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

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

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FINAL REPORT

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Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, DC 20591

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16. Abstract

The interference potential of newly-developed Discrete Address Beacon System (DABS) signal formats upon the performance of TACAN/DME equipment is investigated. This study is based upon information from an equipment test program conducted by ECAC in FY 74, involving several candidate DABS formats. Interference effects of the DABS signals on TACAN performance are described in terms of 1) average DABS signal level received by a TACAN interrogator, relative to the maximum interference level which several can be tolerated by the interrogator, and 2) the percent of deadtime and loading generated by the TACAN beacon as a result of DABS interference. A set of minimum frequency-distance separations that would limit the impact of DABS signal formats on the performance of TACAN equipments is developed.

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METRIC CONVERSION FACTORS

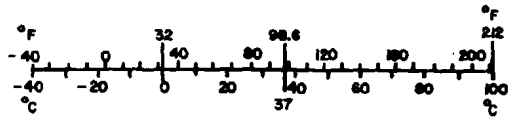
Approximate Conversions to Metric Measures

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

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

Approximate Conversions from Metric Measures

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



FEDERAL AVIATION ADMINISTRATION
SYSTEMS RESEARCH AND DEVELOPMENT SERVICE
SPECTRUM MANAGEMENT STAFF

STATEMENT OF MISSION

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

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

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

PREFACE

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

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

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

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EXECUTIVE SUMMARY

The Federal Aviation Administration has tasked the Electromagnetic Compatibility Analysis Center (ECAC) to determine the impact of the Discrete Address Beacon System (DABS) upon TACAN/DME performance. This analysis deals specifically with the interference effects of the provisional DABS signal formats proposed by the DABS System Engineering Contractor. The data and results contained in this analysis were extrapolated from data taken in an equipment test program, conducted by ECAC in FY 74 with a DABS signal simulator and representative TACAN/DME equipments, using ten candidate DABS signal formats.

The impact of the provisional DABS signal formats was assessed in the following manner. The total average DABS power received at a TACAN interrogator was compared to the highest level of interference power (determined experimentally) which would permit the interrogator to lock on in azimuth. Since the acquisition of azimuth lock had previously been shown to be the interrogator function most susceptible to DABS interference, this criterion was applied to determine the existence of degradation to the TACAN interrogator.

The impact of DABS signals on the TACAN beacon was assessed by calculating the percentage of deadtime generated by the beacon in the presence of DABS signals. A secondary measure of interference to the beacon was the degree of beacon loading caused by the reception and decoding of DABS signals interpreted by the beacon as legitimate TACAN interrogations.

By observing the minimum frequency-distance separations developed in this analysis, deadtime and loading generated in the TACAN beacon by DABS signals can be limited as indicated in the applicable curves. It was shown that the ability of the TACAN interrogator to acquire azimuth lock is unaffected by DABS signals. The use of power programming was shown to be an effective method of limiting the impact of DABS signals on TACAN performance.

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SECTION 1

INTRODUCTION

BACKGROUND

The Federal Aviation Administration (FAA) has instituted a program for the development of a Discrete Address Beacon System (DABS) which will upgrade and eventually replace the existing Air Traffic Control Radar Beacon System (ATCRBS) as the primary means of air traffic control surveillance. The DABS, as presently envisioned, will be capable of supporting air traffic in 1980 and beyond, and will have the potential to improve the aircraft-tracking capacity, azimuth resolution, and ranging accuracy of the ATC system. Additionally, a ground/air data link will be included as an integral part of the DABS. These features are required to support the eventual automation of air traffic control.

In order to facilitate the orderly transition to the DABS, all DABS equipments will include the capability to operate in the ATCRBS mode. Since the DABS will operate on the same interrogation and reply frequencies as the ATCRBS (1030 and 1090 MHz), which fall within the TACAN/DME band, the DABS must also be compatible with existing TACAN/DME services. The FAA has tasked the DoD Electromagnetic Compatibility Analysis Center (ECAC), through task assignment 16 of Interagency Agreement DOT-FA-70WAI-175, to determine the impact of the DABS on TACAN/DME performance.

This analysis, which investigates the interference effect of the prototype DABS signal formats, is an extension of a previous similar analysis performed by ECAC in FY 74.[1] In that study, the effects of ten DABS formats on several TACAN/DME equipments were determined experimentally. A DABS signal simulator was used to inject interference into TACAN/DME interrogators operating with a desired signal at MDS and the resulting impairment of the ability to acquire lock was measured. Beacon testing consisted of introducing a DABS signal into the receiver of TACAN/DME beacons and measuring the resulting amount of deadtime and number of decodes produced by the beacon. Results of equipment tests in that analysis were extrapolated to describe the effects of the

---

[1]Willey, T. M., and Wingard, J. L., *Potential Interference of the Discrete Address Beacon System (DABS) on the X and Y Mode TACAN System*, FAA-RD-74-14, Electromagnetic Compatibility Analysis Center, February 1974.

DABS formats investigated herein. The signal structures and operating characteristics considered were provided by MIT Lincoln Laboratory, the FAA's System Engineering Contractor (SEC).[2]

OBJECTIVE

The objective of this analysis was to determine the interference impact of the prototype DABS interrogation and reply signal structures on TACAN/DME equipments.

APPROACH

An analysis of the interference effect of ten preliminary DABS signal formats on the TACAN/DME system was performed by ECAC in FY 74, based on a test program conducted by ECAC at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, NJ. The test program included measurements of the susceptibility of representative TACAN and DME equipments to each of the DABS signal formats. In all cases, measurements were made for both on-tune DABS interference, and for various frequency differences (Δf) between the DABS signals and the victim receivers. Results of the test program were extrapolated to describe the interference effects of the provisional DABS signal formats.

The interference interactions investigated herein were those resulting from a DABS interrogator/sensor (uplink interference) or a DABS transponder (downlink interference) acting upon the receivers of TACAN beacons and interrogators. The various possible interactions are shown in Figures 1 and 2.

The effects of DABS interference to the TACAN interrogator were assessed by determining the DABS signal level which, when received at the interrogator, would prevent azimuth lock on a desired signal at the minimum-discernible-signal (MDS) level. This criterion was chosen because the azimuth acquire-lock function was the most sensitive parameter tested.

The method chosen to describe the effect of DABS interference on TACAN beacon performance was the computation of percent deadtime generated in the beacon as a result of DABS interference. Percent deadtime refers to the percentage of operation time during which the TACAN beacon cannot process a valid interrogation because the beacon receiver is processing a previously received signal (either valid or interference). Deadtime is generated by the TACAN beacon in the course of answering valid interrogations. Deadtime

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[2]Drouilhet, P., *Provisional Signal Formats for the Discrete Address Beacon System*, FAA-RD-74-62, Lincoln Laboratory ATC-30-REV-1, April 1974.

