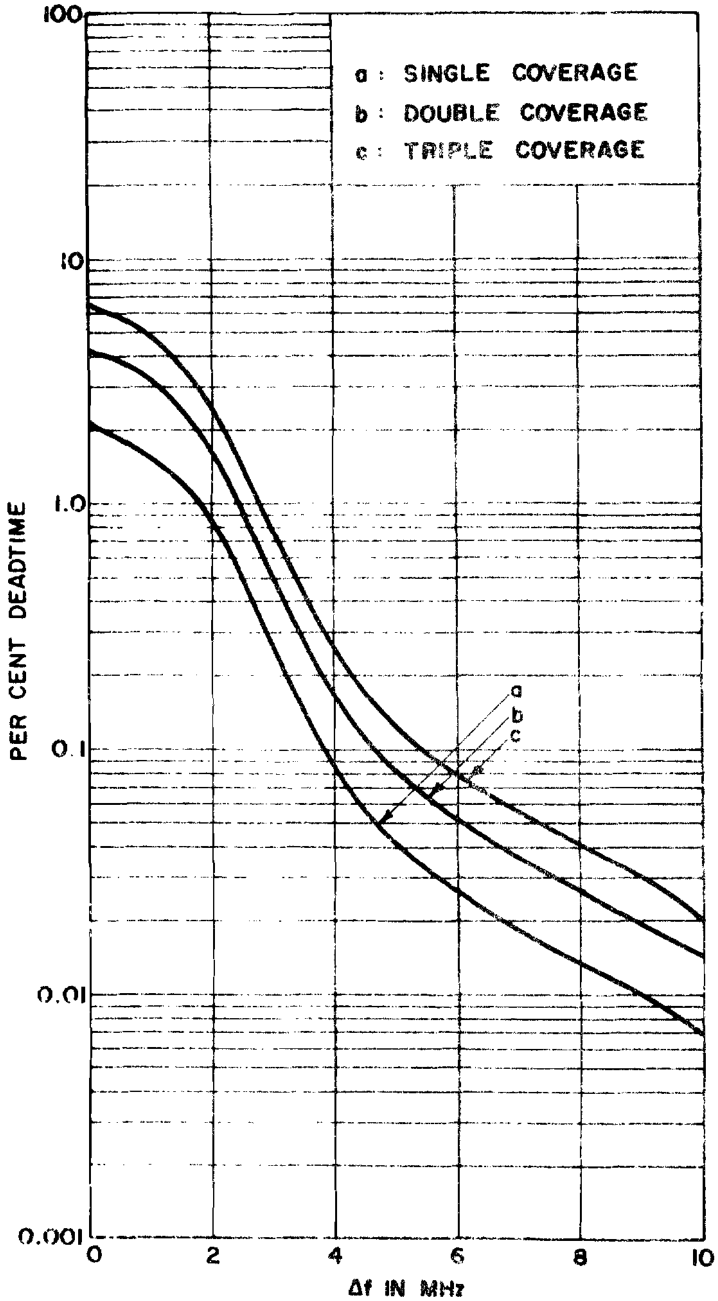


Figure B-77. Percent deadtime vs Δf for RTB-2 X mode beacon DABS format #7, downlink freq. = 1090 ± 3 MHz.

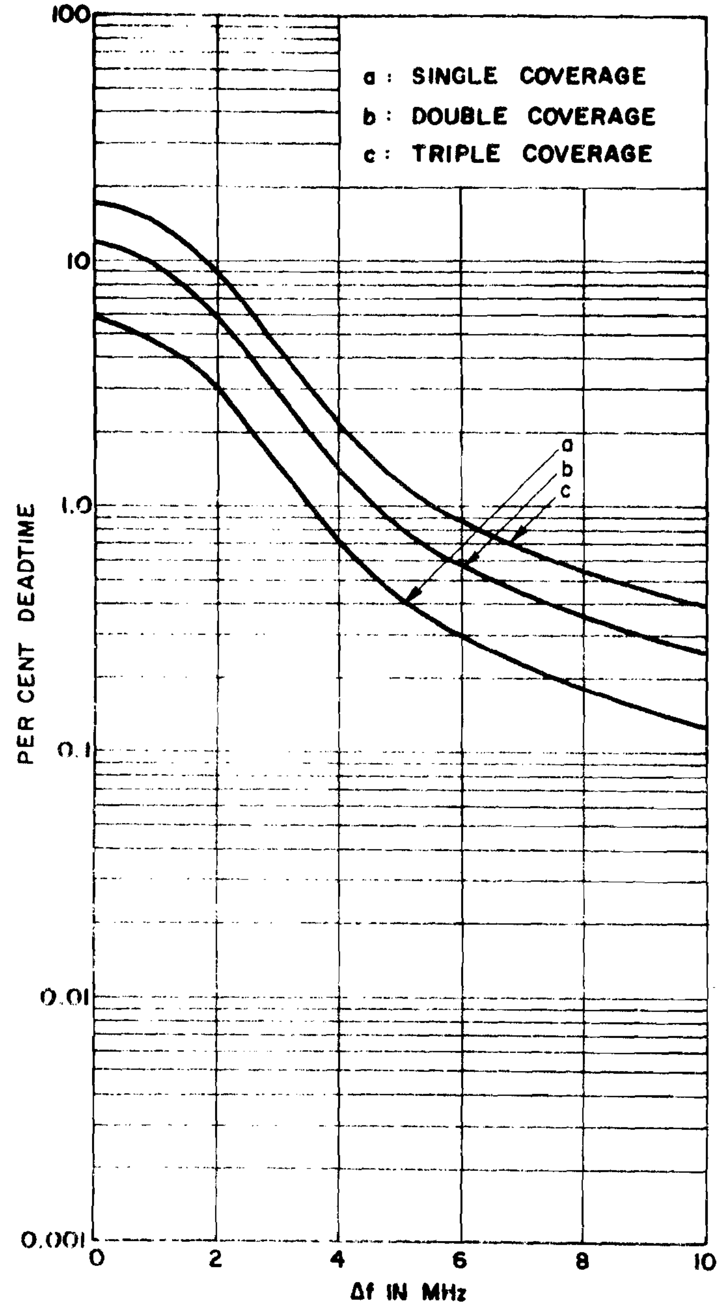


Figure B-78. Percent deadtime vs Δf for RTB-2 X mode beacon DABS format #8, downlink freq. = 1090 ± 3 MHz.

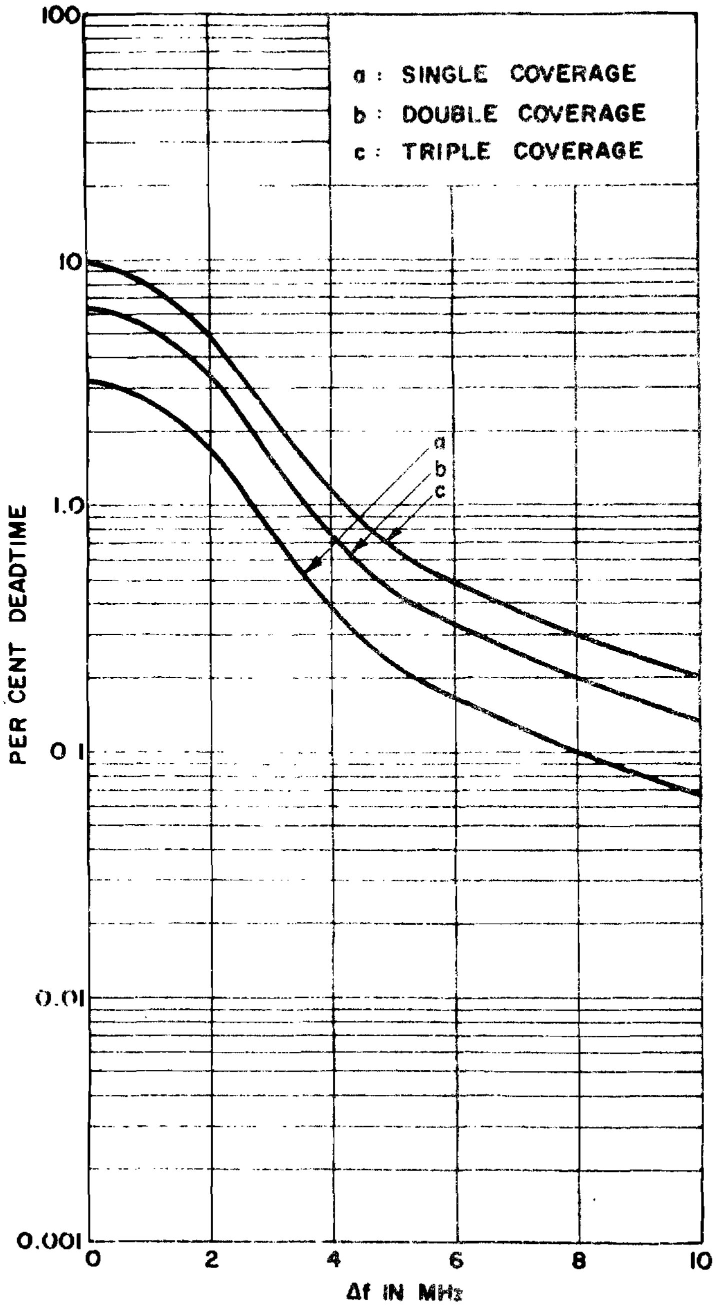


Figure B-79. Percent deadtime vs Δf for RTB-2 X mode beacon DABS format #9, downlink freq. = 1090 ± 3 MHz.

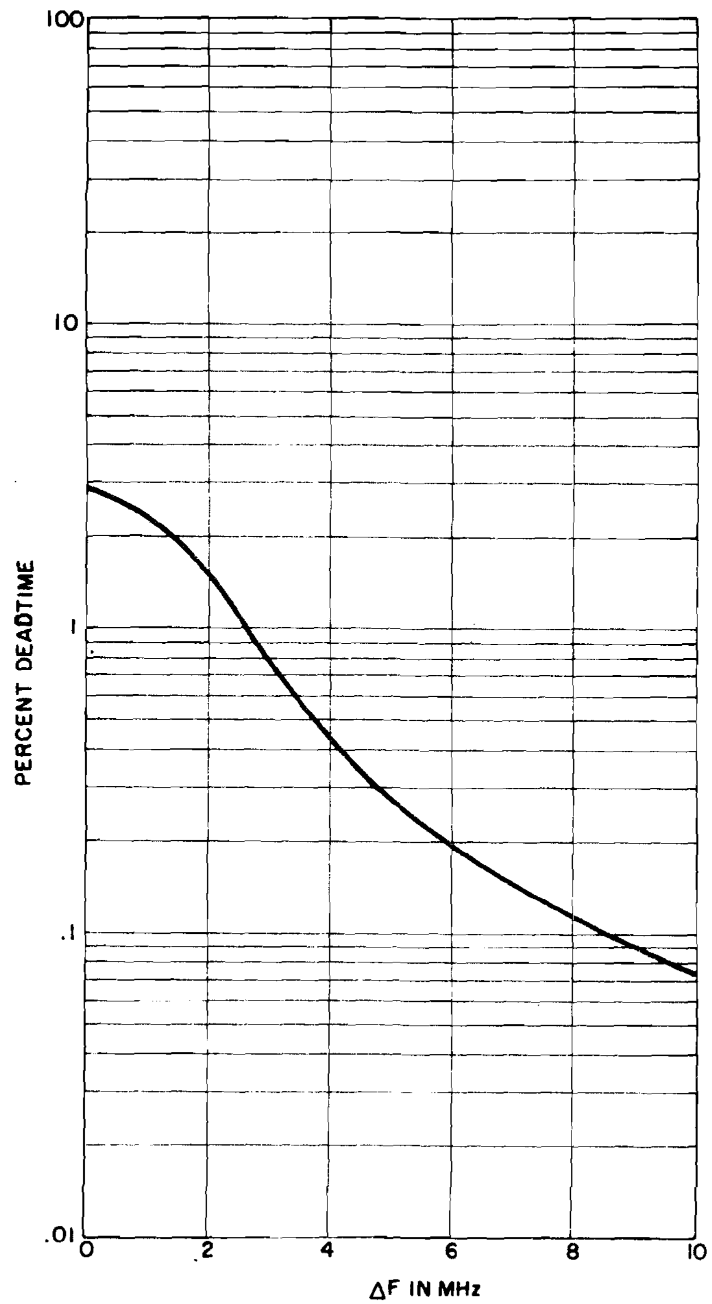


Figure B-80. Percent deadtime vs Δf for RTB-2 X mode beacon DABS format #10, downlink freq. = 1090 ± 3 MHz.

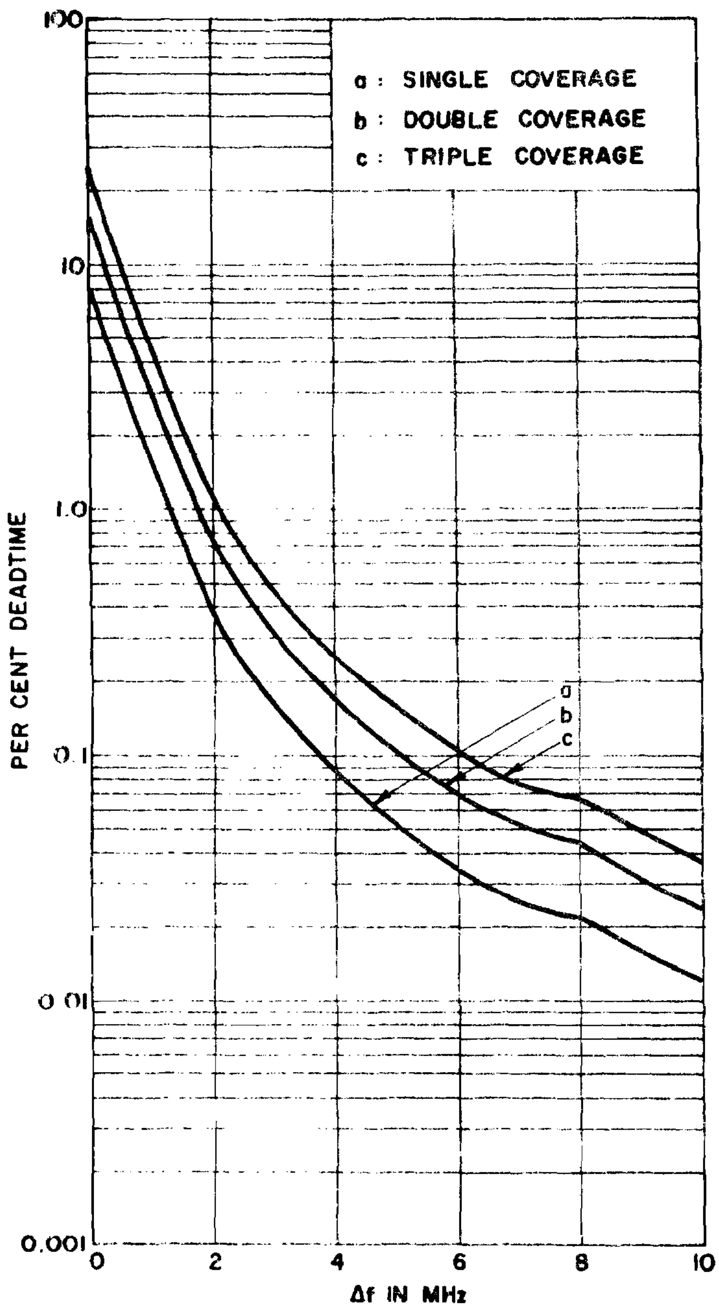


Figure B-81. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #6, downlink freq. = 1090 MHz.

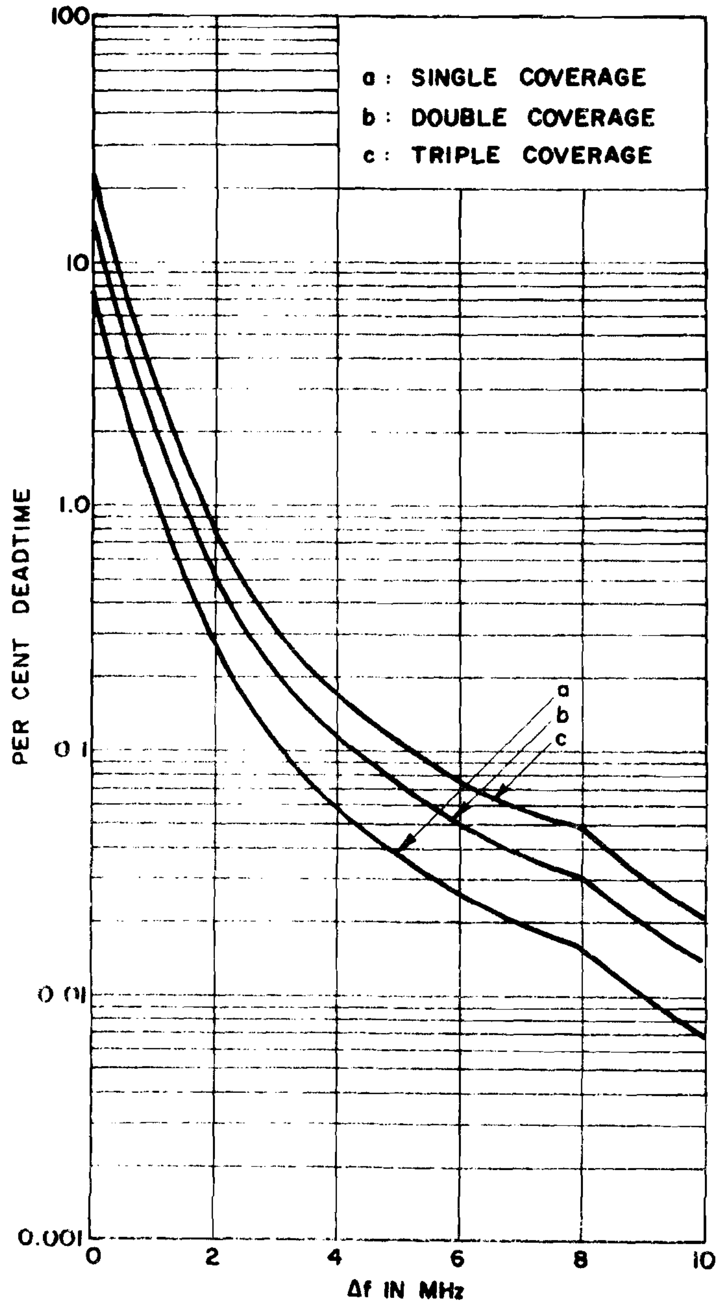


Figure B-82. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #7, downlink freq. = 1090 MHz.

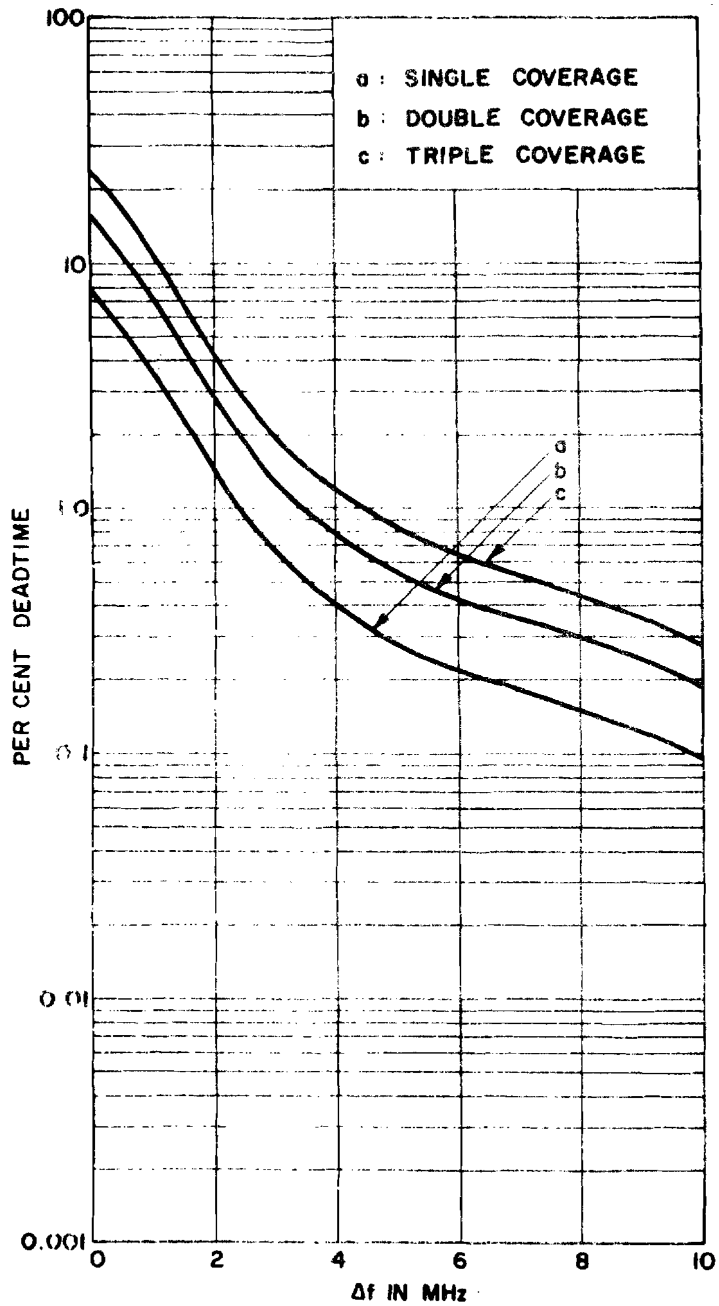


Figure B-83. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #8, downlink freq. = 1090 MHz.