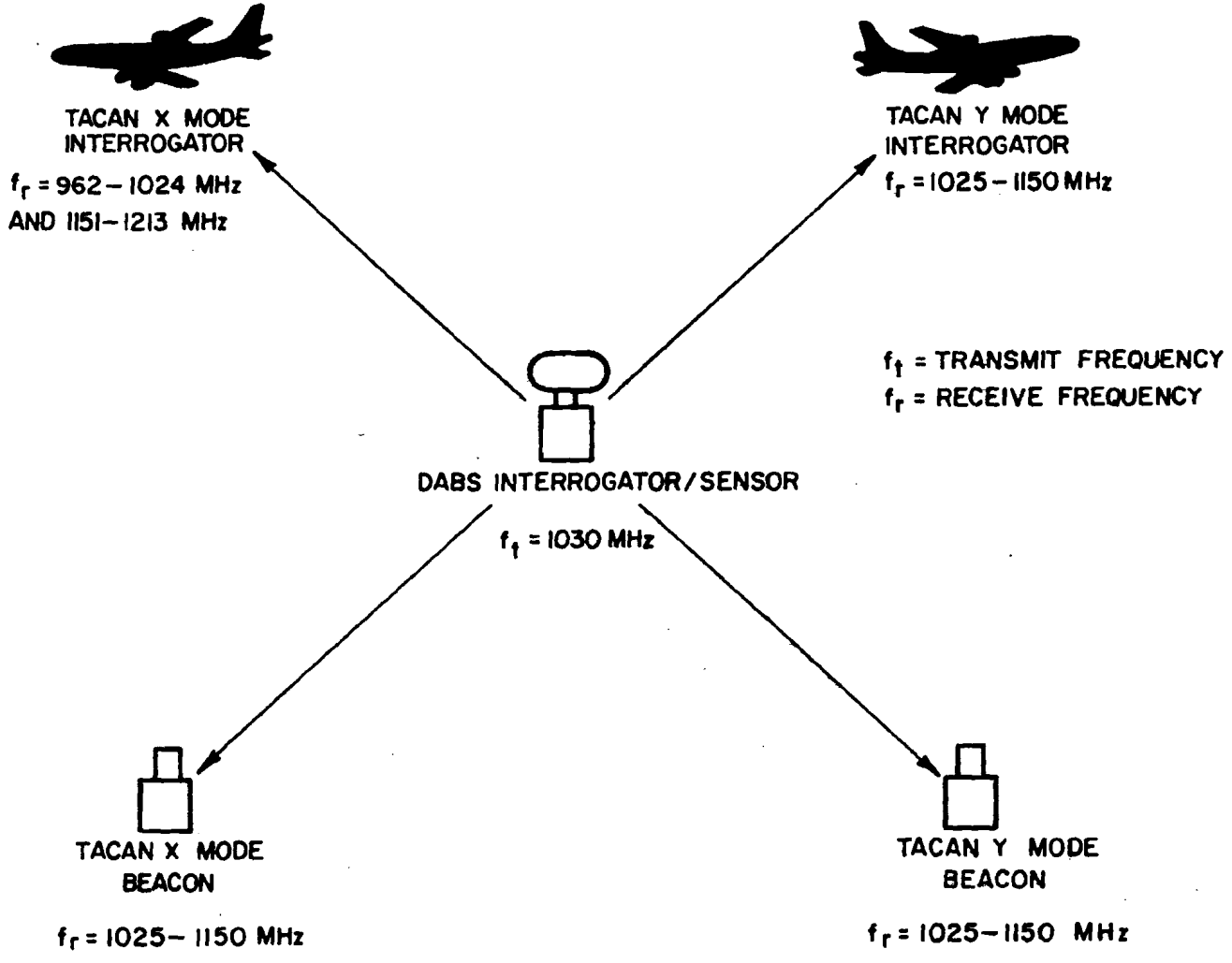

Figure 1. Interference paths for DABS uplink (1030 MHz) signal.

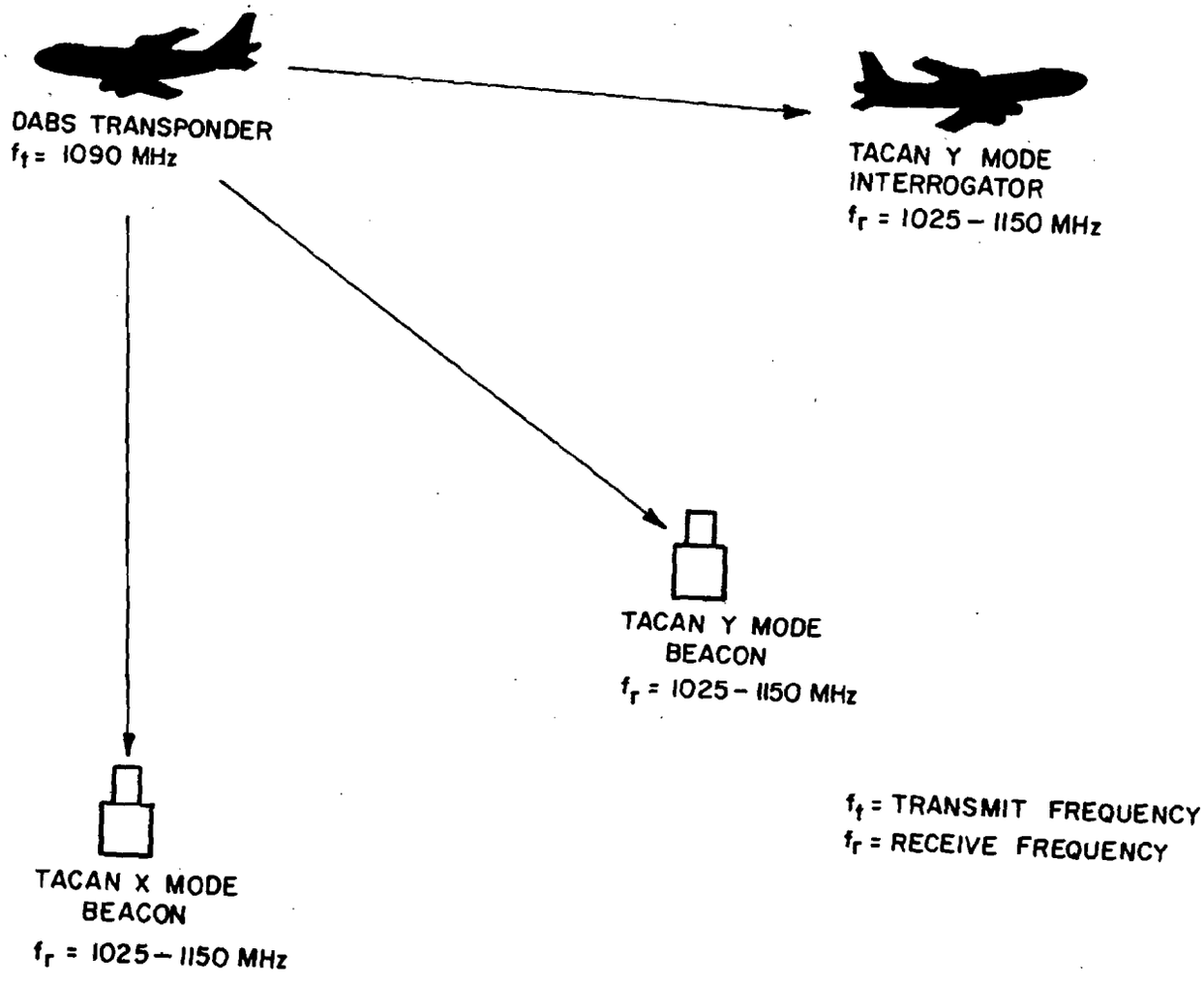

Figure 2. Interference paths for DABS downlink (1090 MHz) signal.

generated as a result of DABS signals may degrade TACAN system performance by denying service to valid interrogations.

As a secondary measure of interference to the beacon, the amount of beacon loading by DABS was considered. When DABS signals received by the beacon are interpreted as valid TACAN interrogations and decoded, replies are generated by the beacon. Since beacon output is limited to a fixed maximum number of replies, the replies generated in response to the DABS signal could deny service to TACAN interrogators. The percentage of beacon loading from DABS signals is a measure of the service denied to TACAN interrogators.

The analysis was divided into two general categories, the first dealing with the effects of DABS uplink (1030 MHz) interference, the second describing the effects of DABS downlink (1090 MHz) emissions. In the uplink analysis, the concept of one DABS sensor acting on one TACAN beacon or interrogator was used to compute the amount of interference caused by DABS. The total effective average received DABS power at the interrogator was computed, while beacon calculations dealt with total deadtime generated in the beacon and the degree of beacon loading in the presence of DABS. Calculations were made for the case of on-tune DABS inteference, and for a range of frequency differences between the DABS and the victim receiver. From these computations it was possible to generate curves showing the frequency-distance (F-D) separations necessary to minimize the effects of DABS interference.

The environment used for the downlink analysis was provided by the system engineering contractor, and consisted of a deployment of DABS-equipped aircraft representative of air traffic in the 1980 time frame. As in the uplink analysis, the impact of DABS signals on TACAN operation was found by computing the total effective average received DABS power at the interrogator, and by finding total deadtime and loading in the beacon caused by DABS emissions.

The number of TACAN equipments in the original test program was limited due to equipment availability. Thus, neither the results obtained from that analysis nor this extension of those results should be construed as being representative of the entire population of TACAN/DME equipments in the field. Rather, these results constitute a parametric analysis which describes the effects of these particular DABS signals on TACAN equipments which have been shown to be susceptible to pulsed interference when operating with minimum discernible desired-signal levels. In the test program, all measurements were made using DABS signals with rectangular waveforms. Since the DABS operating characteristics

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for this analysis specified trapezoidal waveforms, it was necessary to calculate off-frequency rejection curves corresponding to the specified waveforms. Results for both types of waveforms were calculated and are included herein.

It should be emphasized that this analysis does not consider the effects of DABS interference to TACAN system performance, but rather is a measure of the effect of DABS signals upon specific individual pieces of TACAN equipment.

SECTION 2

ANALYSIS

TACAN SYSTEM DESCRIPTION

TACAN (Tactical Air Navigation) is a system from which a pilot in an interrogator-equipped aircraft can obtain bearing and slant range to a selected ground beacon. Bearing information is derived by a measurement of phase differences between signals transmitted by the beacon, while distance information is obtained from a measurement of the time elapsed between sending an interrogation and receiving a reply.

Two modes of operation are presently available in the TACAN system: X mode, which utilizes the band of frequencies between 962 and 1213 MHz, and Y mode, in which only the band between 1025 and 1150 MHz is used. One hundred twenty-six channels, with a channel increment of 1 MHz, are available in each mode. A TACAN channel consists of a pair of frequencies, uplink (ground-to-air) and downlink (air-to-ground), which are separated by 63 MHz. Figure 3 shows the channel frequency pairings for X and Y mode TACAN operation. Each TACAN beacon operates on one assigned channel, while an interrogator can be tuned over the entire range of available channels.

DABS DESCRIPTION

The Discrete Address Beacon System (DABS) is a direct evolvement of the existing ATCRBS. The DABS consists of a network of ground interrogators (or sensors), which, like ATCRBS, can measure range and bearing to transponder-equipped aircraft. Additionally, aircraft identity and altitude can be automatically obtained from coded transponder replies. The DABS will use the same frequencies as ATCRBS, 1030 MHz uplink and 1090 MHz downlink, and will be capable of operating in the ATCRBS mode to facilitate the transition between systems.

The major difference between these systems is that the ATCRBS interrogates all aircraft within range during every sweep, while the DABS interrogates each aircraft individually and elicits a reply from only one aircraft at a time, using a discretely coded address message. The number of replies received by ATCRBS is a direct function of the number of aircraft present, which leads to overlapping and garbling of replies as the number increases. DABS interrogations are scheduled so as to prevent overlap and garbling of the replies.

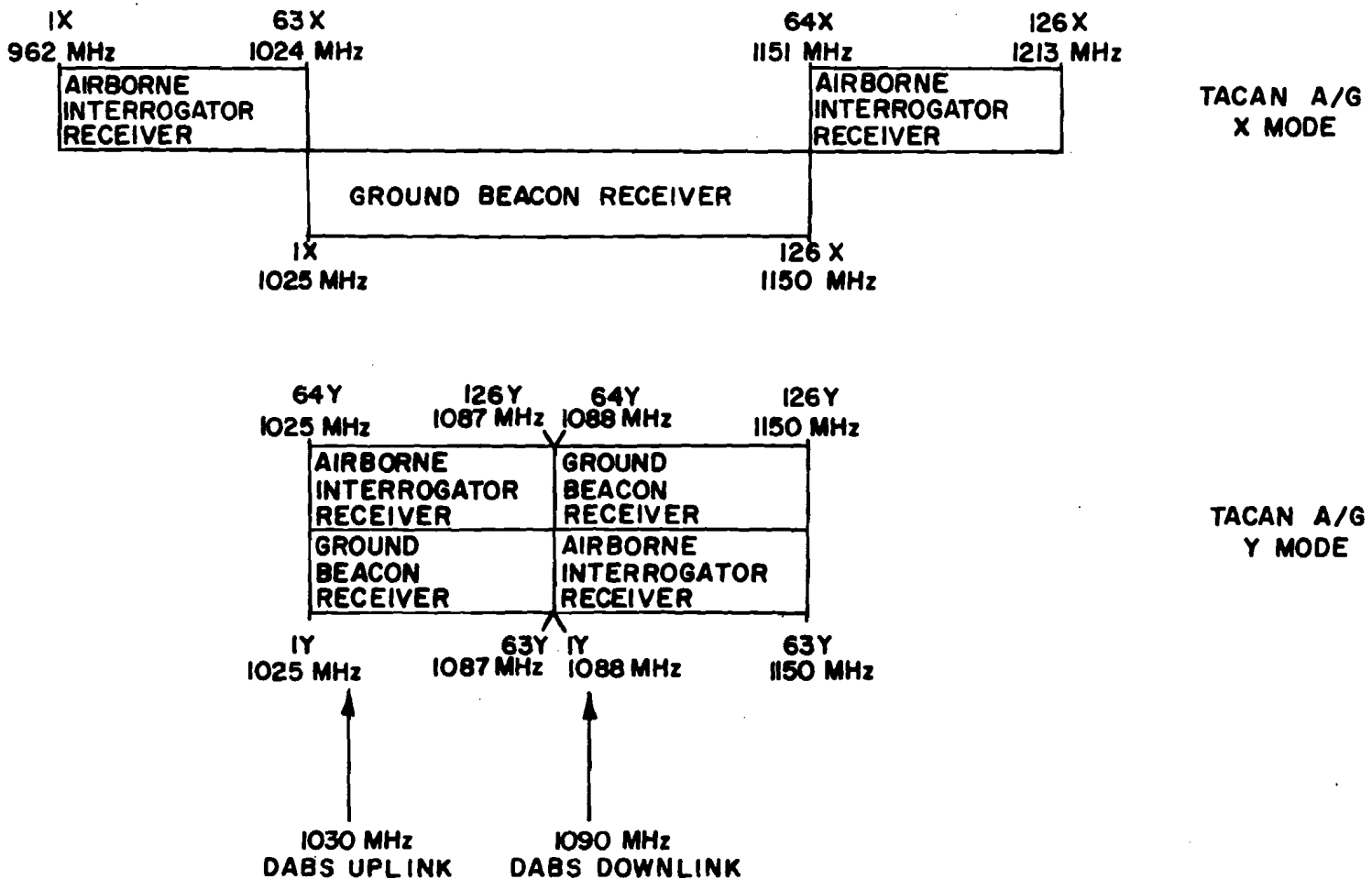


Figure 3. TACAN X and Y mode channel pairings.