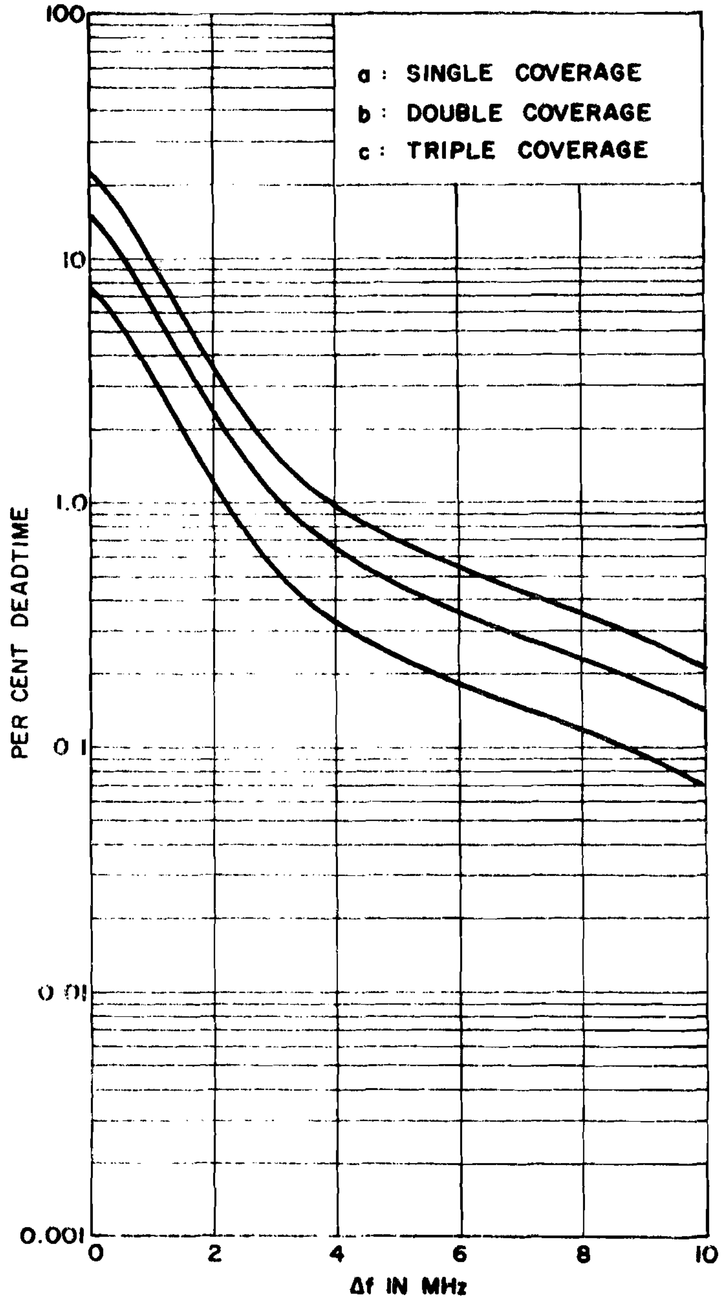


Figure B-84. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #9, downlink freq. = 1090 MHz.

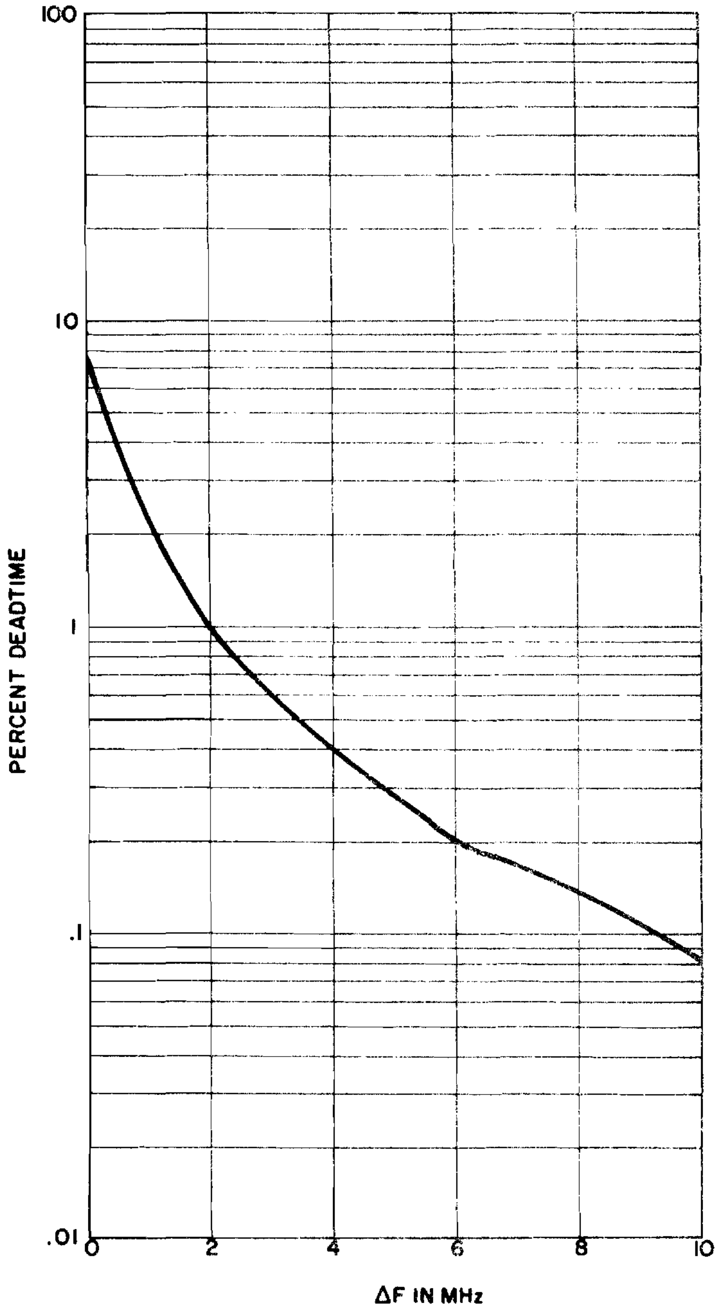


Figure B-85. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #10, downlink freq. = 1090 MHz.

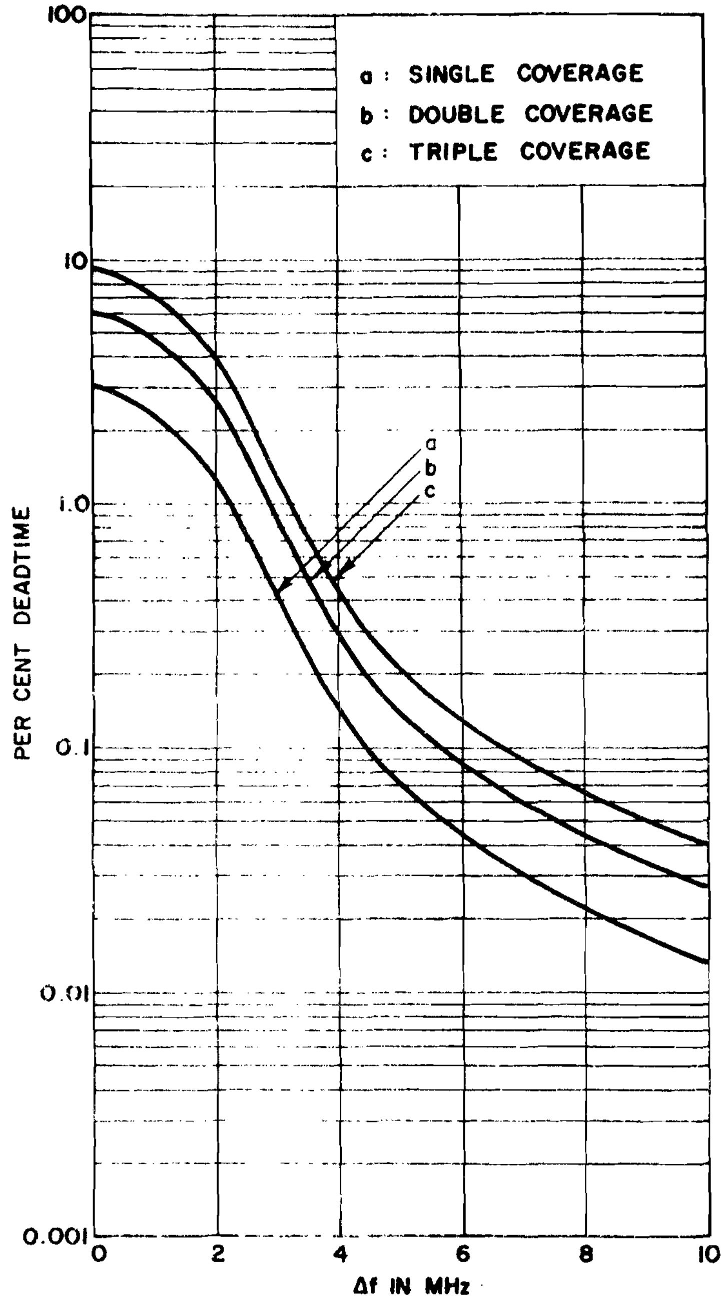


Figure B-86. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #6, downlink freq. = 1090 ± 3 MHz.

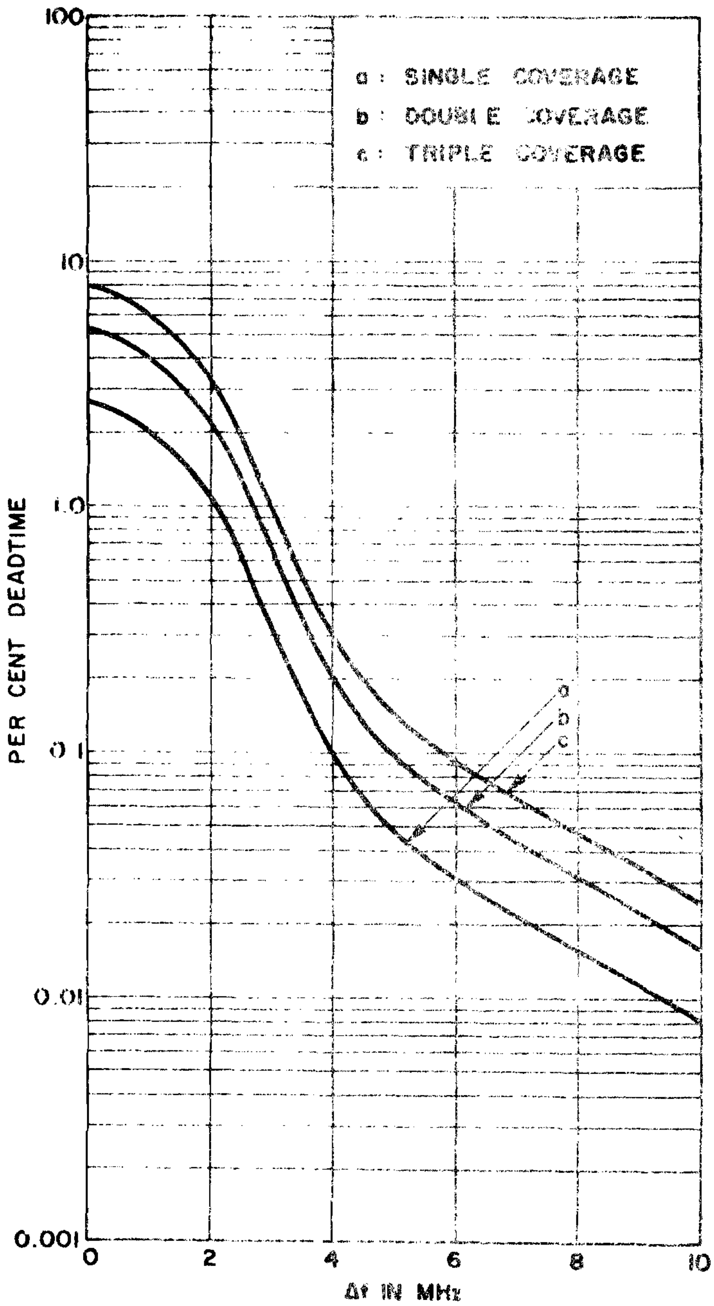


Figure B-87. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #7, downlink freq. = 1090 ± 3 MHz.

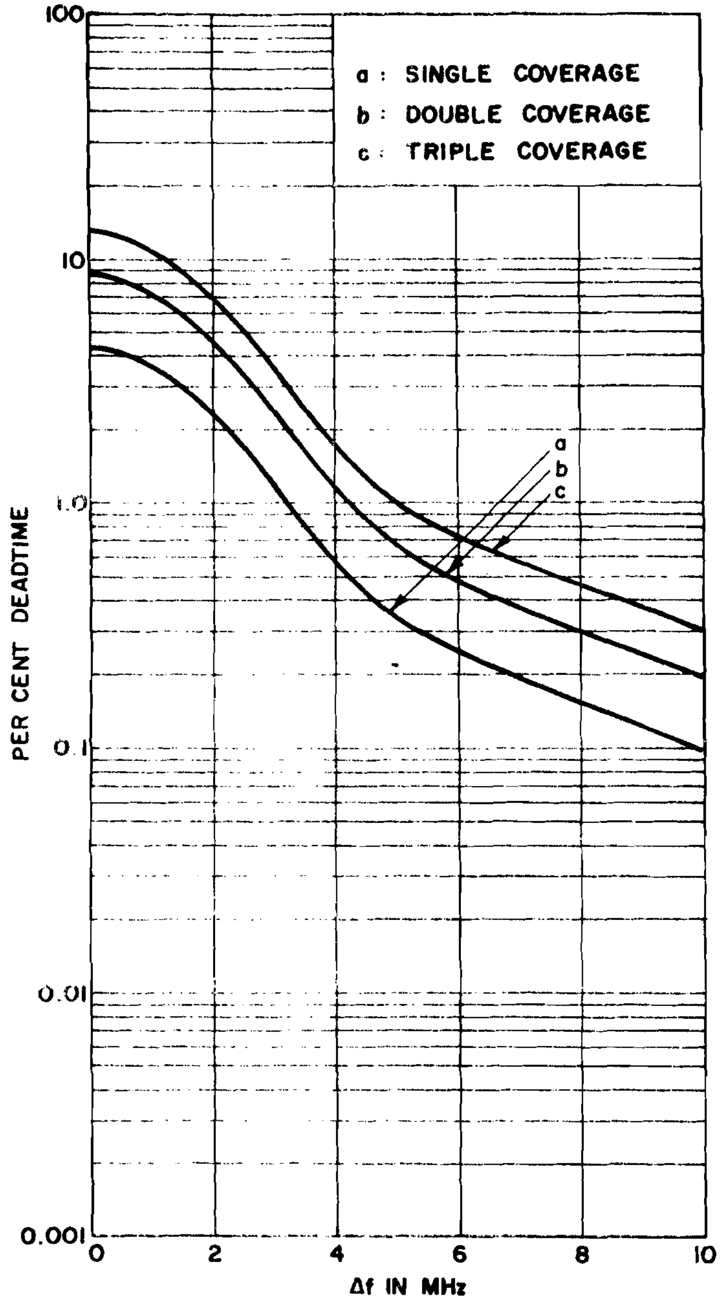


Figure B-88. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #8, downlink freq. = 1090 ± 3 MHz.

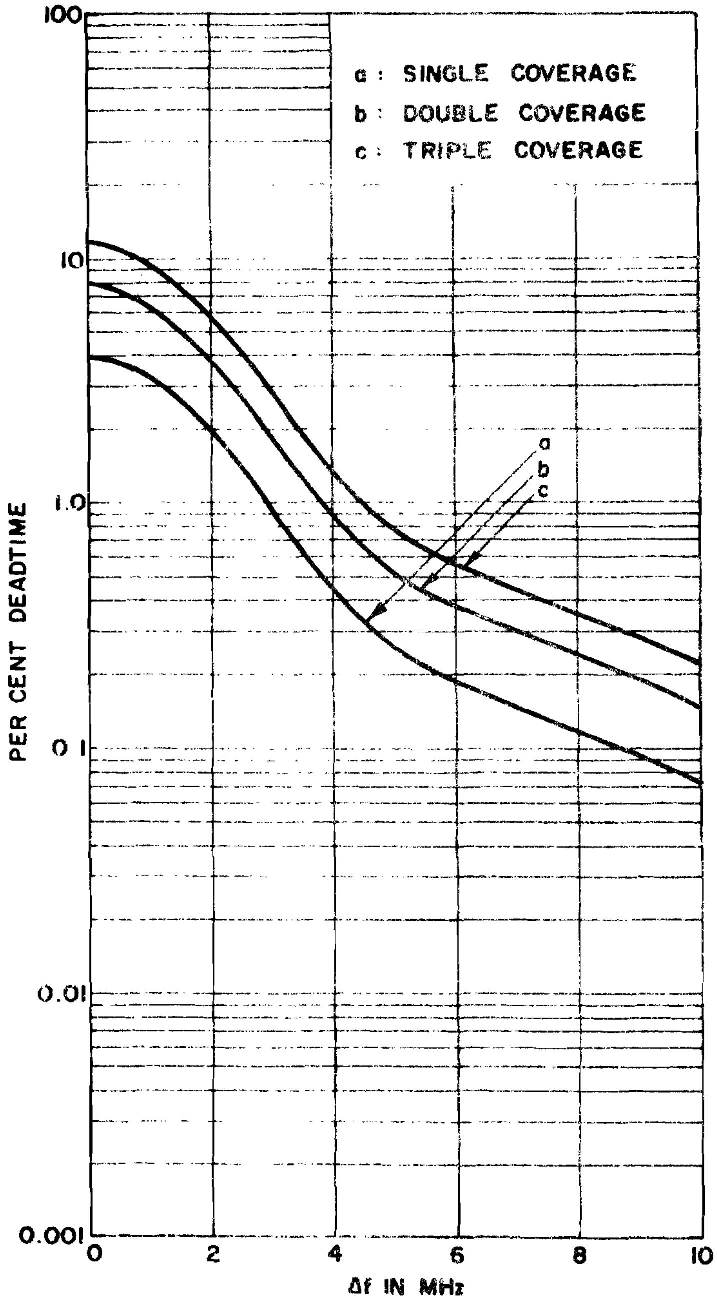


Figure B-89. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #9, downlink freq. = 1090 ± 3 MHz.