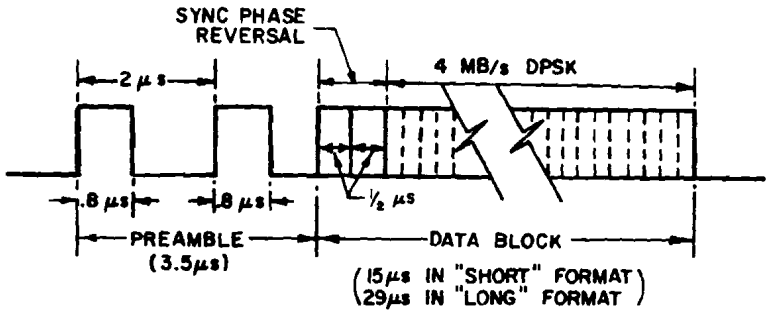
The candidate DABS signal formats, along with salient operating characteristics are described in Figures 4a and 4b. The specific uplink and downlink DABS operating characteristics used in this analysis are shown in TABLE 1.

TACAN INTERROGATOR INTERFERENCE SUSCEPTIBILITY

The presence of external interference may impact TACAN interrogator receiver performance in any of several ways. The ability of the interrogator to acquire either range or azimuth lock may be affected. If lock has been acquired in either the azimuth-or range-determining function, the introduction of interference may cause loss of the desired signal, or a "break-lock" condition. Another possibility is that the interrogator will maintain range and azimuth lock but, because of interference, may present erroneous range or azimuth information.

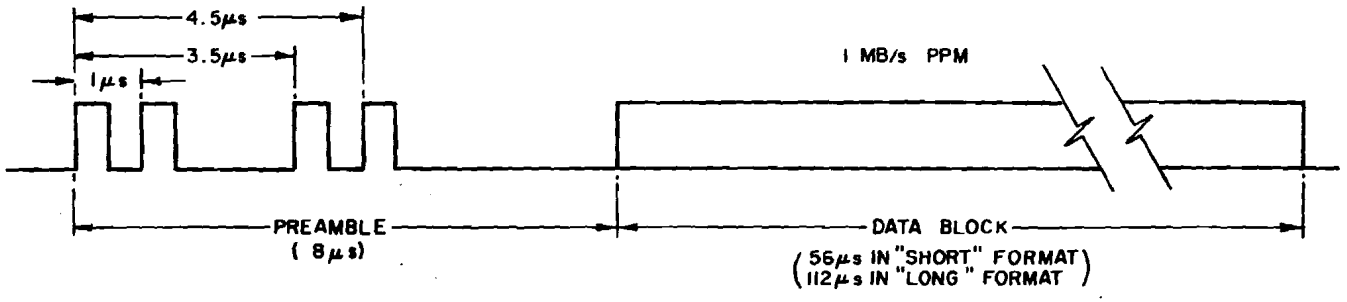
It was found in the test program that the interrogator function most vulnerable to external interference effects was the ability of the TACAN interrogator to acquire azimuth lock. A DABS signal at a level so minimal that other functions were unaffected was sufficient to prevent the interrogator from acquiring azimuth lock. TABLE 2 shows typical test results. Thus, the criterion for determining interference-caused interrogator performance degradation was defined for this analysis as the ability to acquire azimuth lock in the presence of an interfering signal with a desired-beacon signal at the minimum discernible signal (MDS) level.

It was determined experimentally that the effect of the DABS interference on the ability of the interrogator to acquire or maintain azimuth lock was related directly to the action of the automatic gain control (AGC) circuitry in the interrogator receiver. A major purpose of the AGC circuits is to maintain a constant signal level at the output of the detector. If the input signal level (desired signal) to the interrogator receiver is increased, the AGC reduces the gain of the receiver in order to maintain the detector output at some specified level. In the event that the interfering signal (DABS) is interpreted as a valid signal and decoded, the AGC will also be activated, thereby reducing receiver gain. In this case, the desired-signal level is reduced, relative to the total received signal level (valid signal plus decoded interference). If the desired signal were at the MDS level, the addition of decoded interference would result in the loss of reference bursts and distortion of amplitude modulation information necessary for acquisition and maintenance of azimuth lock.



NOTE: ALL TRANSMISSIONS CONSIST OF 90% "SHORT" FORMAT, 10% "LONG" FORMAT.

Figure 4a. DABS uplink signal formats.



NOTE: ALL TRANSMISSIONS CONSIST OF 90% "SHORT" FORMAT, 10% "LONG" FORMAT.

Figure 4b. DABS downlink signal formats.

TABLE 1

DABS OPERATING CHARACTERISTICS USED IN ANALYSIS

INTERROGATOR/SENSOR:

PRF: 200/s (secondary interest in 100/s & 500/s)

Transmit Power: 800 watts[a]

Power Programming: 100 watts[a] for 90% of interrogations
800 watts[a] for 10% of interrogations

Coupling Loss to Antenna: 1.5 dB

Antenna Gain of Fan Beam: 26 dBi (ground-to-air) } for 3° main beam
20 dBi (ground-to-ground) } for 3° main beam
-5 dBi for 15° (1st sidelobe level)
-10 dBi for 72° (2nd sidelobe level)
-16 dBi for 270° (backlobe level)

TRANSPONDER:

Reply Rate: 1/second, average for each DABS target

Transmit Power: 250 watts, referred to antenna

Antenna Gain: 0 dBi

Transponder Frequency: 1087 to 1093 MHz, triangular distribution

GENERAL:

Shape of waveforms: Trapezoidal, with risetimes = 60 ns uplink, 75 ns downlink

Mix of Formats: All transmissions, interrogations and replies, consist of 10% long formats and 90% short formats.

[a]Referred to sensor RF port.

TABLE 2

MEASURED (PEAK POWER) ACQUIRE-LOCK AND BREAK-LOCK LEVELS FOR 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 (4MB, DPSK, 25 μs data block) 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 are MDS, represent worst-case conditions.)

Since the amount of AGC control is determined by the average received power level, it follows that there is a correlation between the average interference power level received and the ability of the interrogator to acquire azimuth lock. It was observed from the test results that, by converting the measured interfering power level to average power, the point at which an interrogator acquires azimuth lock can be predicted. Acquire-lock levels were determined experimentally for the original ten DABS formats. Typical test results are shown in TABLE 3. Acquire-lock levels for the provisional signal formats analyzed herein were extrapolated from test results for formats which were similar with respect to modulation, data rate, and message length. The extrapolation was based primarily upon the average power contained in the various formats.

The test data indicate that the concept of a linear correlation between average power received and the ability to acquire lock holds true only for interference PRF's at or above some minimum value. When an interfering signal exceeds a given power level (determined by the PRF and signal format of the interference), the interrogator receiver becomes saturated, and a built-in limiting process holds the detector output constant for any further increases in received signal level. Thus, any received interference 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 original ten DABS formats were determined experimentally. TABLE 4 contains typical test results. Saturation levels for the formats considered in this analysis were extrapolated from test data for similar formats.

Tests showed that an off-tuned interfering signal had the same effect on the interrogator as an on-tune signal at a lower power level. This difference in the power levels is defined as the off-frequency rejection (OFR) of the interrogator receiver, and is a function of frequency separation (Δf). The interrogator OFR of the previous DABS signal formats was found experimentally. In the case of off-frequency interference, the interference mechanism was found to be the same as with the on-tune case, i.e., AGC capture. OFR curves generated in Reference 1 for two specific DABS formats are shown in Figures 5 and 6. These formats (uplink: 4 MB, DPSK, 25 μs data block, and downlink: 2 MB, PAM NRZ, 40 or 80 μs data block) correspond most closely to the formats considered in this analysis, and their respective OFR curves were used in the computations to determine DABS interference effects.

TABLE 3

ACQUIRE-LOCK AND BREAK-LOCK LEVELS (AVERAGE POWER)
FOR TACAN X MODE INTERROGATOR

DABS PRF (PPS)	DABS Signal Level Above Which the TACAN will not Acquire Azimuth Lock (dBm)	DABS Signal Level for Azimuth Breaklock (dBm)
1.6K	-89	-87
1.0K	-89	-87
800	-89	-87
600	-89	-86
500	-89	-86
400	-88	-86
300	-88	-85
200	-86	-83
150	-72	-69

NOTES: DABS signal format #4 (4MB, DPSK, 25μs data block) was used.
DABS signal-co-channel with TACAN receiver.
TACAN desired signal level is MDS, represents worst-case situation.

TABLE 4

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

	X Mode Interrogator		Y Mode Interrogator	
DABS Format Number[a]	DABS Signal Level Which Produces Saturation in Interrogator Receiver (dBm)	DABS Signal Level Above Which the TACAN Will Not Acquire Azimuth Lock (dBm)	DABS Signal Level Which Produces Saturation in Interrogator Receiver (dBm)	DABS Signal Level Above Which the TACAN Will Not Acquire Azimuth Lock (dBm)
1	-69	-92	-69	-91
2	-69	-92	-65	-88.5
3	-69	-98	-61	-86
4	-68	-89	-55	-78
5[b]	-70	-91	-67	-89
6	N.A.[c]	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]Numbers refer to the ten signal formats used in the equipment test program in FY 74; 1 through 5 are uplink, 6 through 10 are downlink.

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

[c]Not applicable.

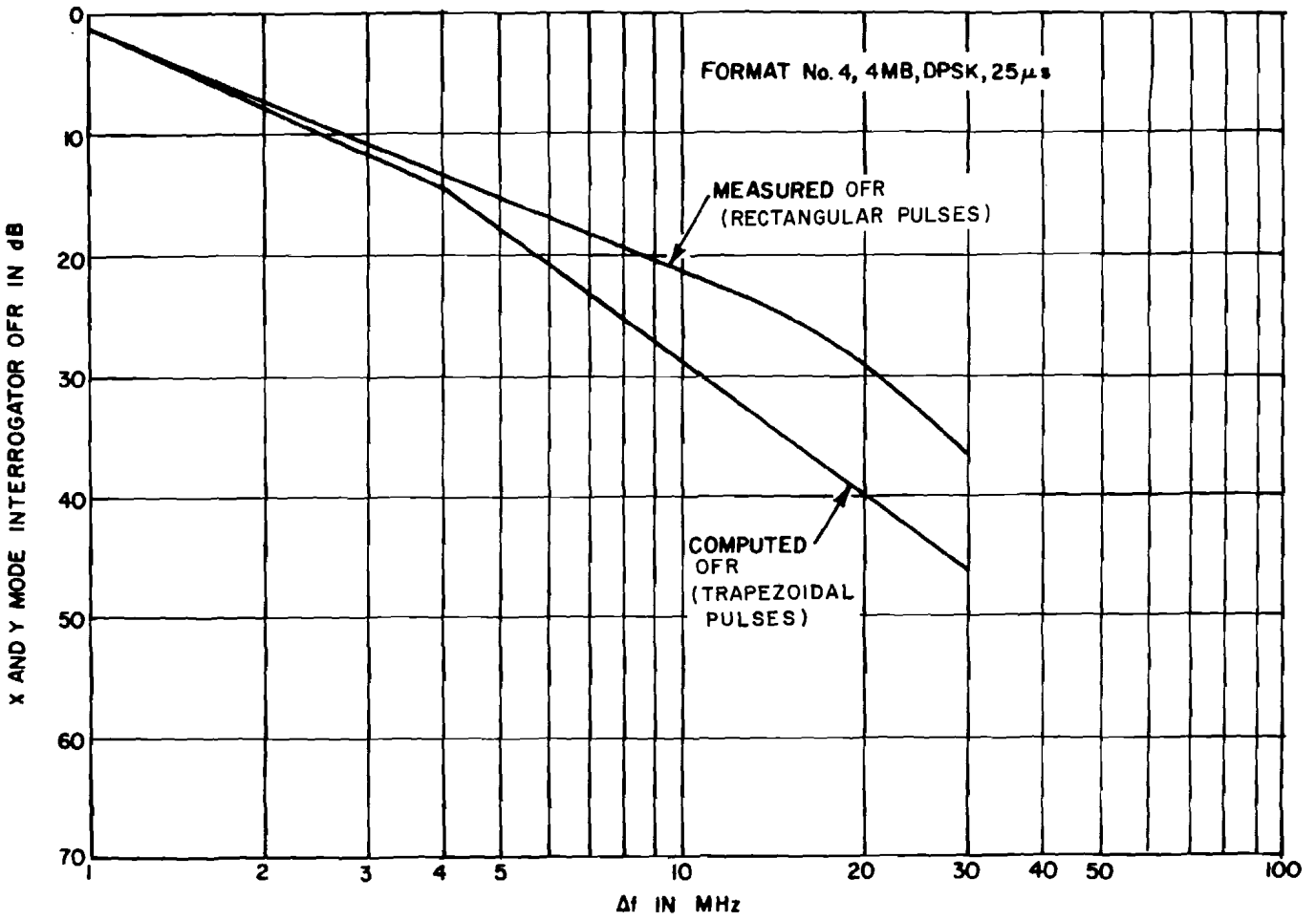


Figure 5. TACAN interrogator OFR for DABS uplink format: 4MB, DPSK, 25μs data block.