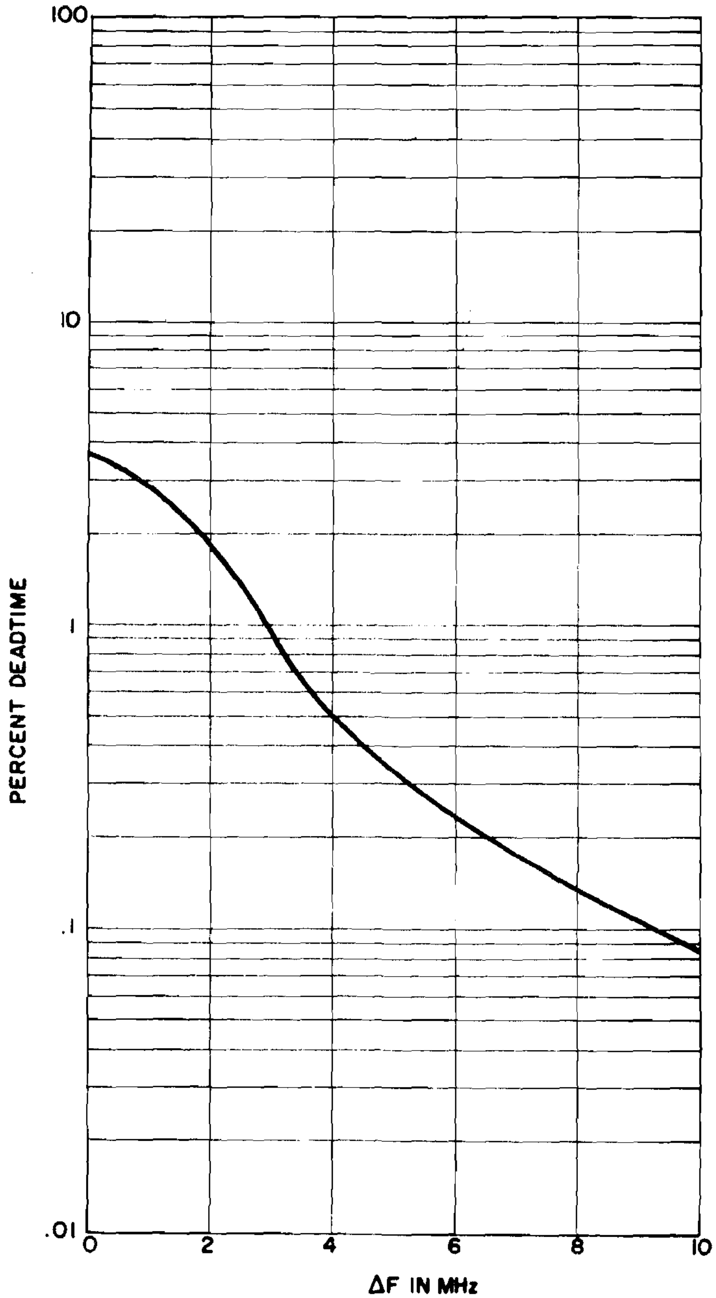


Figure B-90. Percent deadtime vs Δf for RTB-2 Y mode beacon DABS format #10, downlink freq. = 1090 ± 3 MHz.

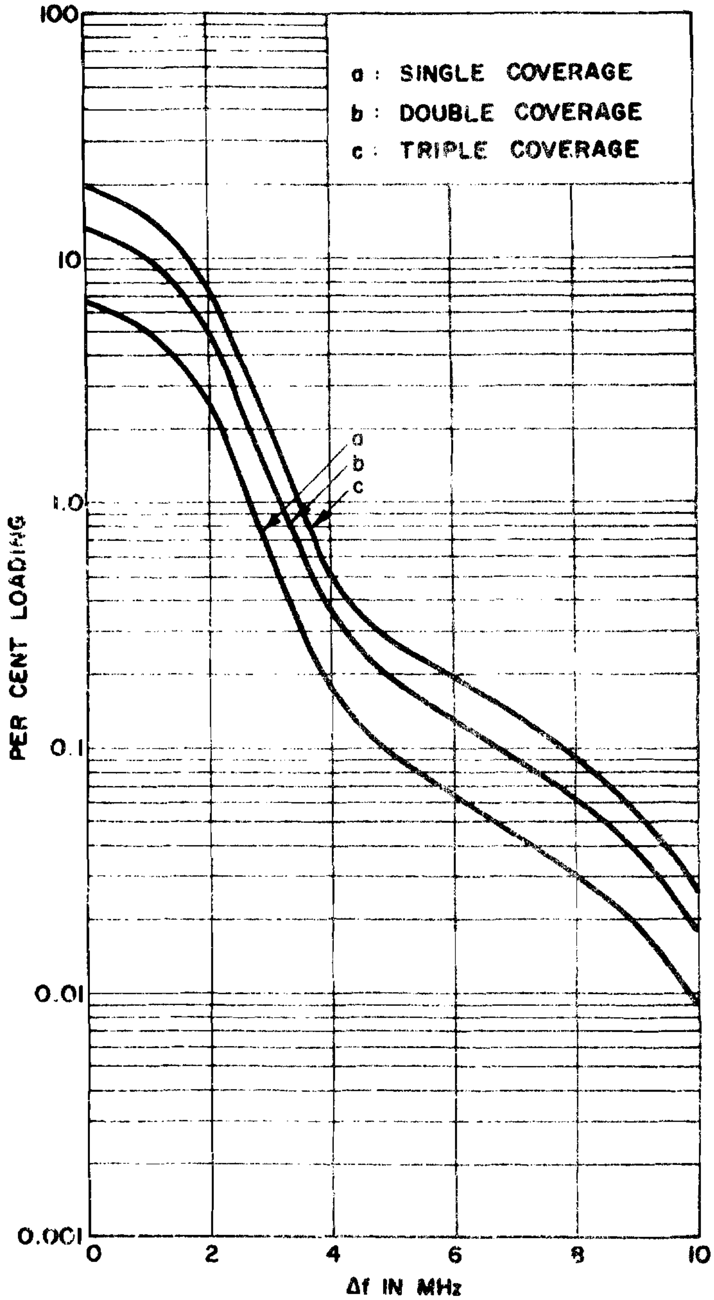


Figure B-91. Percent loading vs Δf for RTB-2 Y mode beacon DABS format #6, downlink freq. = 1090 ± 3 MHz.

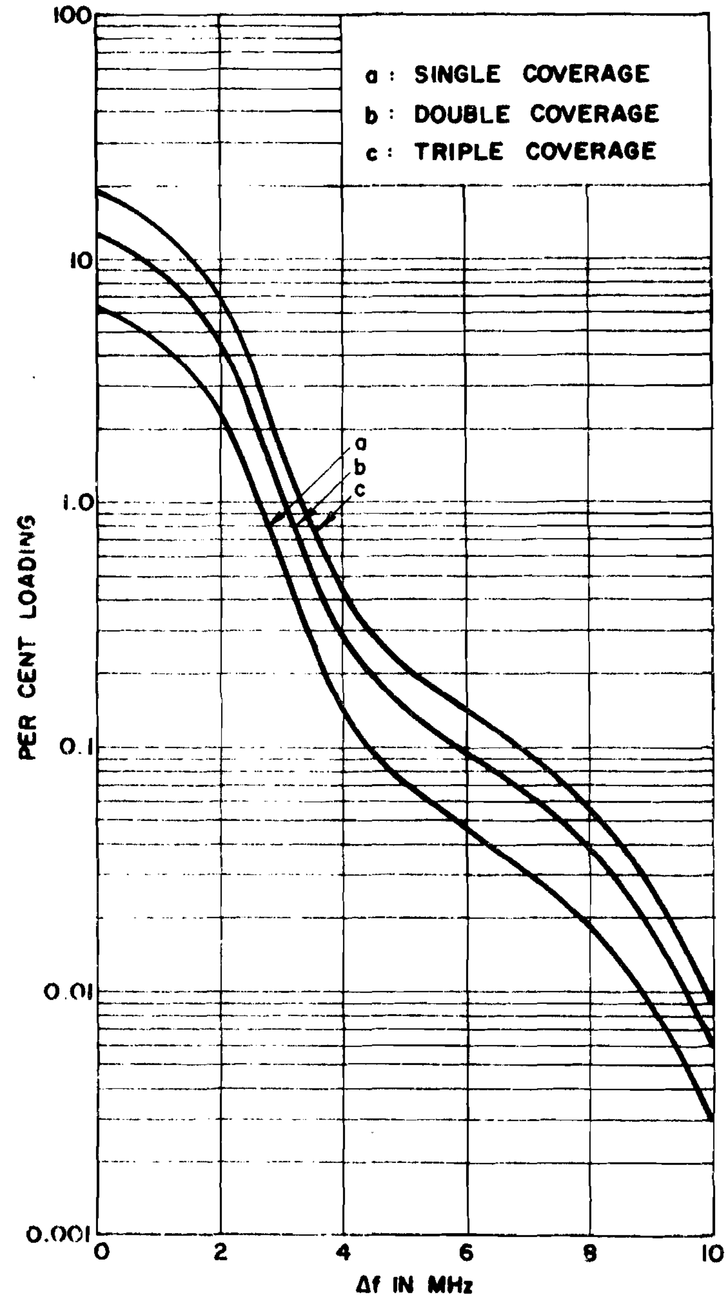


Figure B-92. Percent loading vs Δf for RTB-2 Y mode beacon DABS format #7, downlink freq. = 1090 ± 3 MHz.

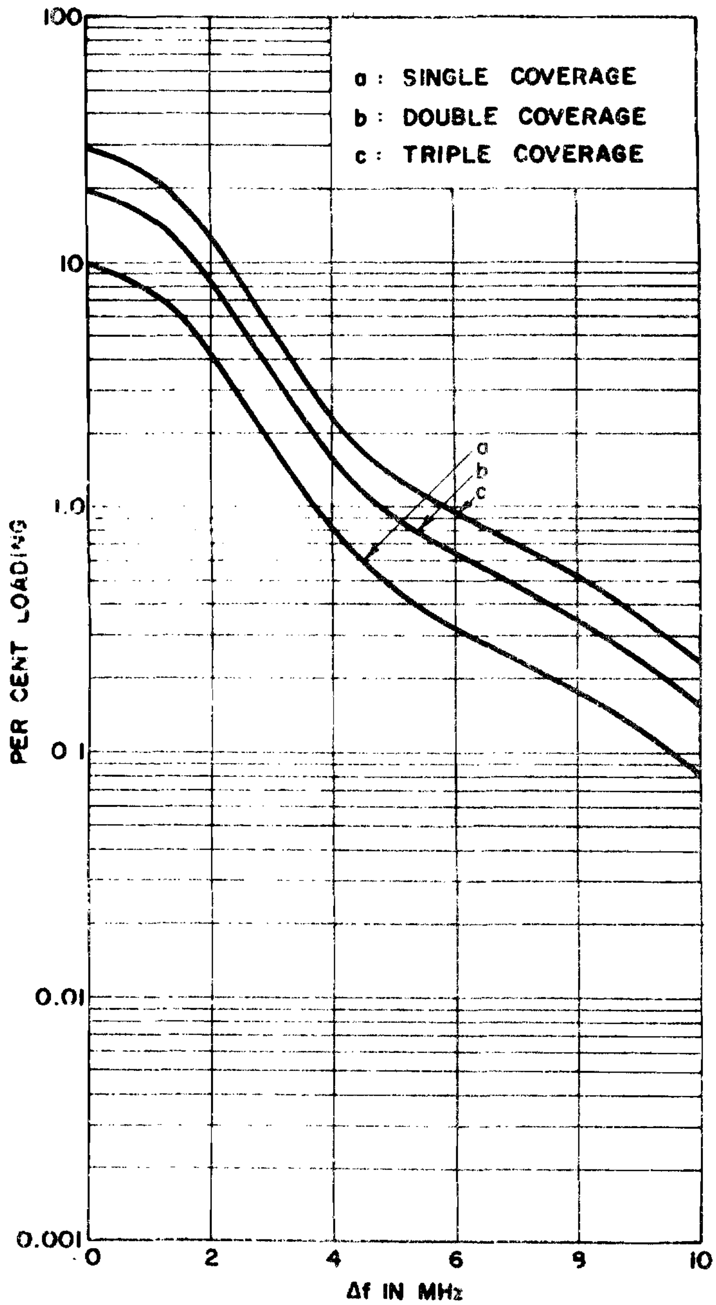


Figure B-93. Percent loading vs Δf for RTB-2 Y mode beacon DABS formats #8 and #9, downlink freq. = 1090 ± 3 MHz.

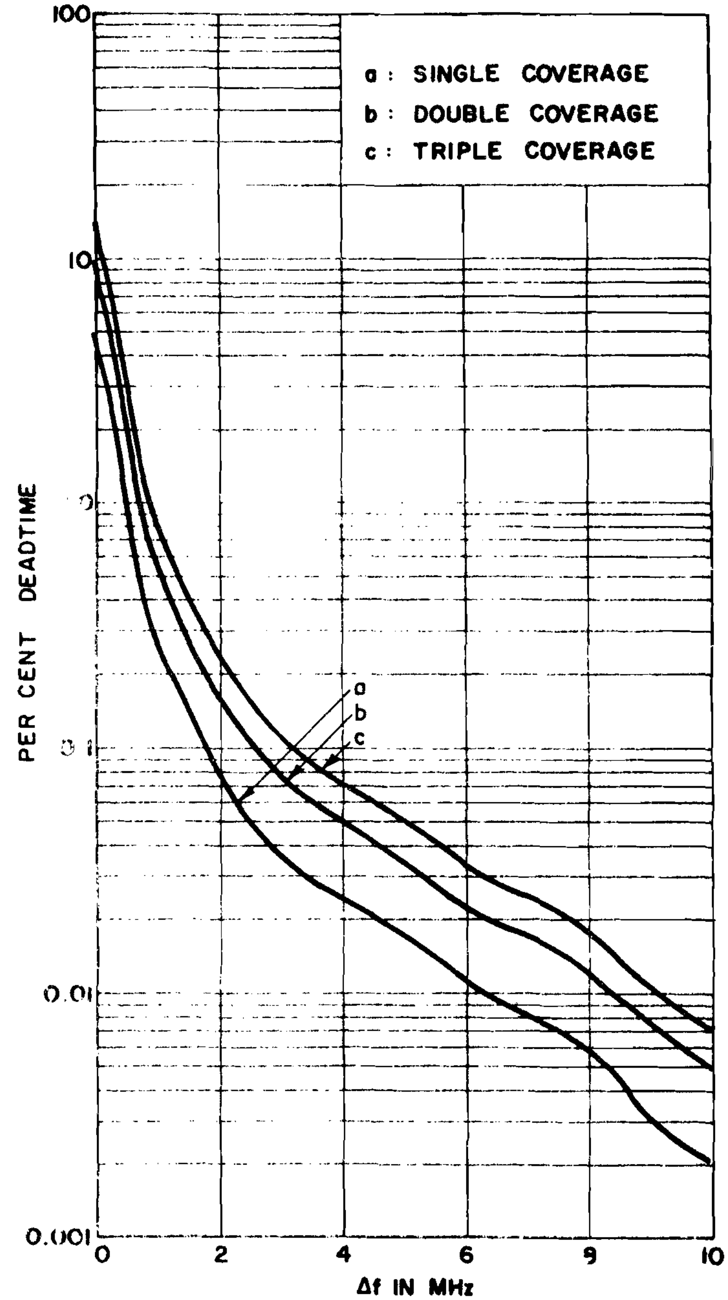


Figure B-94. Percent deadtime vs Δf for Butler DME X mode beacon DABS format #6, downlink freq. = 1090 MHz.

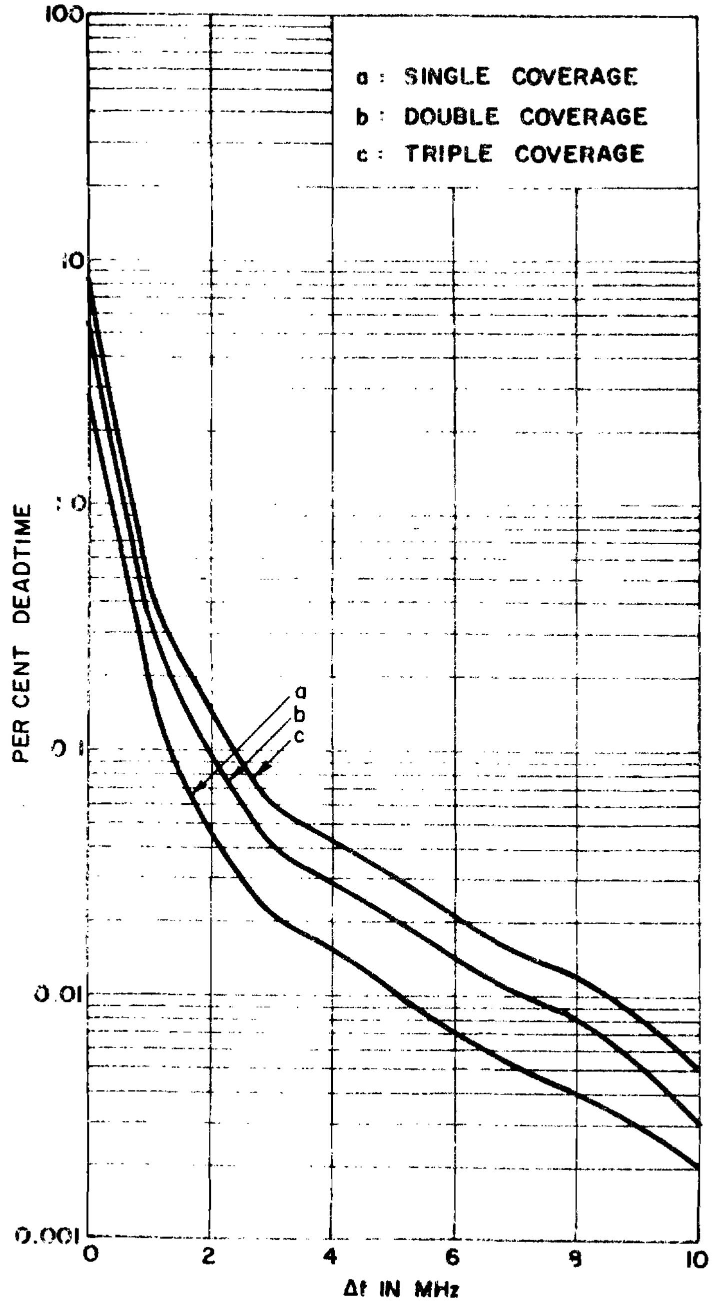


Figure B-95. Percent deadtime vs Δf for Butler DME Y mode beacon DABS format #7, downlink freq. = 1090 MHz.

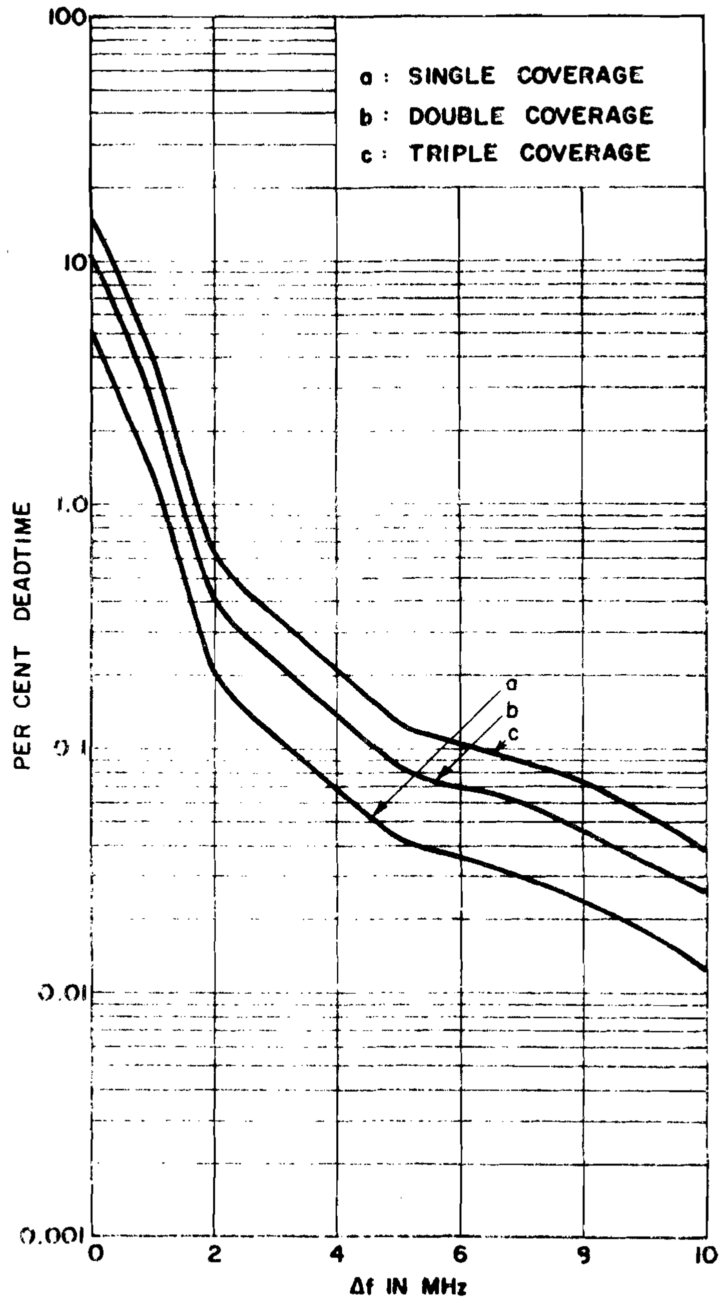


Figure B-96. Percent deadtime vs Δf for Butler DME X mode beacon DABS format #8, downlink freq. = 1090 MHz.