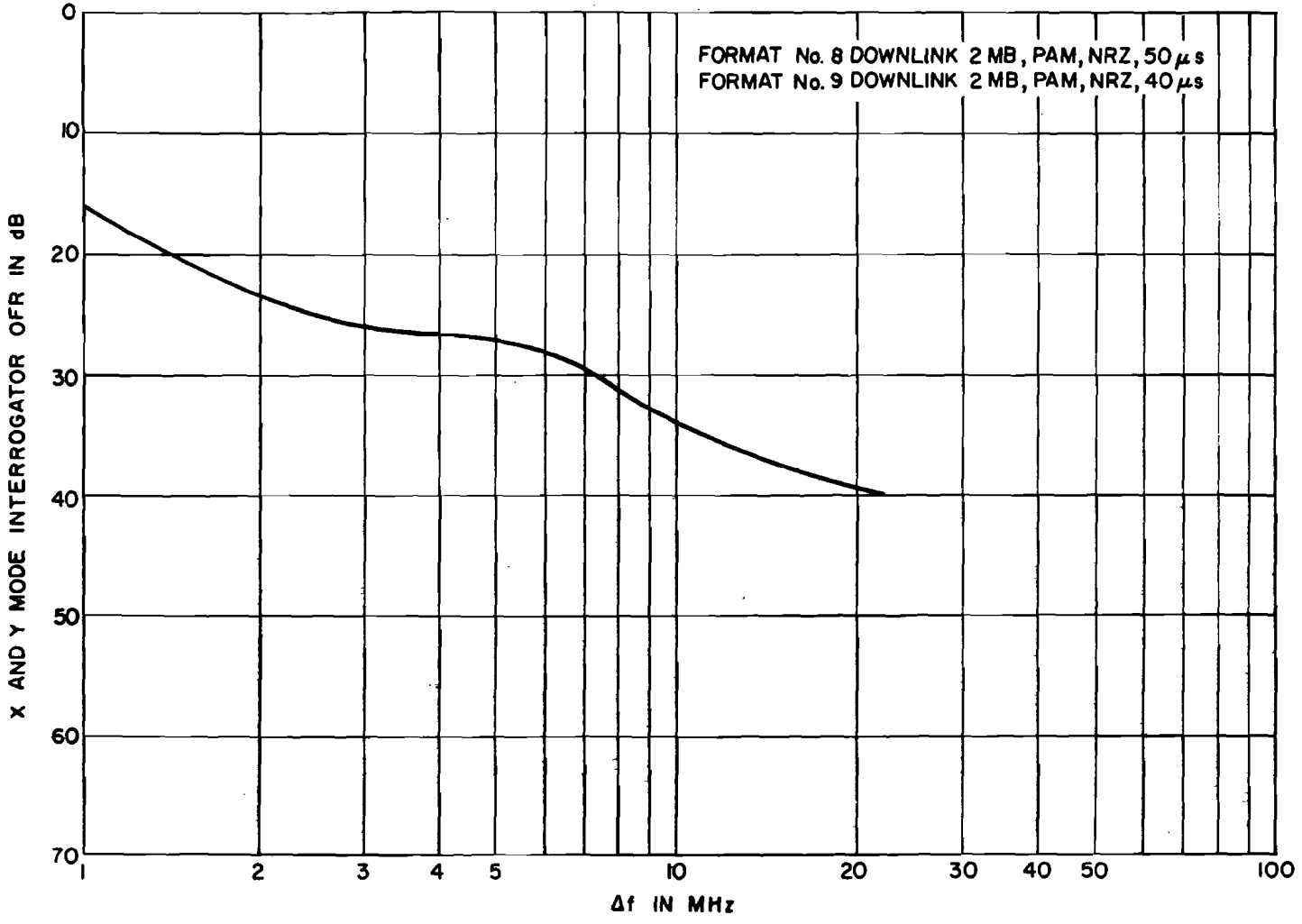


Figure 6. TACAN interrogator OFR for DABS downlink format: 2MB, PAM NRZ, 40 or 80μs data block.

The "Measured" curve in Figure 5 refers to results obtained from the test program, in which rectangular pulses were used. The "Computed" curve was calculated, based on the use of trapezoidal pulses having a risetime of 60 ns, as specified by the SEC.

TACAN BEACON INTERFERENCE SUSCEPTIBILITY

No standard criterion exists for assessing the net effect of external interference on TACAN beacon performance. No condition corresponding, for example, to acquisition of lock in the interrogator (a go/no-go condition) is defined for the beacon. It is therefore necessary to evaluate the relative effect of DABS signals on the TACAN beacon in terms of similar effects inherent in normal beacon operation: the deadtime generated by self-interference and beacon loading.

Beacon self-interference is a result of automatic decoder-inhibit circuitry in the receiver. When a valid interrogation (or a noise signal interpreted as an interrogation) is decoded by the beacon receiver, the decoder is disabled for the next 60 μs. Thus, there is a built-in minimum deadtime period of 60 μs between beacon replies.

External interference, such as DABS signals, received by the beacon can also result in the generation of deadtime. Further, interference-generated deadtime can be caused by either of two mechanisms within the beacon. If the interference is interpreted by the beacon as being a valid interrogation and is decoded, a minimum of 60 μs of deadtime is generated, as with any valid decode. If the interference is not decoded, an amount of deadtime which varies as a function of interference signal strength will be generated by echo suppression circuits in the beacon. The deadtime generated as a result of decoded interference will be constant for a wide range of interference signal levels, while non-decoding interference will produce deadtime which varies with the signal strength. The latter deadtime will be less than the maximum value generated when the signal is decoded over the same range of interference signal levels.

The amount of deadtime typically generated in the beacon as a result of DABS interference is depicted in Figure 7. In the original test program, measured data was used to plot such a curve for each format examined. It was determined that different regions of the curve were the results of the interference mechanisms within the beacon and were a function of DABS format and signal strength. Experimental data for similar formats were extended to describe the effects of the DABS signal structures in this analysis. TABLE 5 contains typical values of deadtime calculated from test data. Using