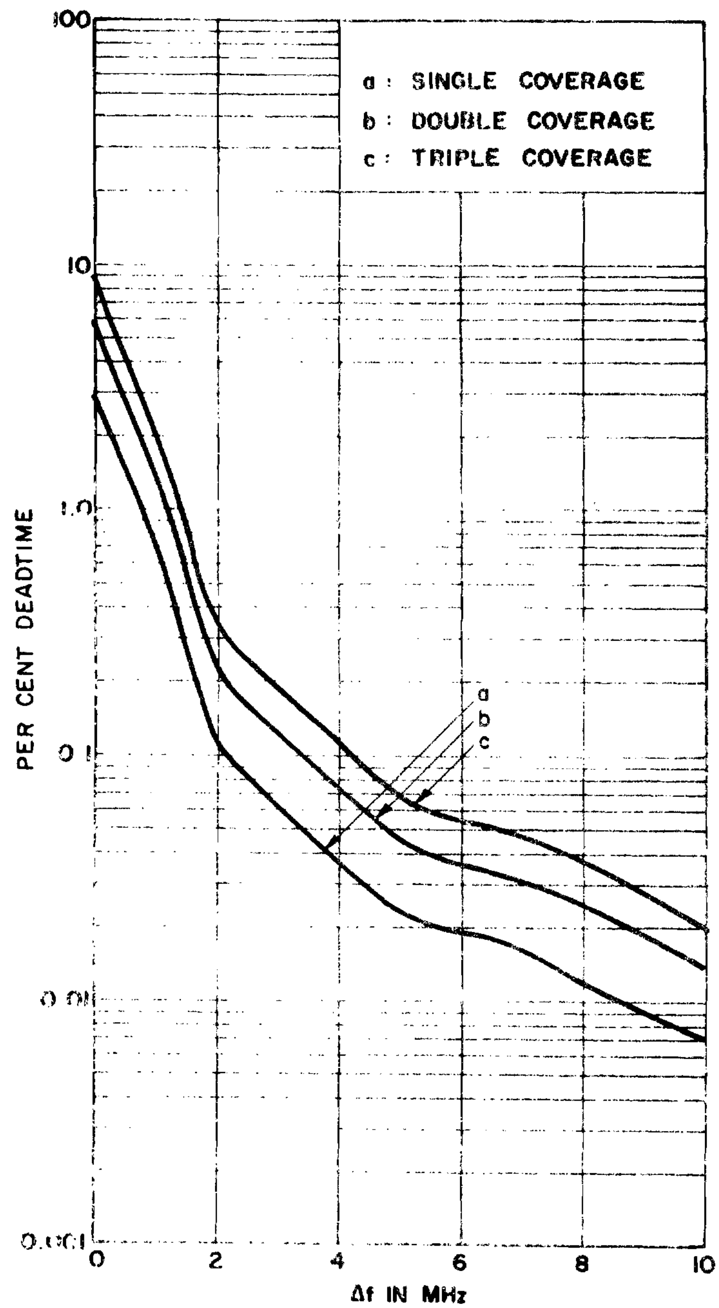


Figure B-97. Percent deadtime vs Δf for Butler DME X mode beacon, DABS format #9, downlink freq. = 1090 MHz.

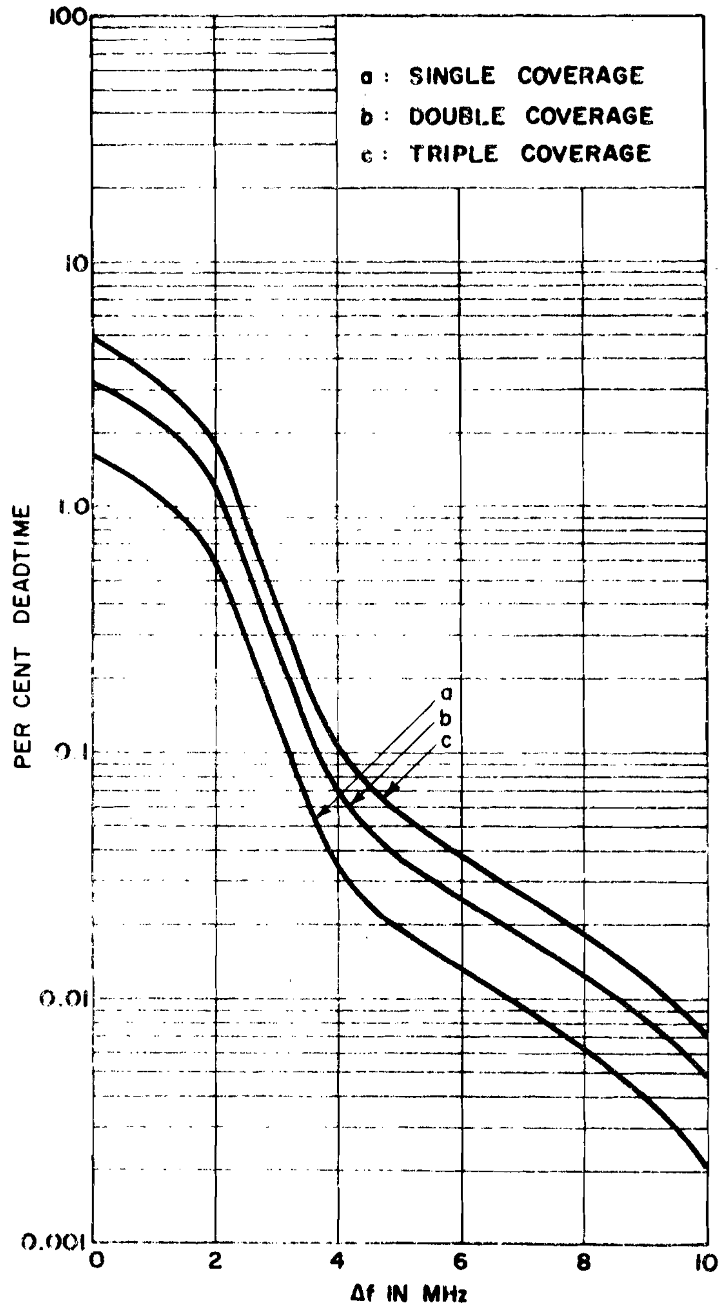


Figure B-98. Percent deadtime vs Δf for Butler DME X mode beacon, DABS format #6, downlink freq. = 1090 ± 3 MHz.

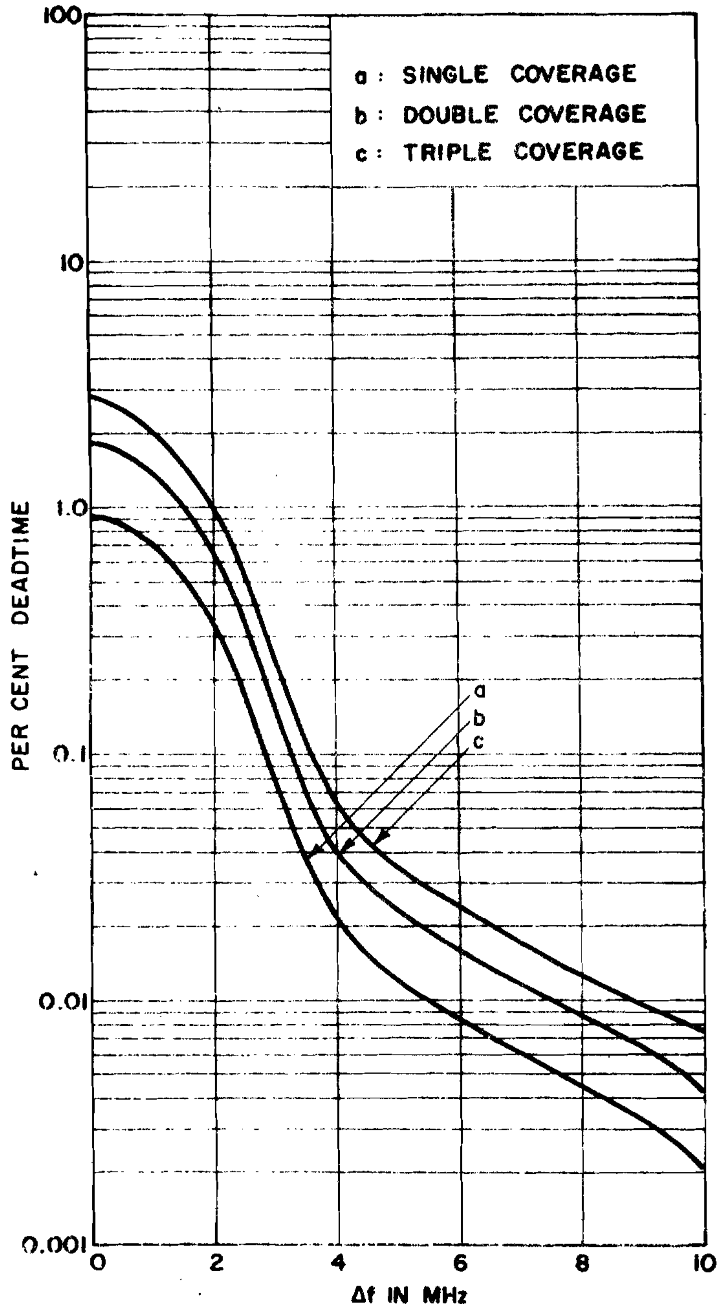


Figure B-99. Percent deadtime vs Δf for Butler DME X mode beacon, DABS format #7, downlink freq. = 1090 ± 3 MHz.

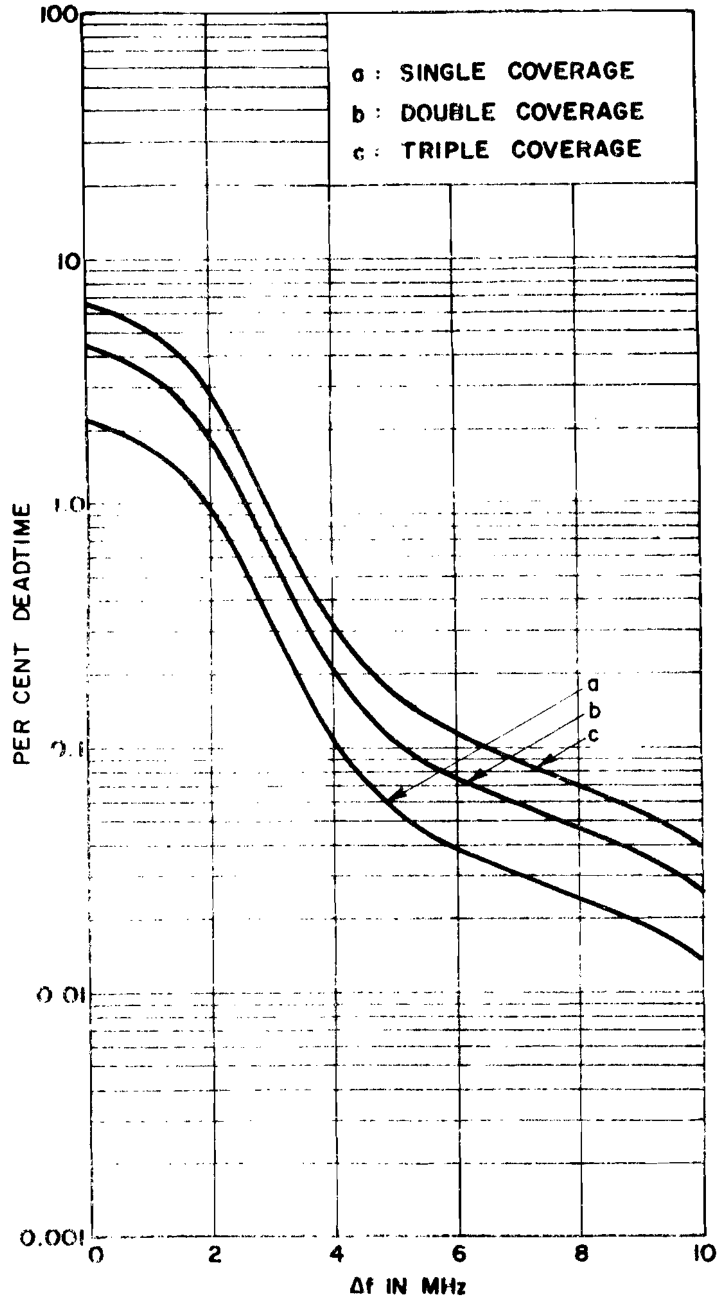


Figure B-100. Percent deadtime vs Δf for Butler DME X mode beacon, DABS format #8, downlink freq. = 1090 ± 3 MHz.

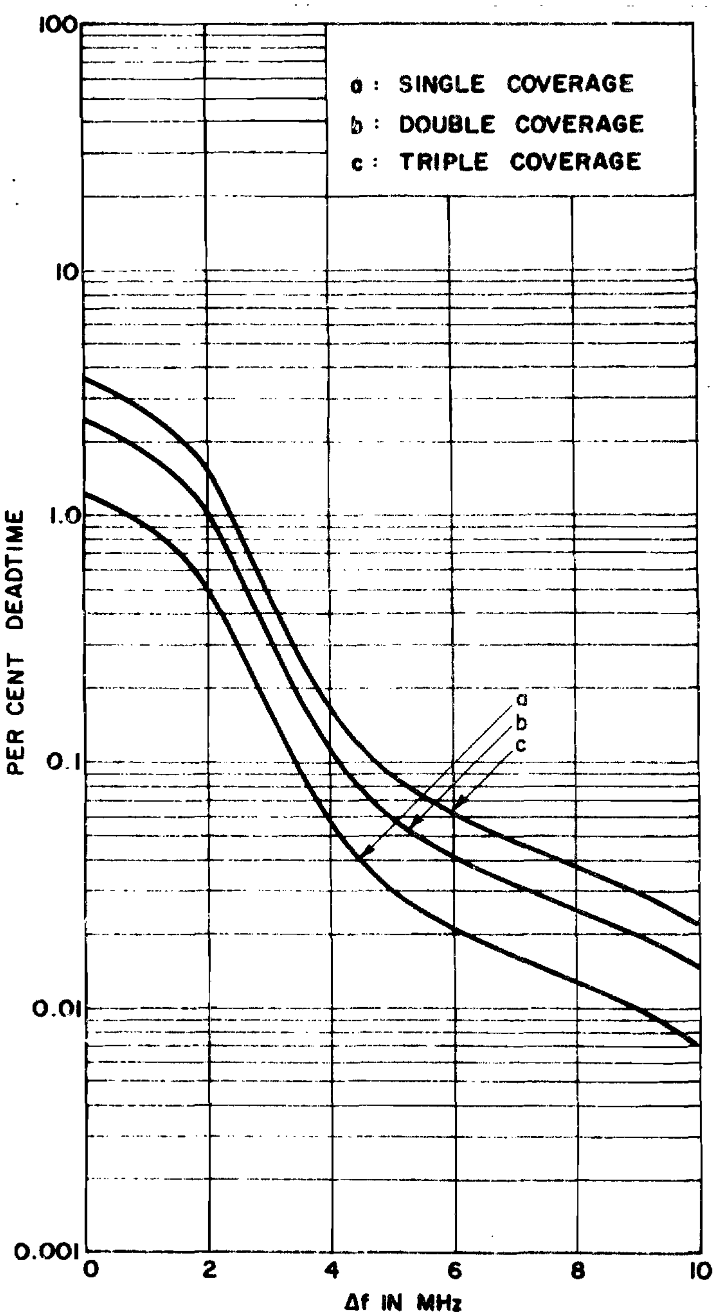


Figure B-101. Percent deadtime vs Δf for Butler DME X mode beacon, DABS format #9, downlink freq. = 1090 ± 3 MHz.

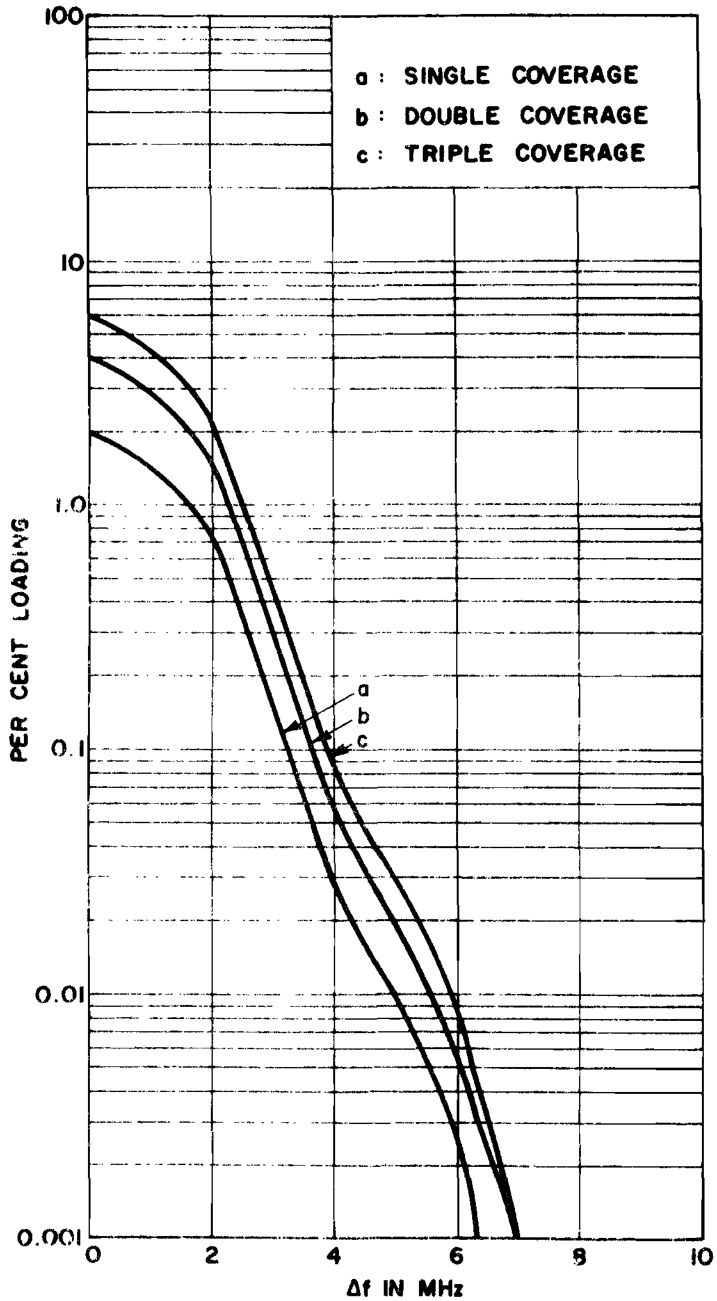


Figure B-102. Percent loading vs Δf for Butler DME X mode beacon, DABS format #6, downlink freq. = 1090 ± 3 MHz.