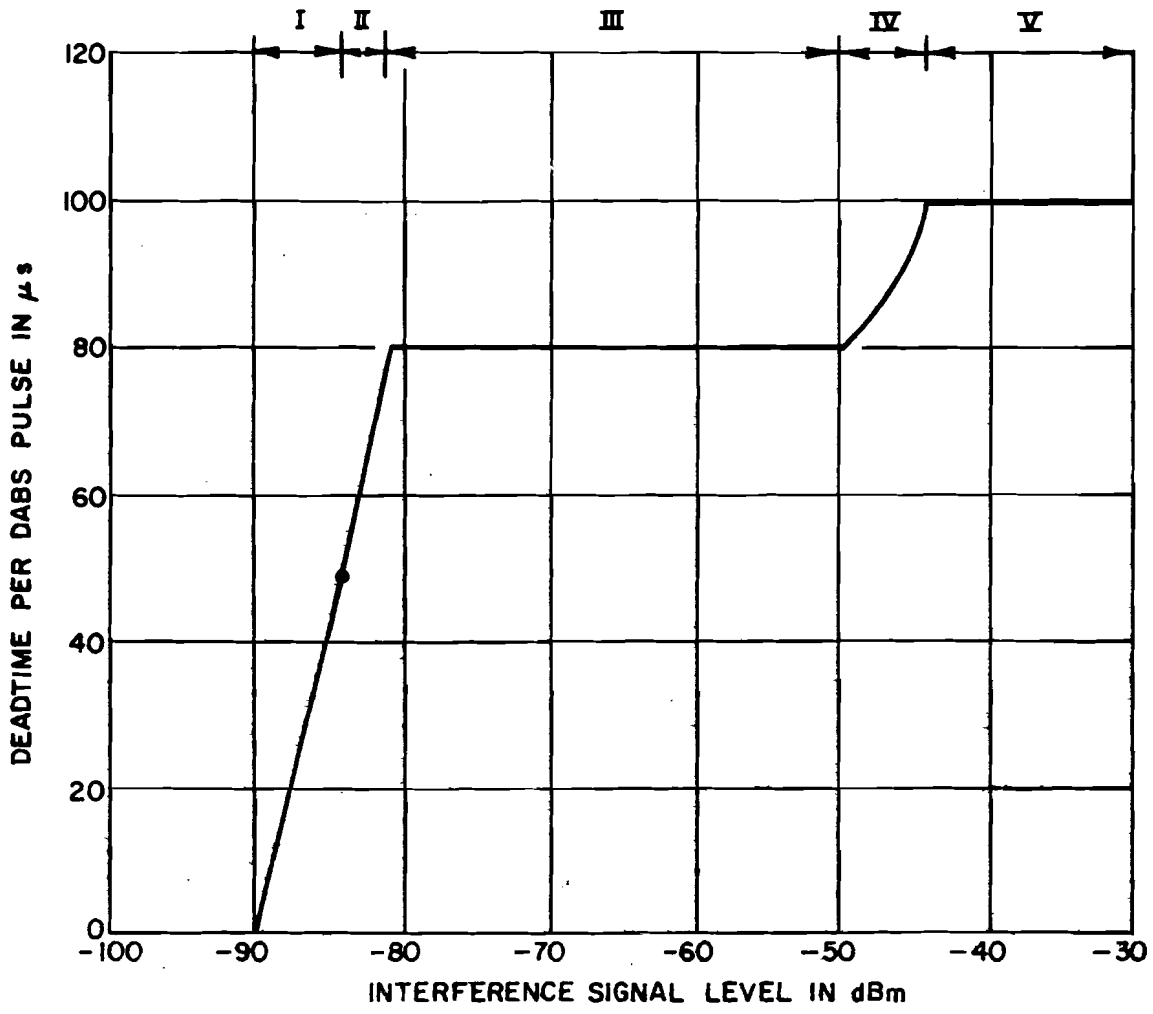


Figure 7. Deadtime per pulse generated in TACAN beacon by DABS (typical).

TABLE 5

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	1.3
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.)

Figure 7 as a typical example, the various amounts of interference-caused deadtime generated in the beacon can be illustrated. Deadtime per pulse refers to the amount of deadtime (in μs) generated by the beacon for a single complete DABS "pulse"(interrogation or reply, including preamble and data block). The portion of the curve titled Region I, represents the detected DABS signal levels which were just slightly greater than the detected desired signal at the MDS level but were not decoded. A slightly higher level of DABS signal strength, Region II, caused the activation of the 60 μs decoder inhibit, as the interference began to be decoded as a valid interrogation. The deadtime in this area is an average value, since the interference was not always decoded. In Region III, the deadtime results from the consistent decode of the interference signal, while in Region IV, deadtime is a result of the echo suppression circuits plus the decoded DABS signals. A further increase in interference signal level results in the deadtime shown in Region V. This deadtime is also generated by echo suppression and decoded DABS signals. Its value is constant, representing the maximum deadtime produced by the combination of decoder inhibiting and echo suppression.

Curves similar to the one described above were developed for both X and Y mode beacons, as affected by the DABS formats specified for this analysis, and are displayed in Figures 8 through 11.

An additional measure of TACAN beacon performance degradation is the percent loading of the beacon caused by the DABS signals. This is an indication of the amount by which TACAN beacon traffic-handling capacity is reduced due to DABS interference. Since the average rate at which interrogations are received by the beacon from a TACAN interrogator in the track mode is 26 per second, and the full operating capacity of a TACAN beacon is taken to be 100 interrogators (nominally), the nominal capacity of the beacon is therefore approximately 100 X 26 = 2600 interrogations per second, and the percent beacon loading by DABS is expressed as:

$$\text{Percent TACAN Beacon Loading} = \frac{N}{2600} \times 100$$

where N is the total number of DABS signals (either interrogations or replies) received and decoded by the TACAN beacon in one second.

The TACAN beacon OFR of the original ten DABS signal formats was determined experimentally in the test program. The testing showed that an off-tuned DABS signal had the same effect on the

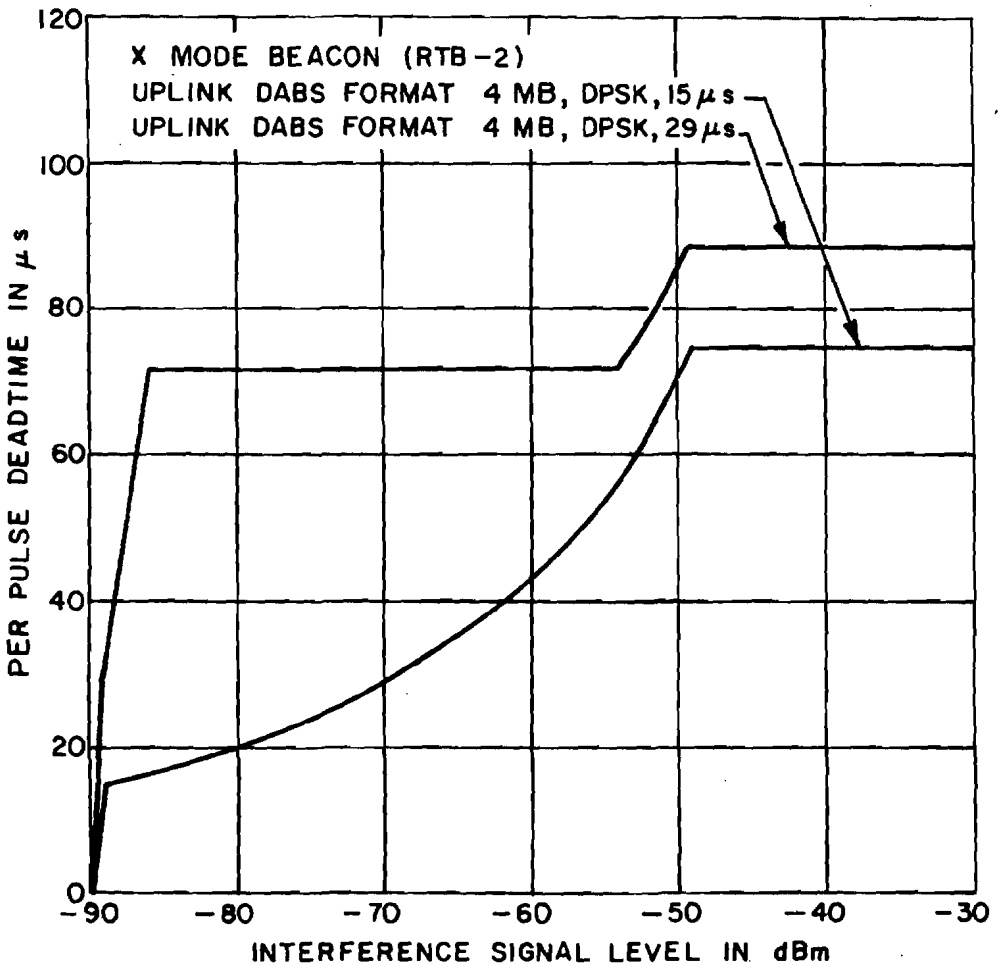


Figure 8. Deadtime per pulse generated in X mode beacon by DABS uplink formats.