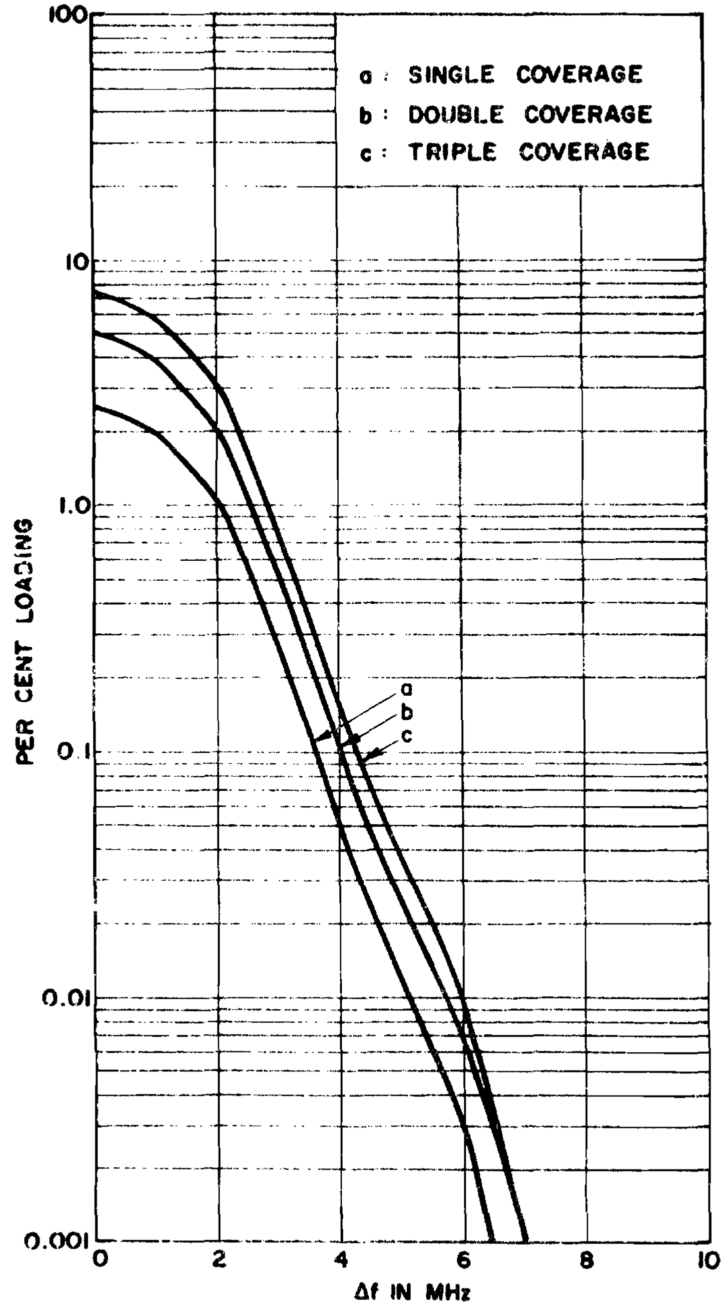


Figure B-103. Percent loading vs Δf for Butler DME X mode beacon, DABS format #7, downlink freq. = 1090 ± 3 MHz.

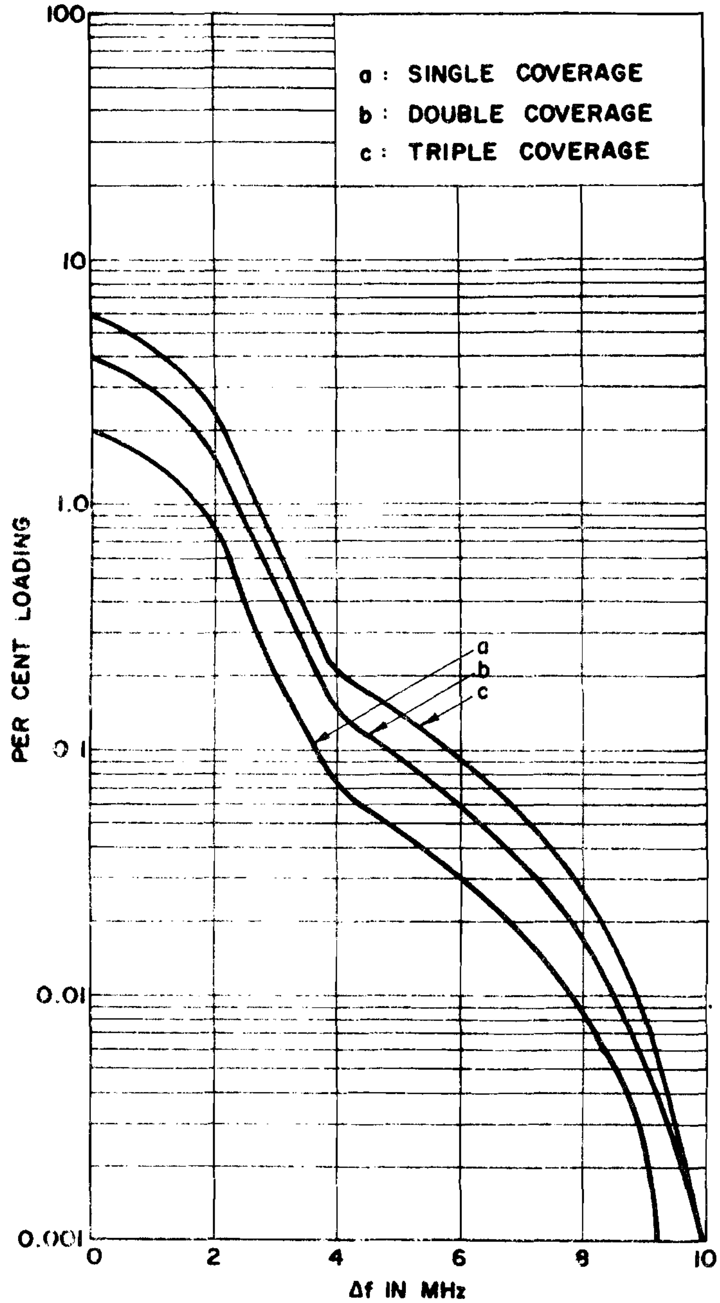


Figure B-104. Percent loading vs Δf for Butler DME X mode beacon, DABS format #8, downlink freq. = 1090 ± 3 MHz.

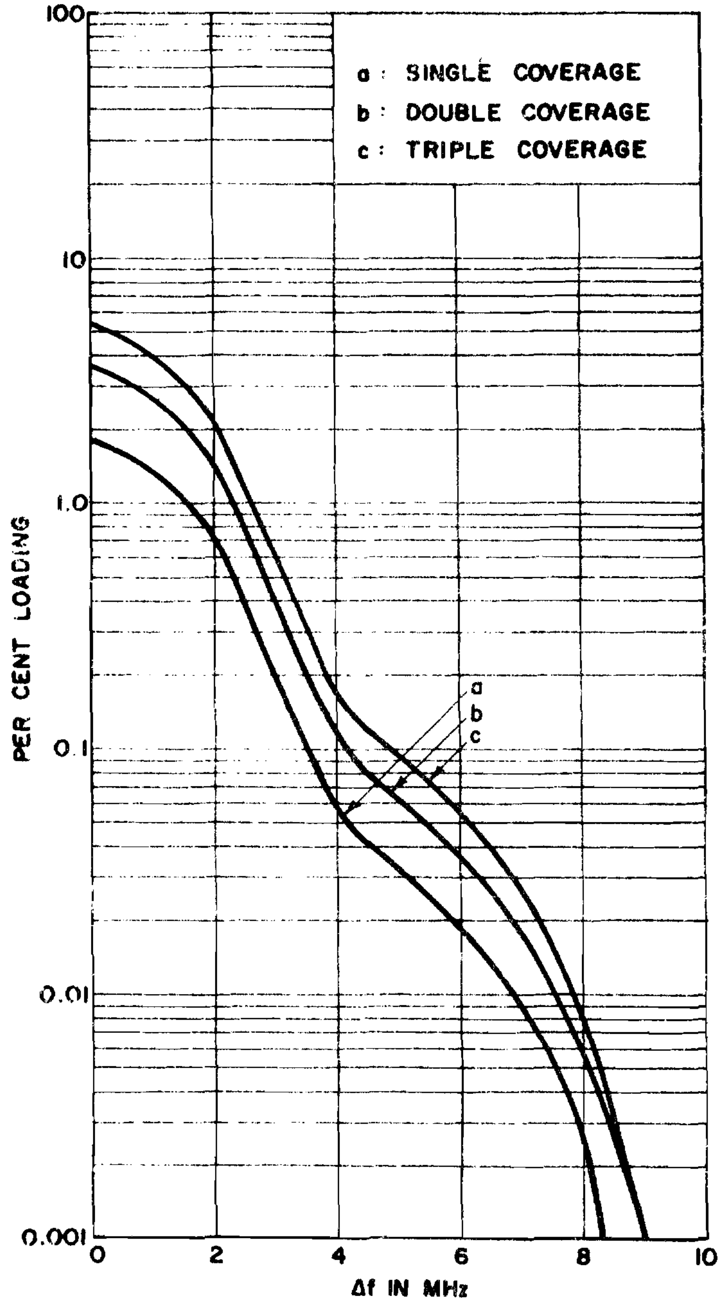


Figure B-105. Percent loading vs Δf for Butler DME X mode beacon, DABS format #9, downlink freq. = 1090 ± 3 MHz.

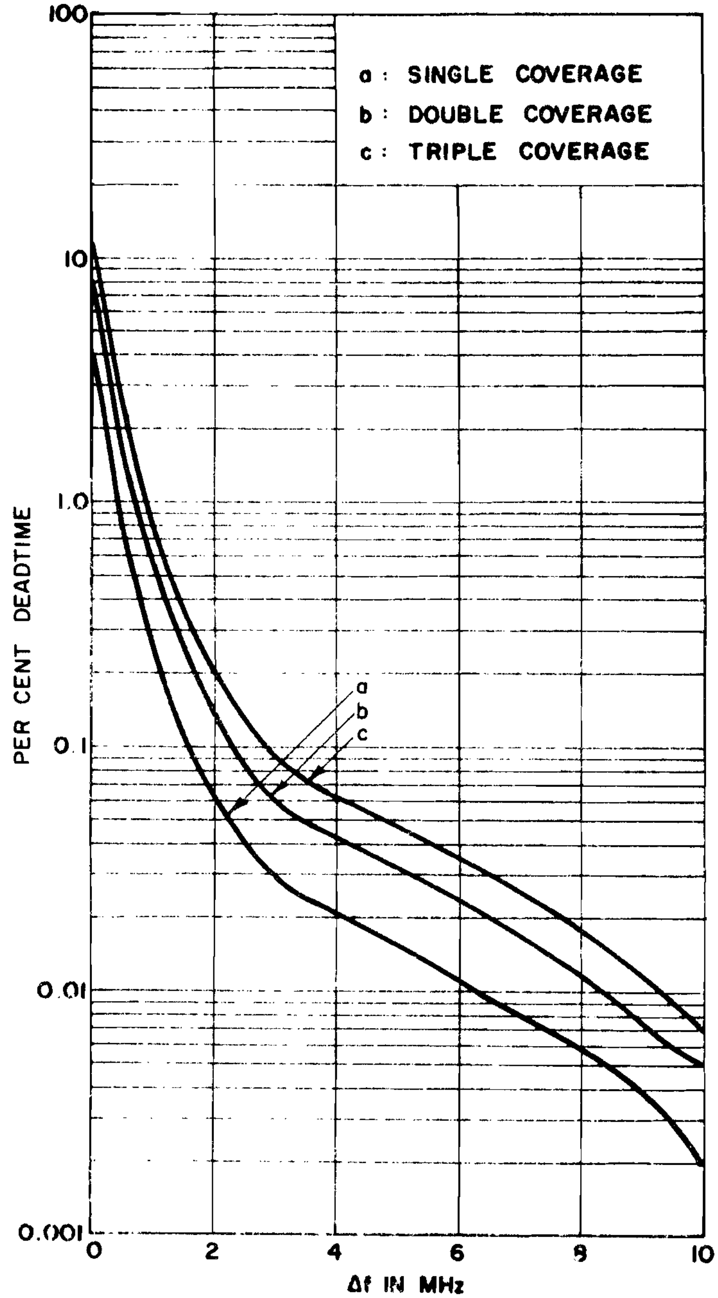


Figure B-106. Percent deadtime vs Δf for Butler DME Y mode beacon, DABS format #6, downlink freq. = 1090 MHz.

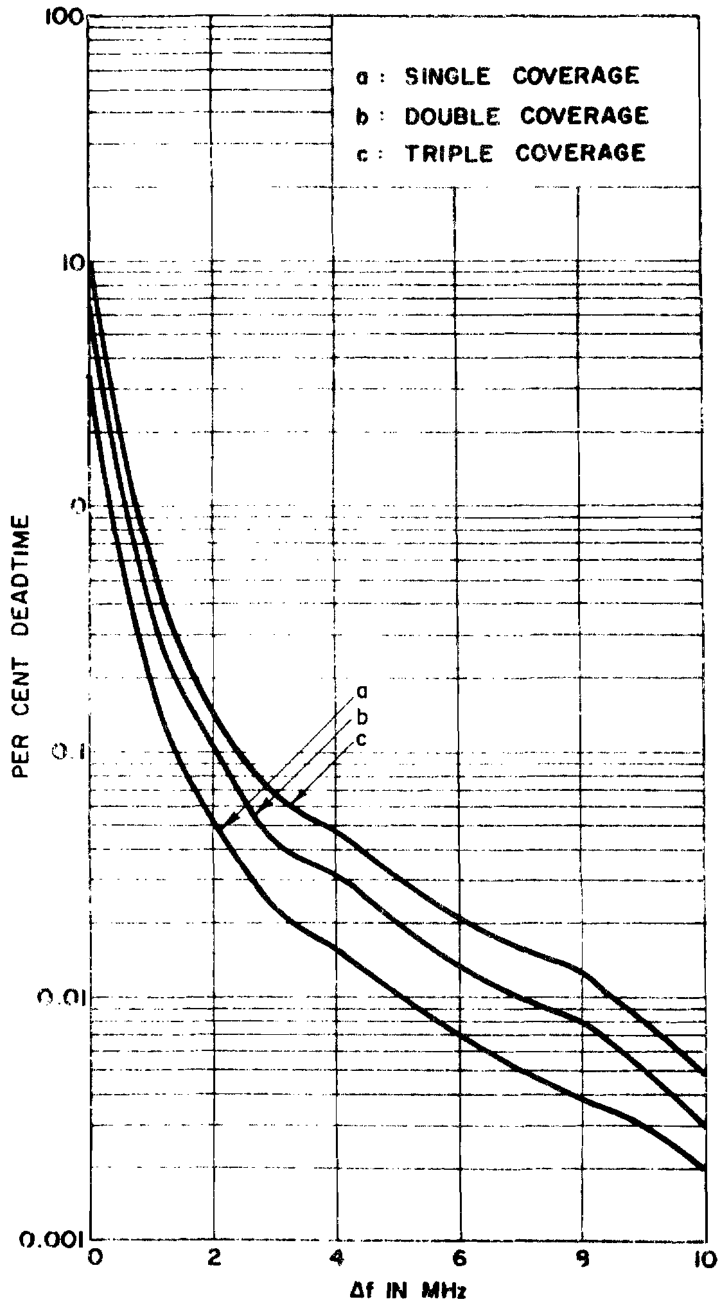


Figure B-107. Percent deadtime vs Δf for Butler DME Y mode beacon DABS format #7, downlink freq. = 1090 MHz.

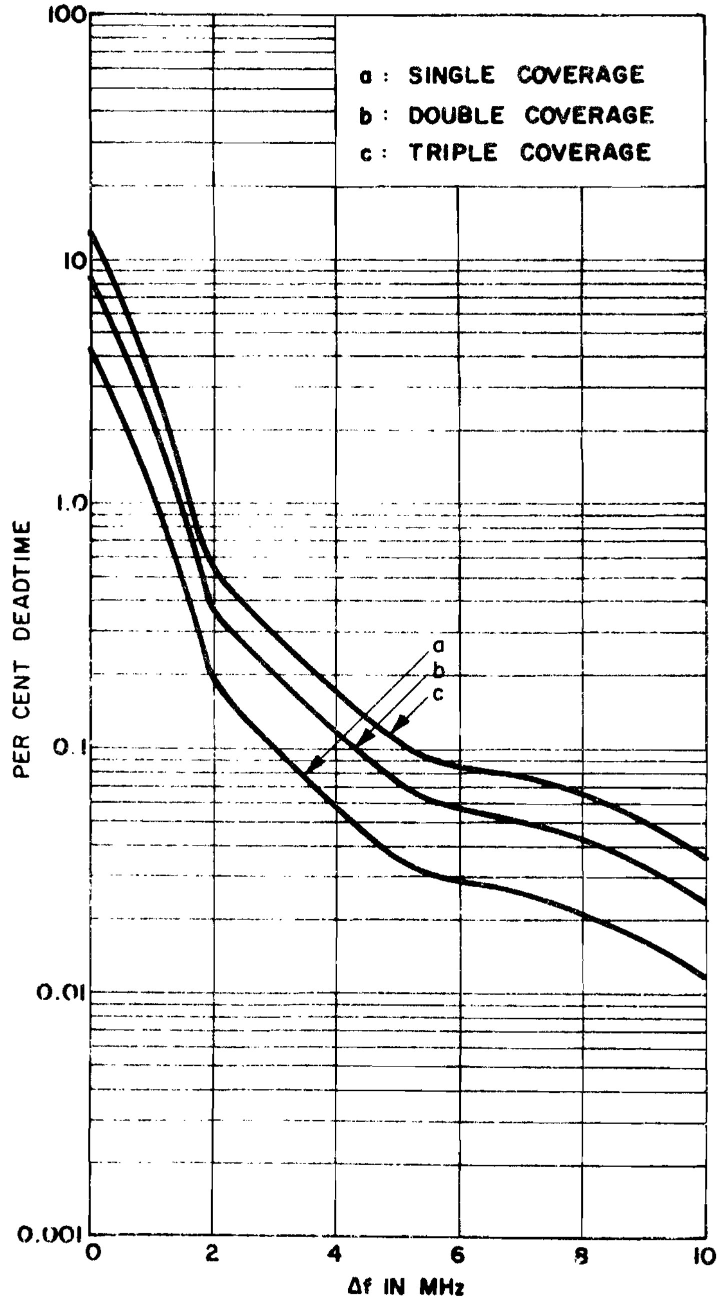


Figure B-108. Percent deadtime vs Δf for Butler DME Y mode beacon, DABS format #8, downlink freq. = 1090 MHz.

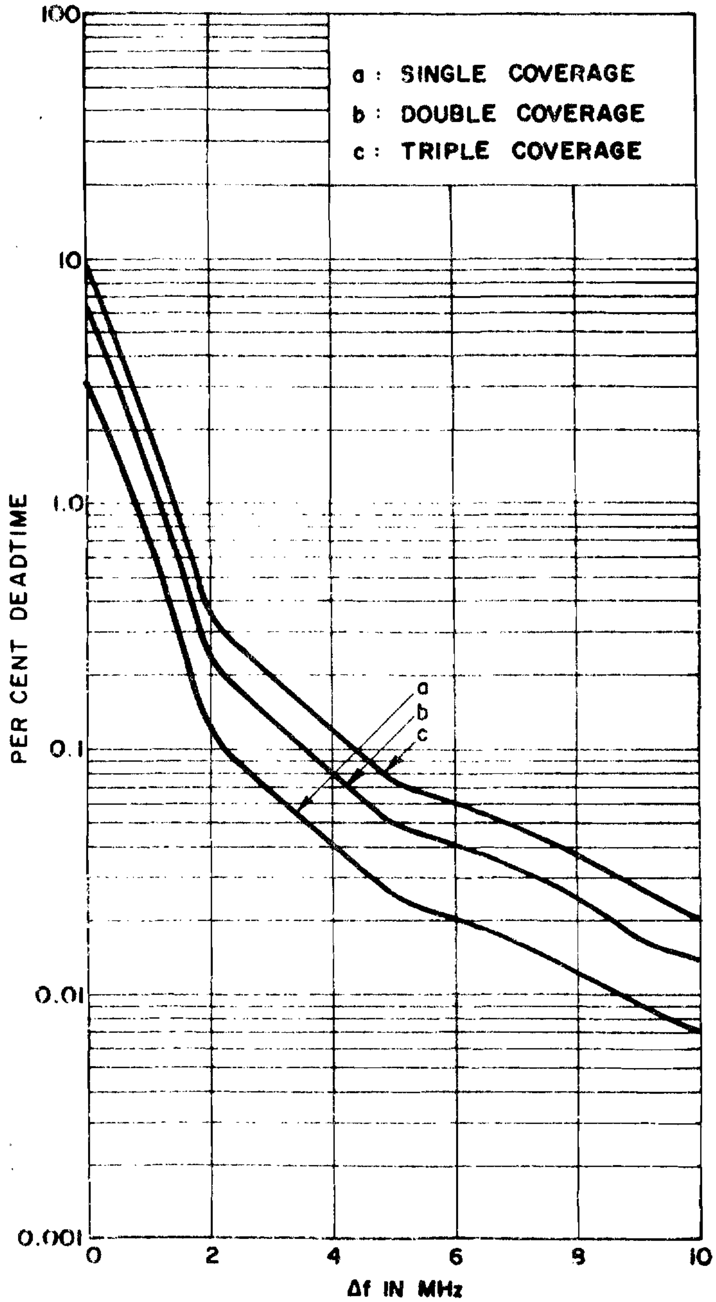


Figure B-109. Percent deadtime vs Δf for Butler DME Y mode beacon, DABS format #9, downlink freq. = 1090 MHz.

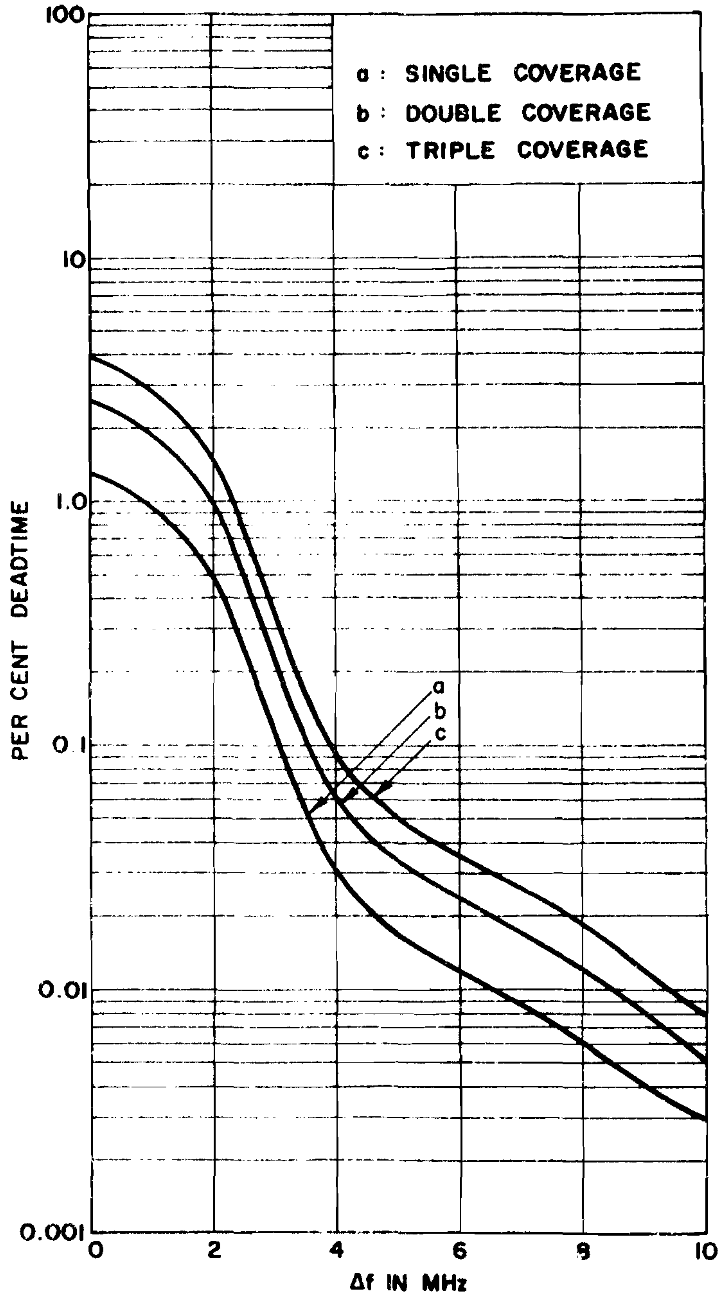


Figure B-110. Percent deadtime vs Δf for Butler DME Y mode beacon,DABS format #6, downlink freq. = 1090 ± 3 MHz.

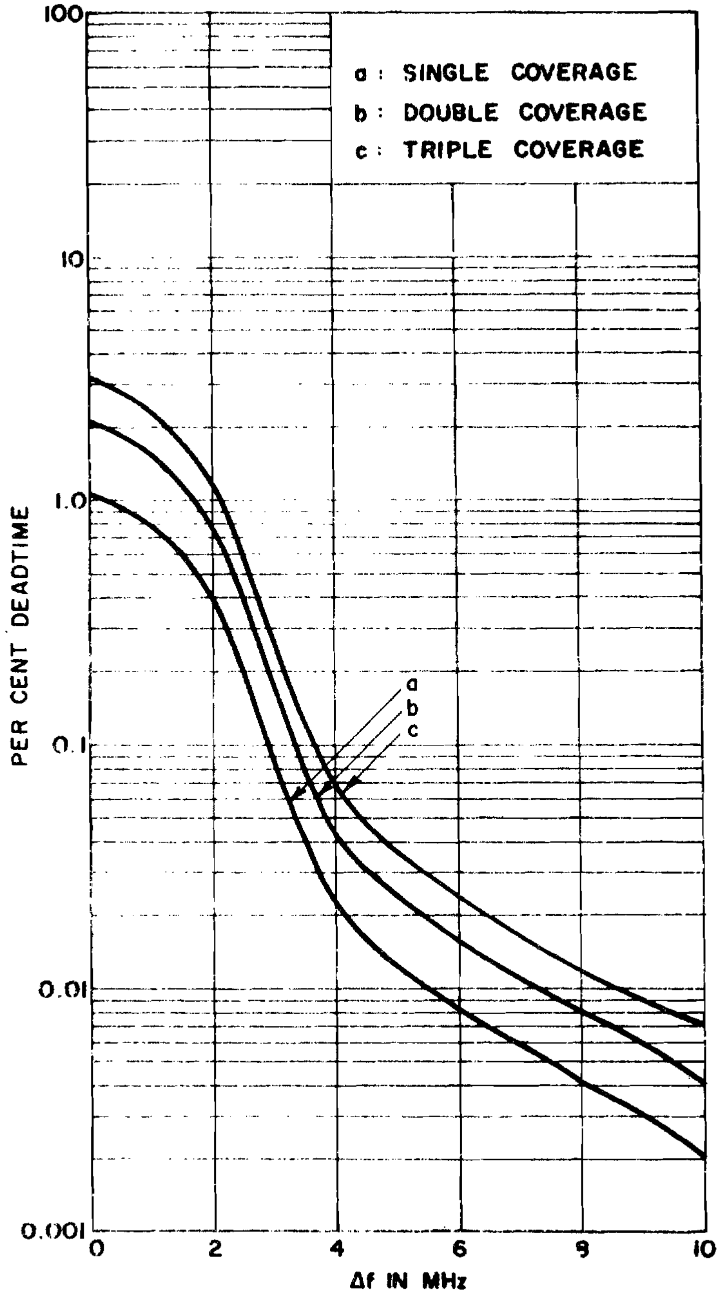


Figure B-111. Percent deadtime vs Δf for Butler DME Y mode beacon, DABS format #7, downlink freq. = 1090 ± 3 MHz.

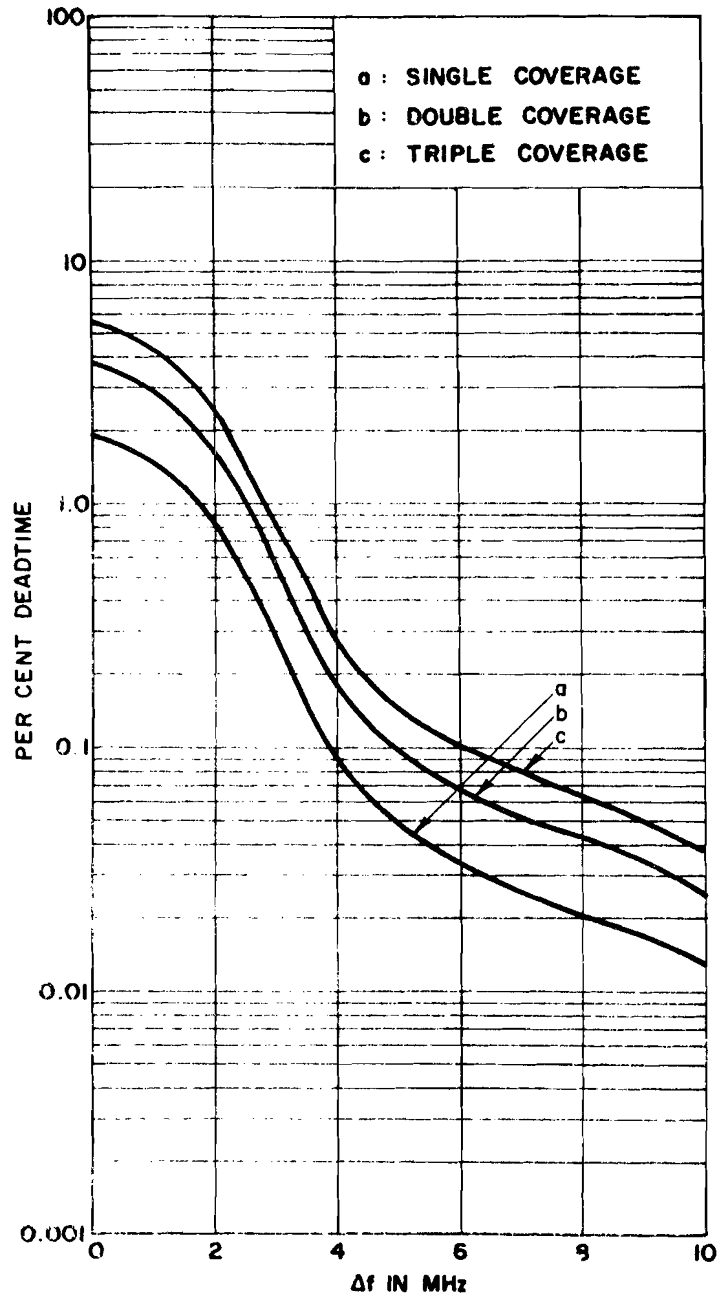


Figure B-112. Percent deadtime vs Δf for Butler DME Y mode beacon, DABS format #8, downlink freq. = 1090 ± 3 MHz.

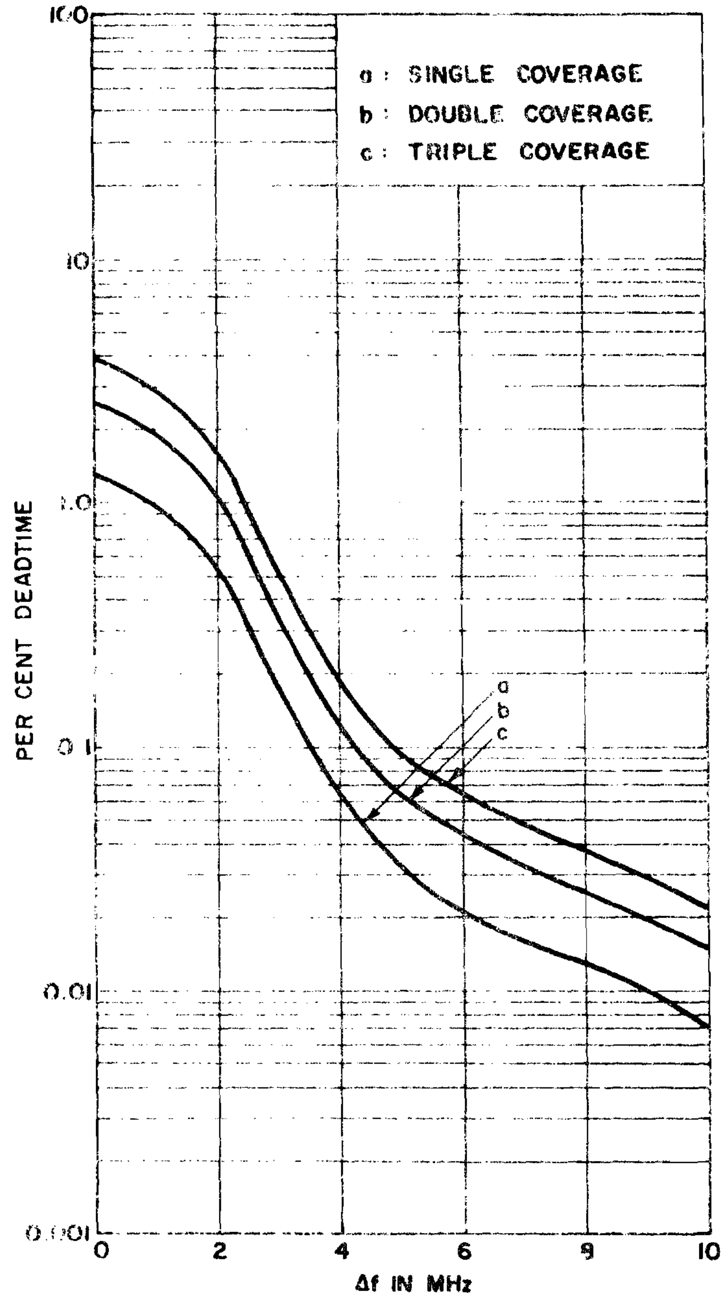


Figure B-113. Percent deadtime vs Δf for Butler DME Y mode beacon, DABS format #9, downlink freq. = 1090 ± 3 MHz.

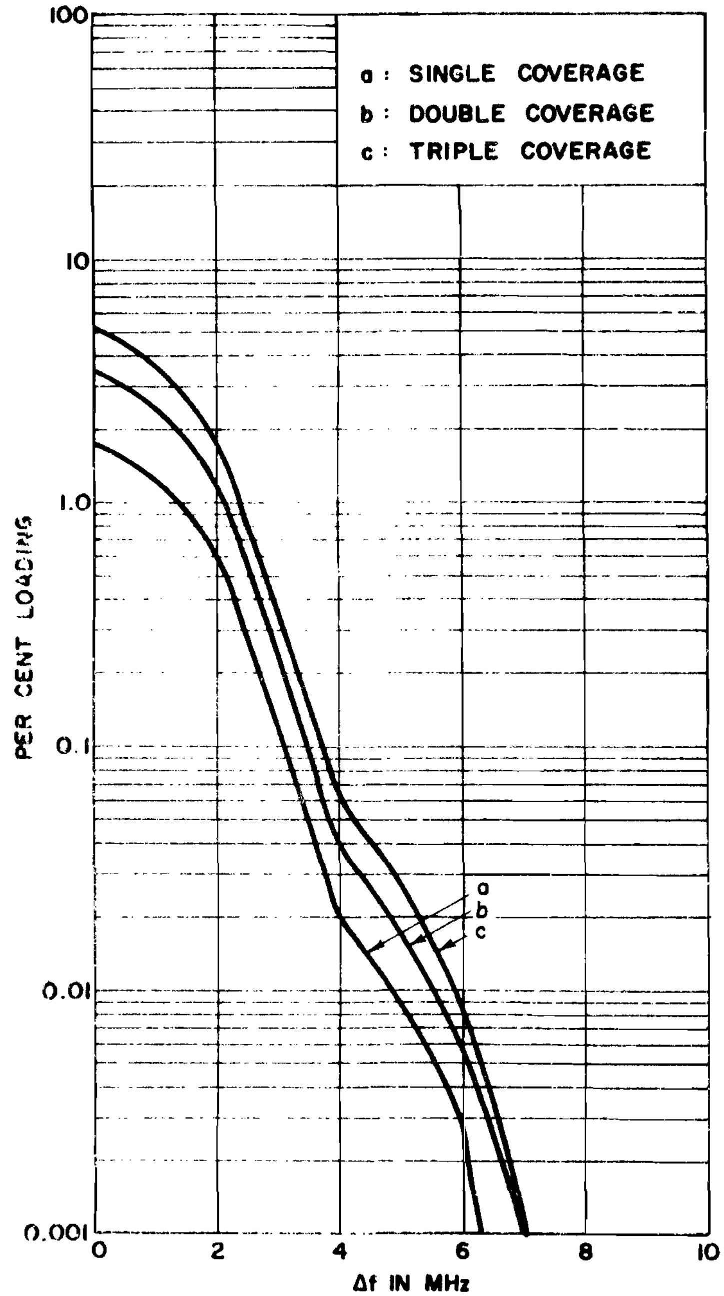


Figure B-114. Percent loading vs Δf for Butler DME Y mode beacon, DABS format #6 and #7, downlink freq. = 1090 ± 3 MHz.

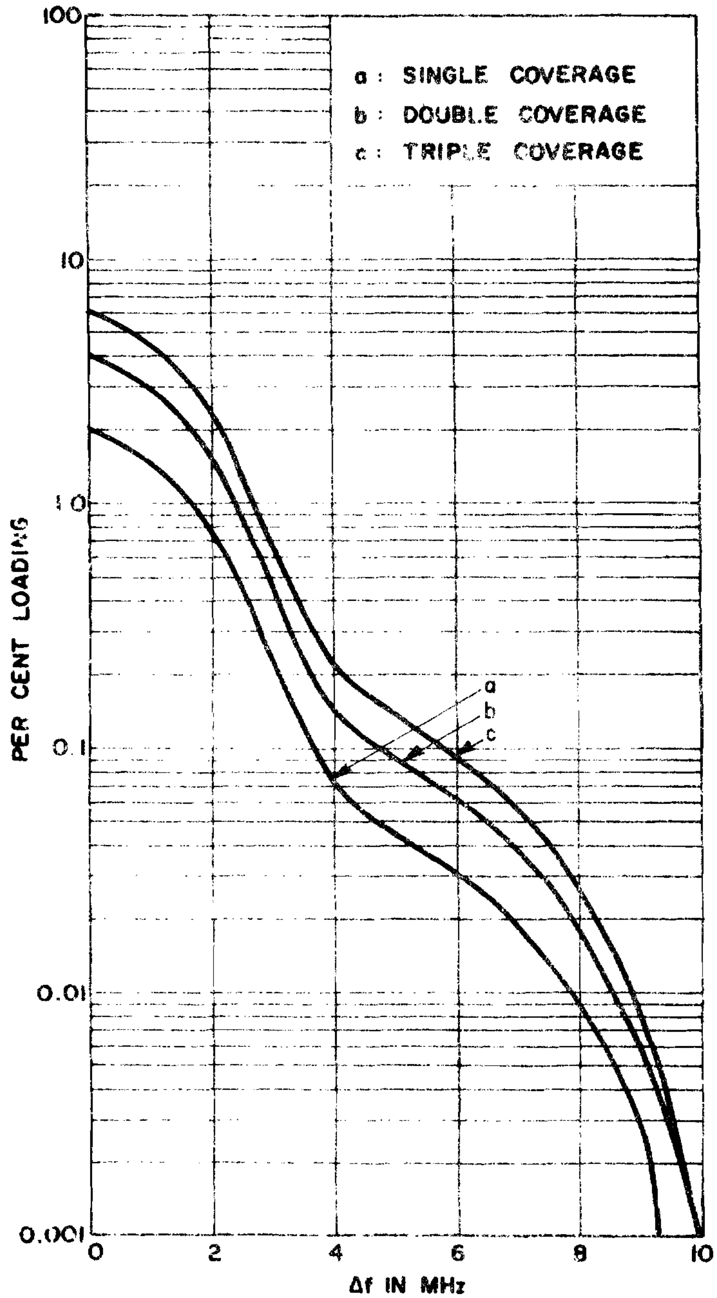


Figure B-115. Percent loading vs Δf for Butler DME Y mode beacon, DABS format #8, downlink freq. = 1090 ± 3 MHz.

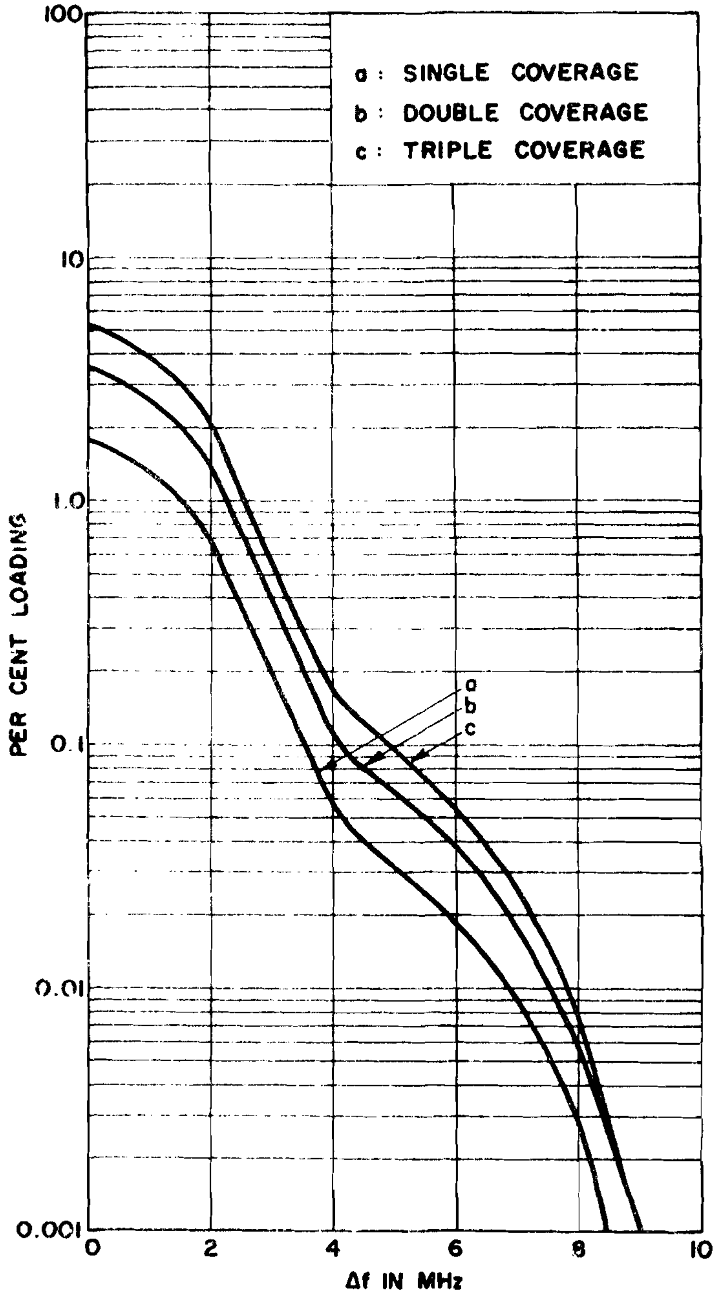


Figure B-116. Percent loading vs Δf for Butler DME Y mode beacon, DABS format #9, downlink freq. = 1090 ± 3 MHz.

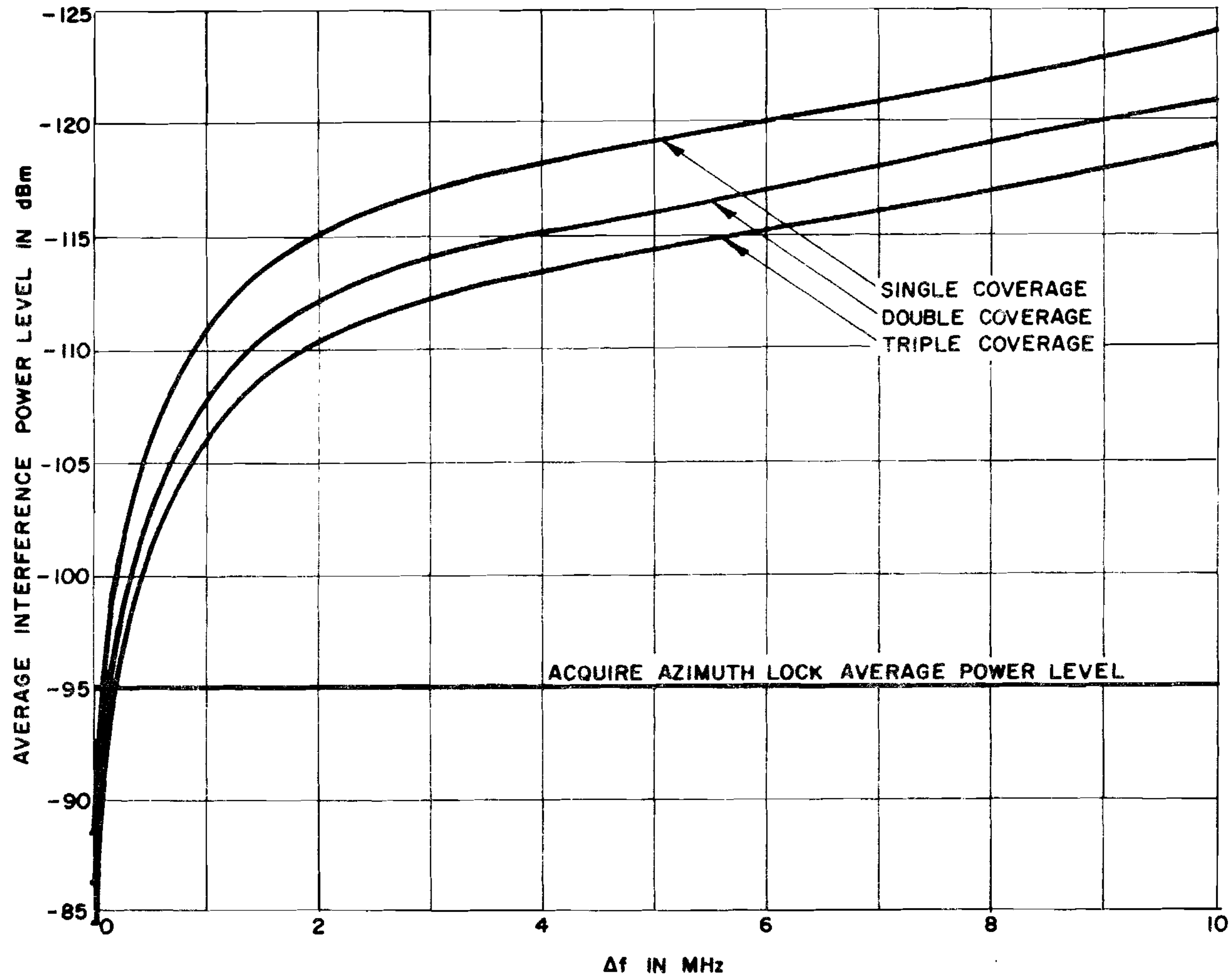


Figure B-117. Average interference power vs Δf for Y mode TACAN interrogator DABS format #6, downlink freq. = 1090 MHz.

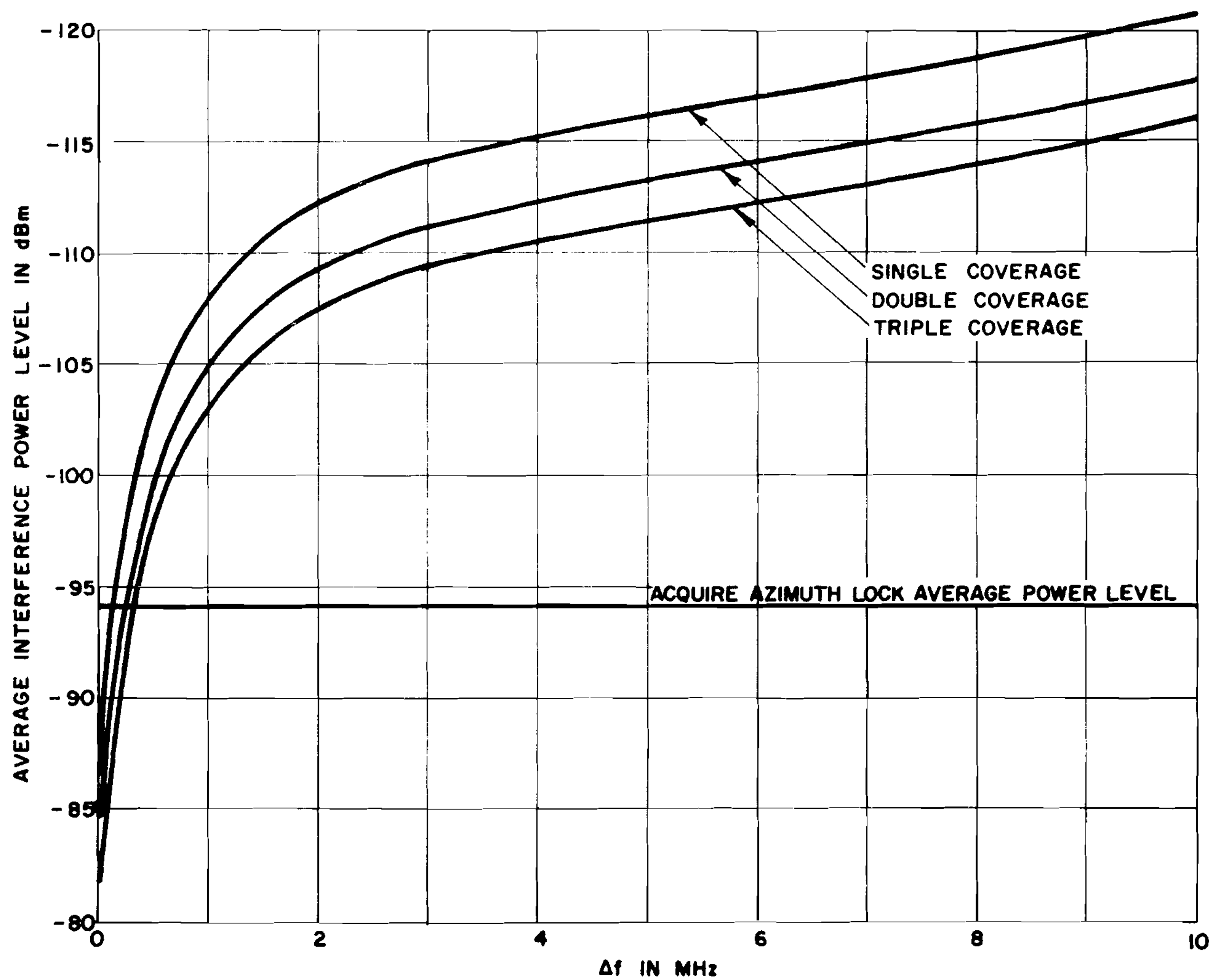


Figure B-118. Average interference power vs Δf for Y mode TACAN interrogator, DABS format #7, downlink freq. = 1090 MHz.

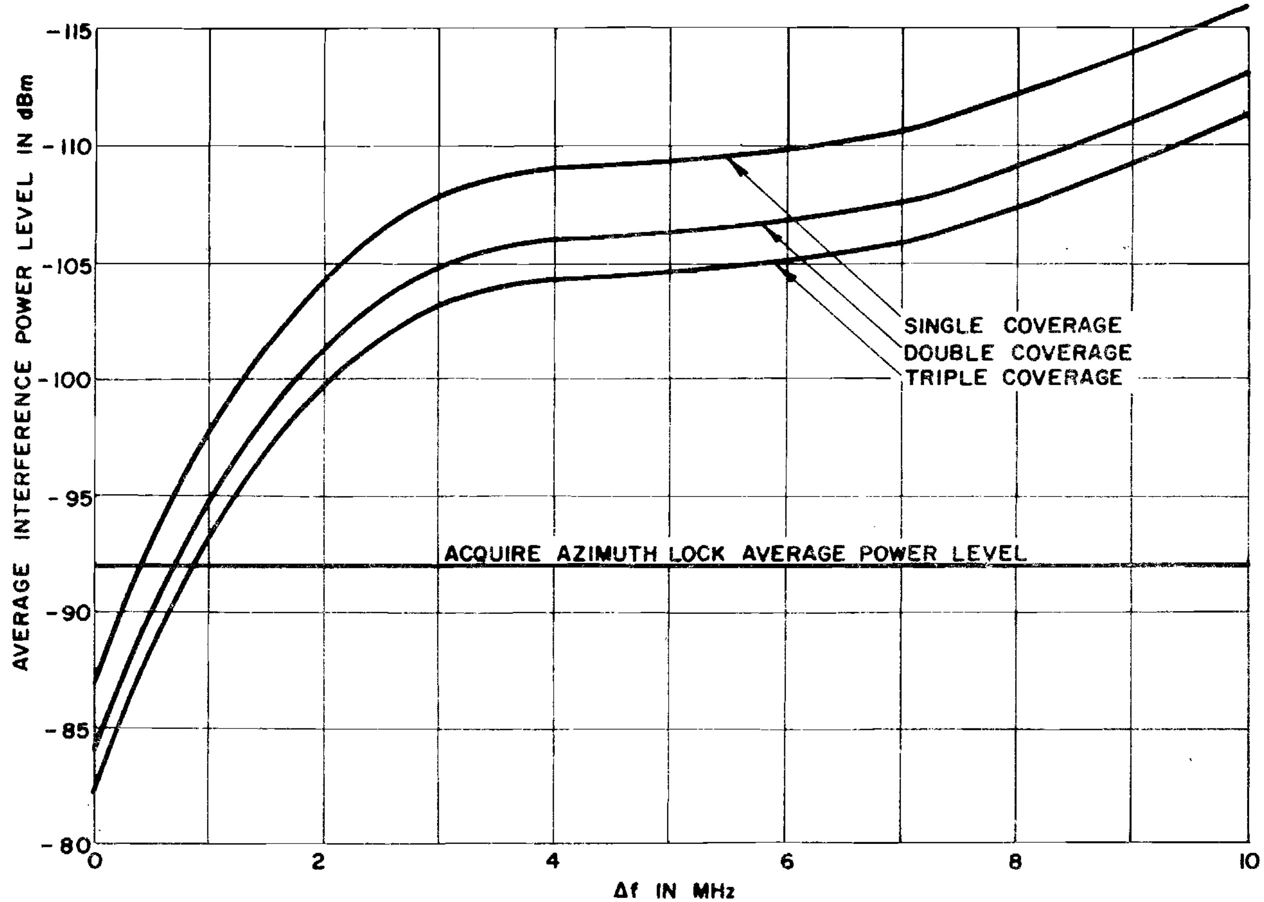


Figure B-119. Average interference power vs Δf for Y mode TACAN interrogator, DABS format #8, downlink freq. = 1090 MHz.

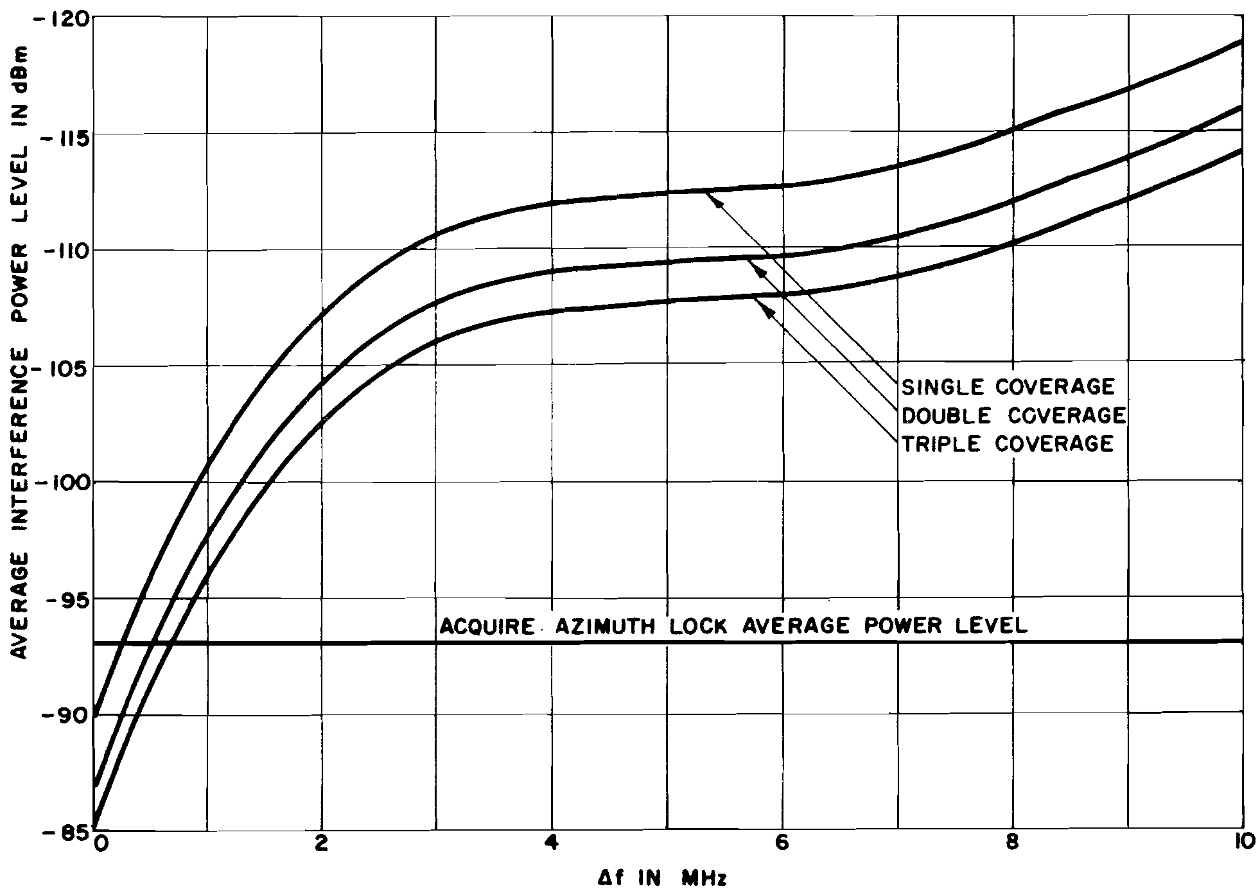


Figure B-120. Average interference power vs Δf for Y mode TACAN interrogator, DABS format #9, downlink freq. = 1090 MHz.

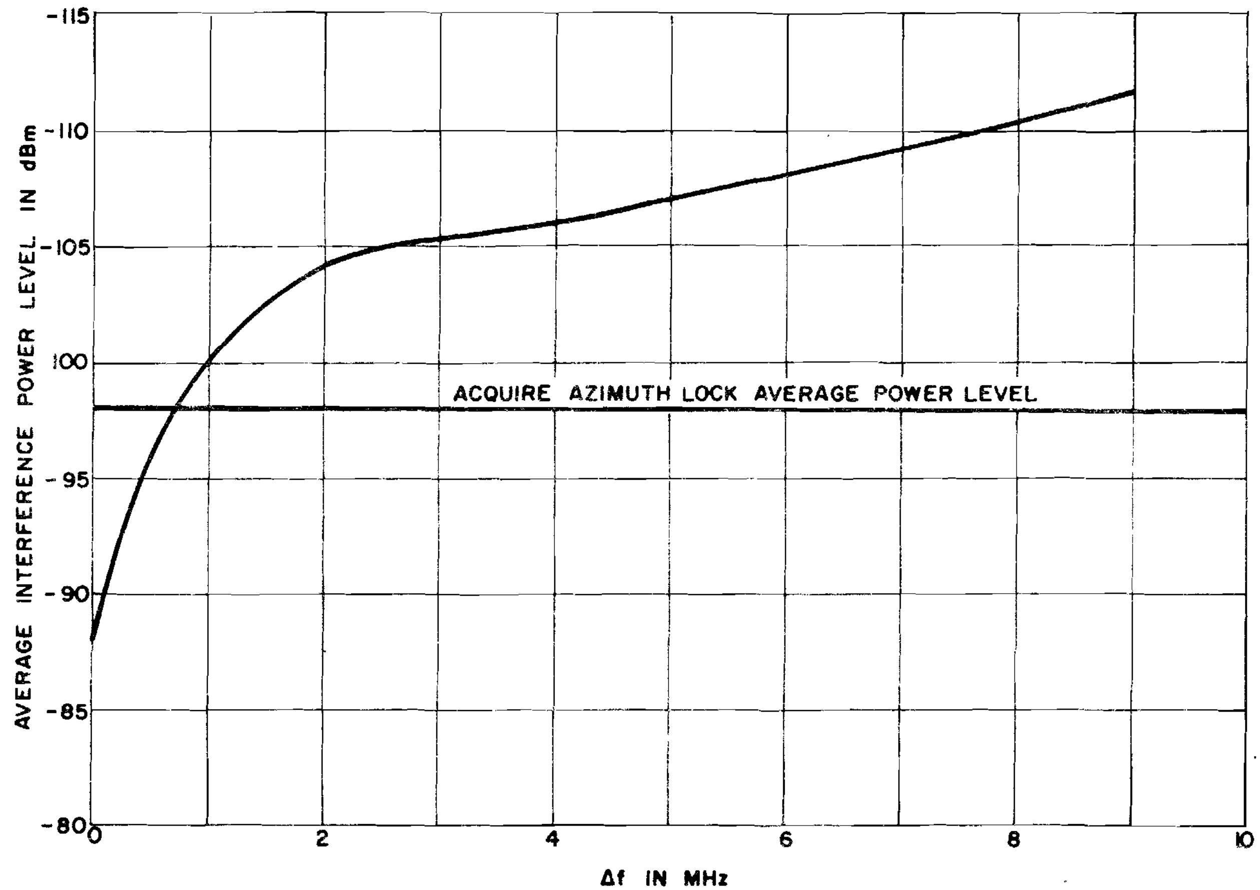


Figure B-121. Interference power level vs Δf for Y mode interrogator, DABS format #10, downlink freq. = 1090 MHz.

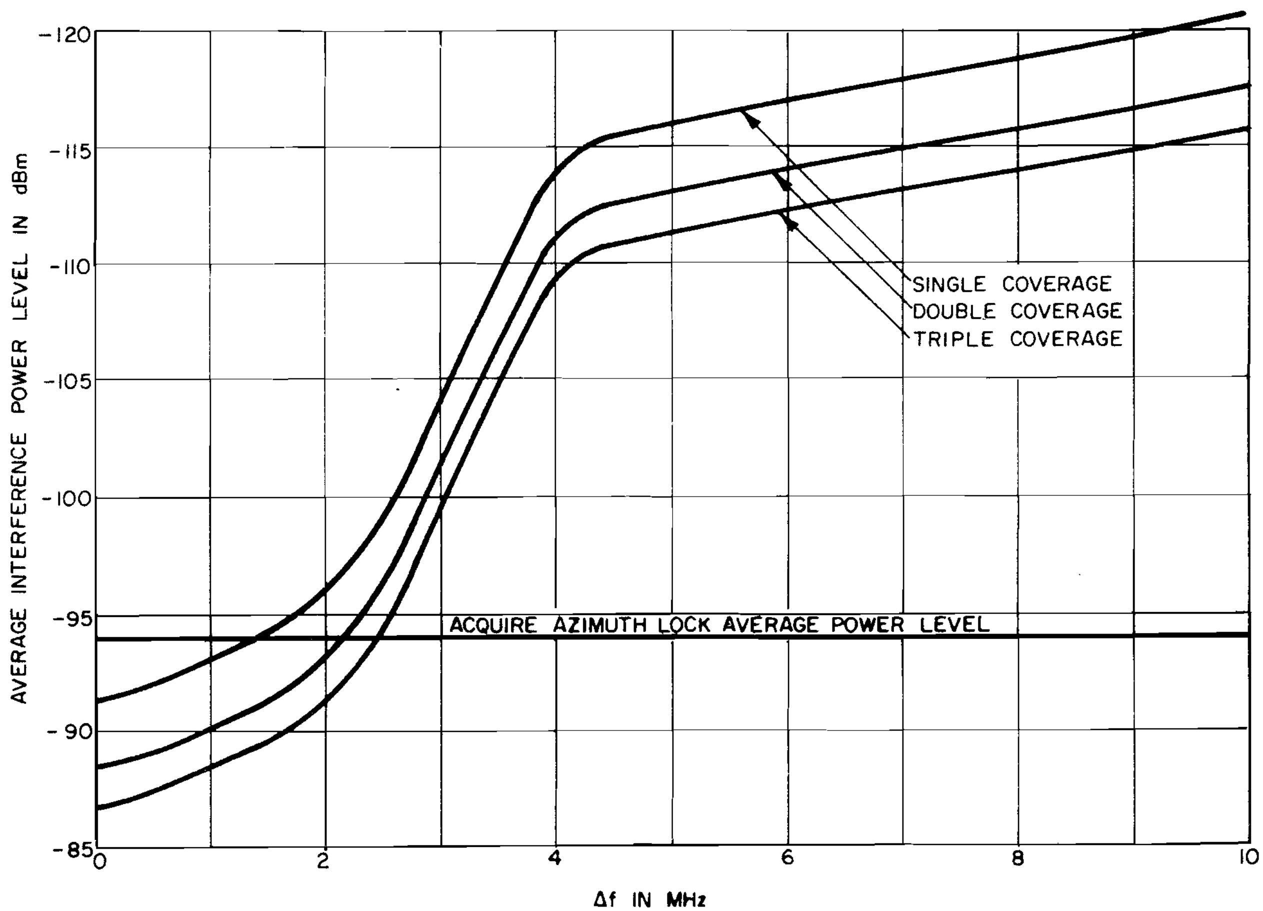


Figure B-122. Average interference power vs Δf for Y mode TACAN interrogator, DABS format #6, downlink freq. = 1090 ± 3 MHz.

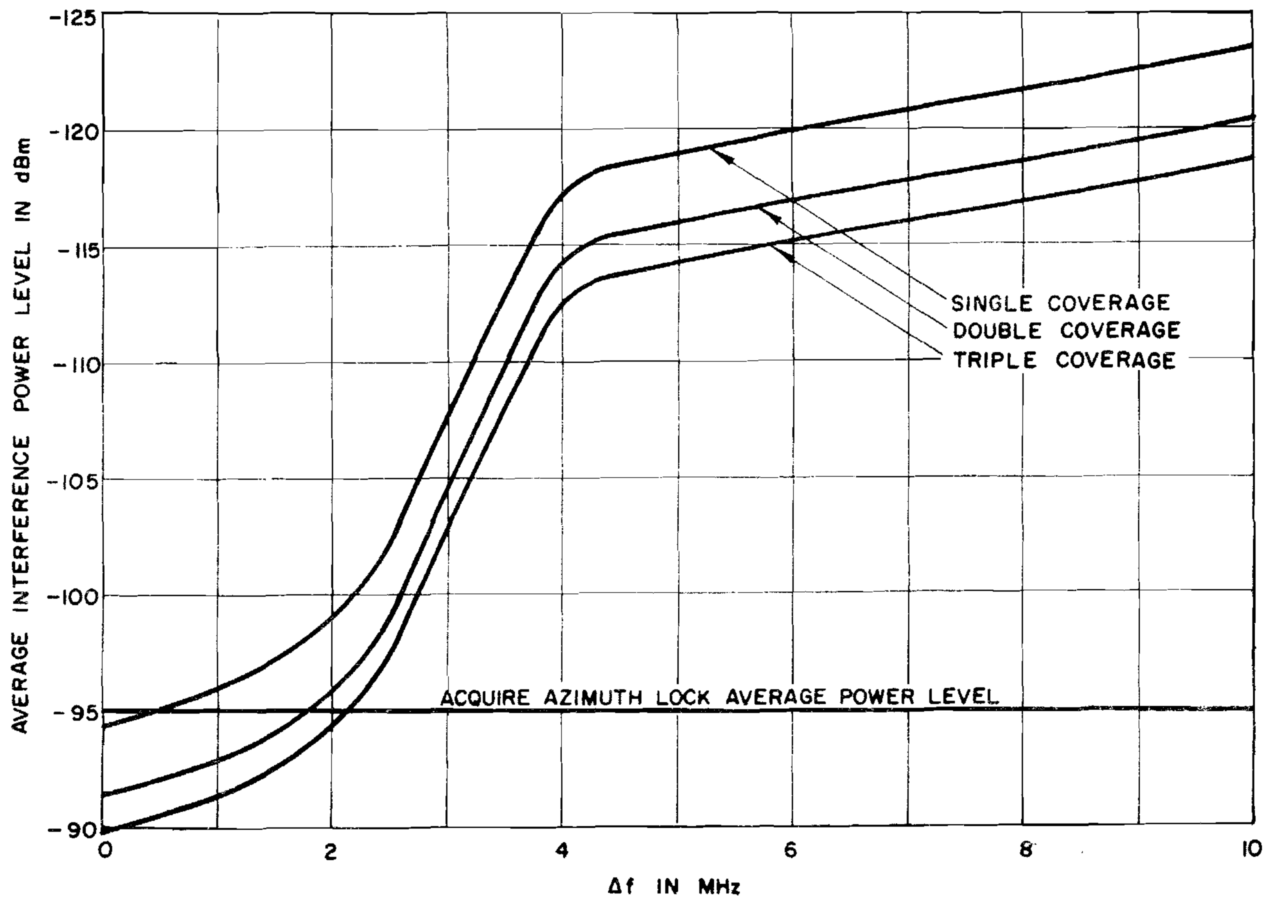


Figure B-123. Average interference power level vs Δf for Y mode TACAN interrogator, DABS format #7, downlink freq. = 1090 ± 3 MHz.

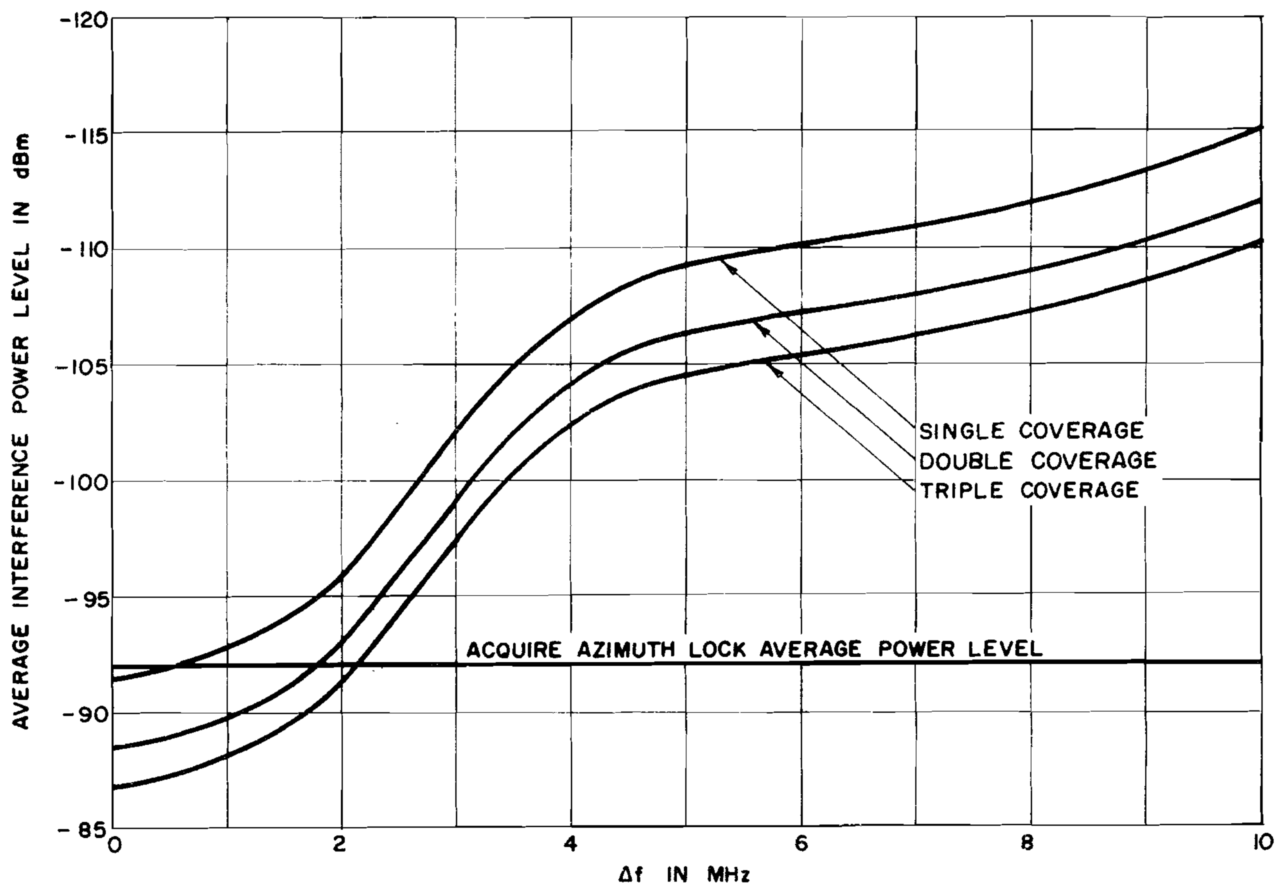


Figure B-124. Average interference power level vs Δf for Y mode TACAN interrogator, DABS format #8, downlink freq. = 1090 ± 3 MHz.

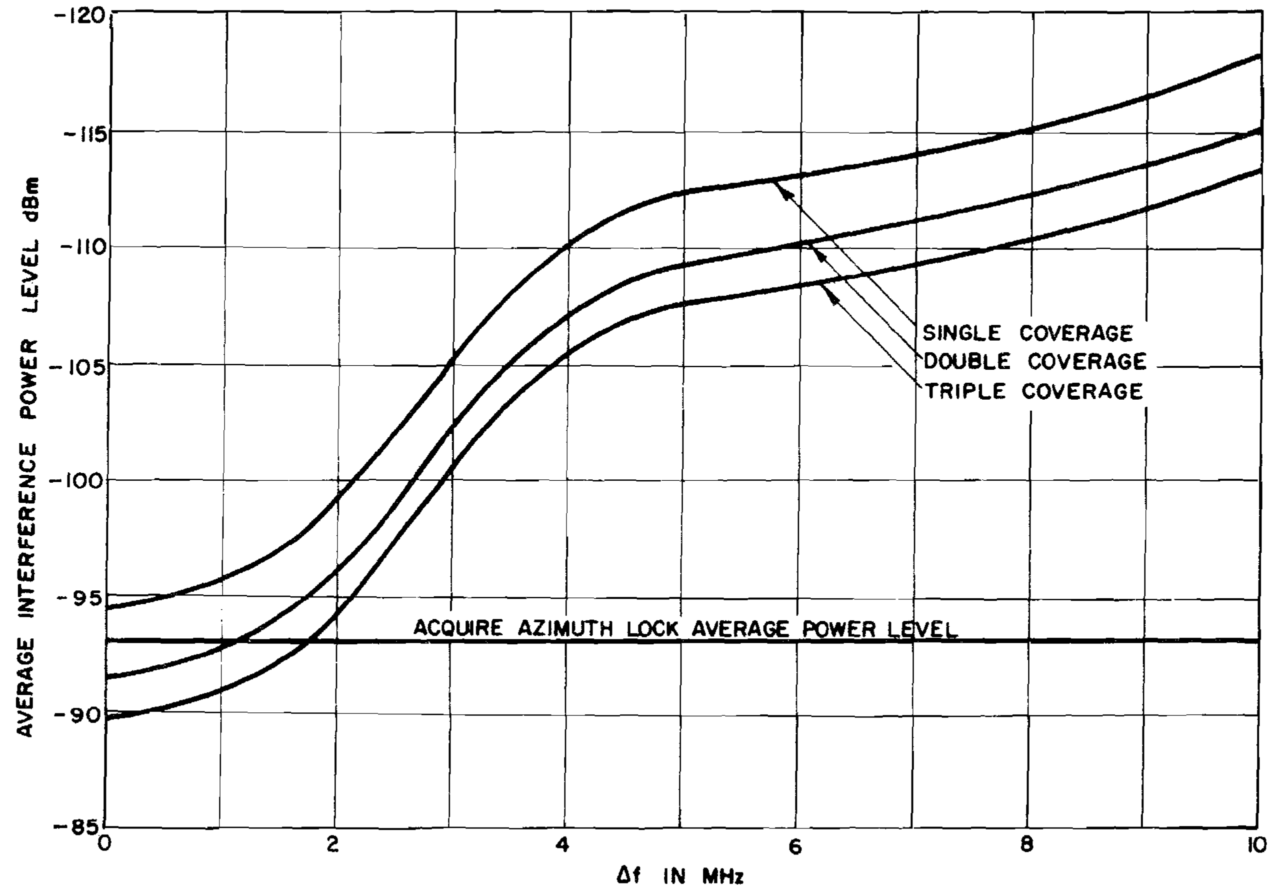


Figure B-125. Average interference power level vs Δf for Y mode TACAN interrogator, DABS format #9, downlink freq. = 1090 ± 3 MHz.

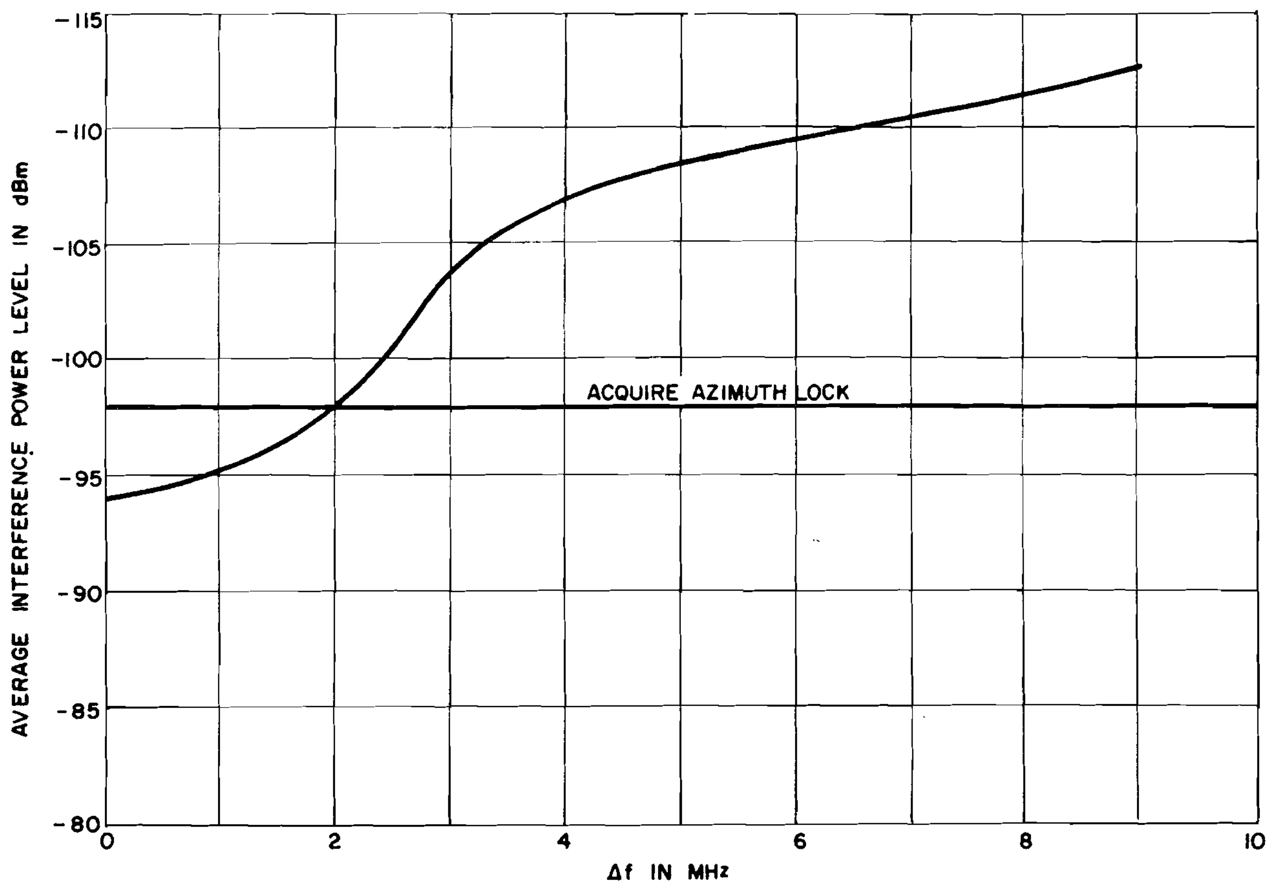


Figure B-126. Interference power level vs Δf for Y mode interrogator, DABS format # 10, downlink freq. = 1090 ± 3 MHz.