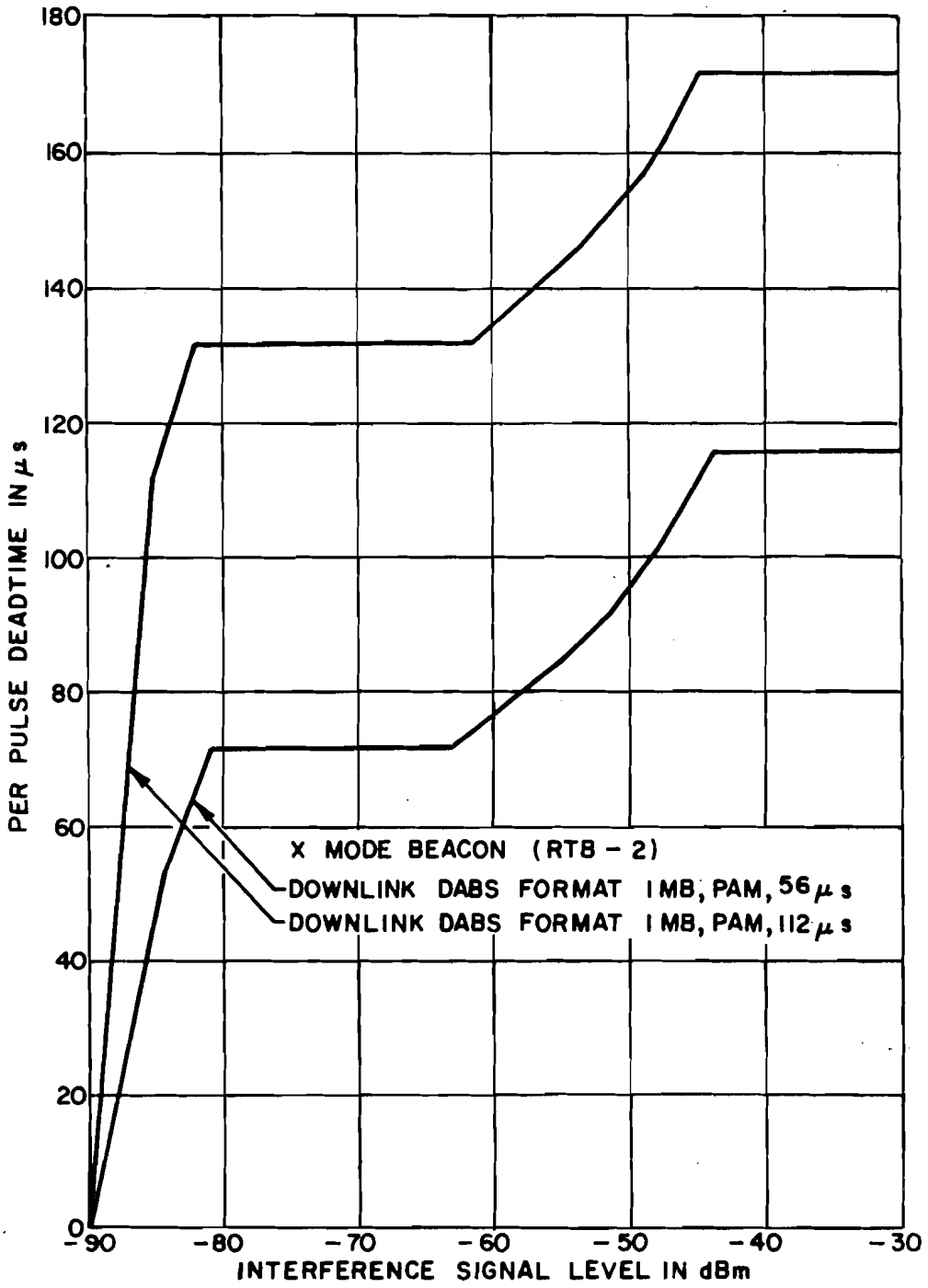


Figure 9. Deadtime per pulse generated in X mode beacon by DABS downlink formats.

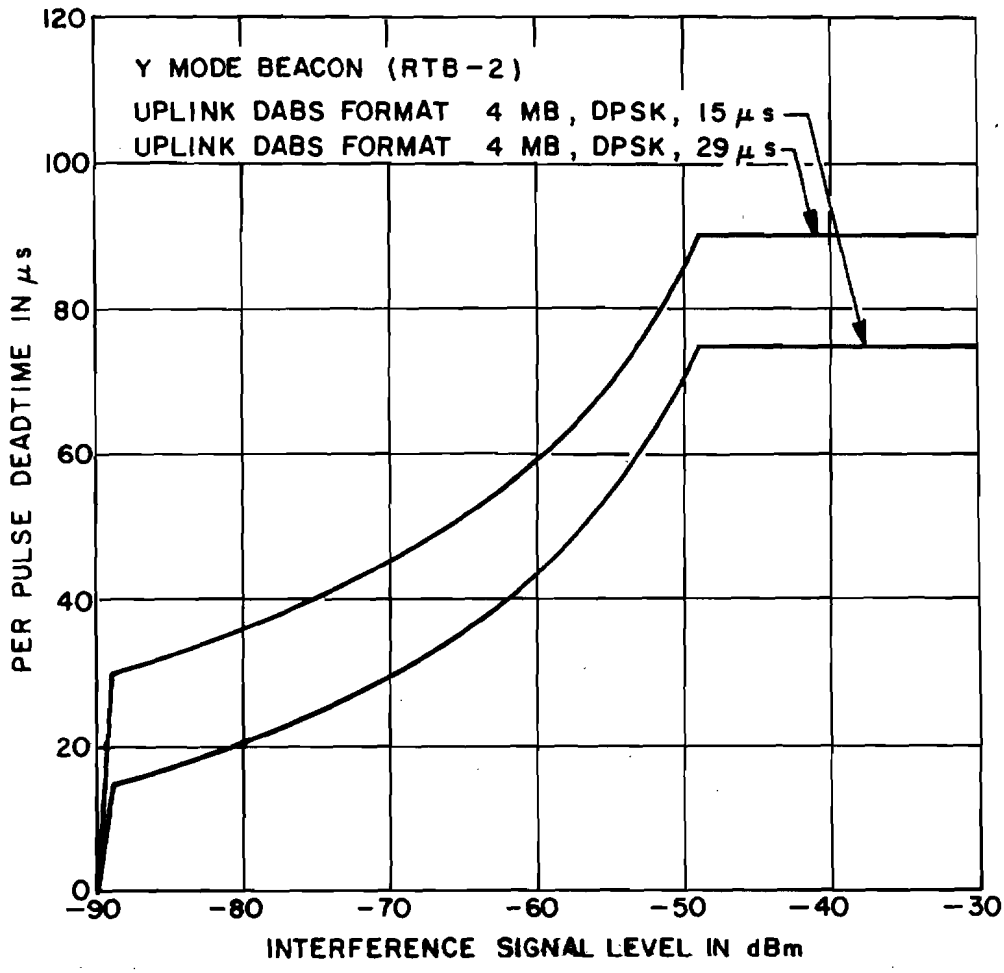


Figure 10. Deadtime per pulse generated in Y mode beacon by DABS uplink formats.

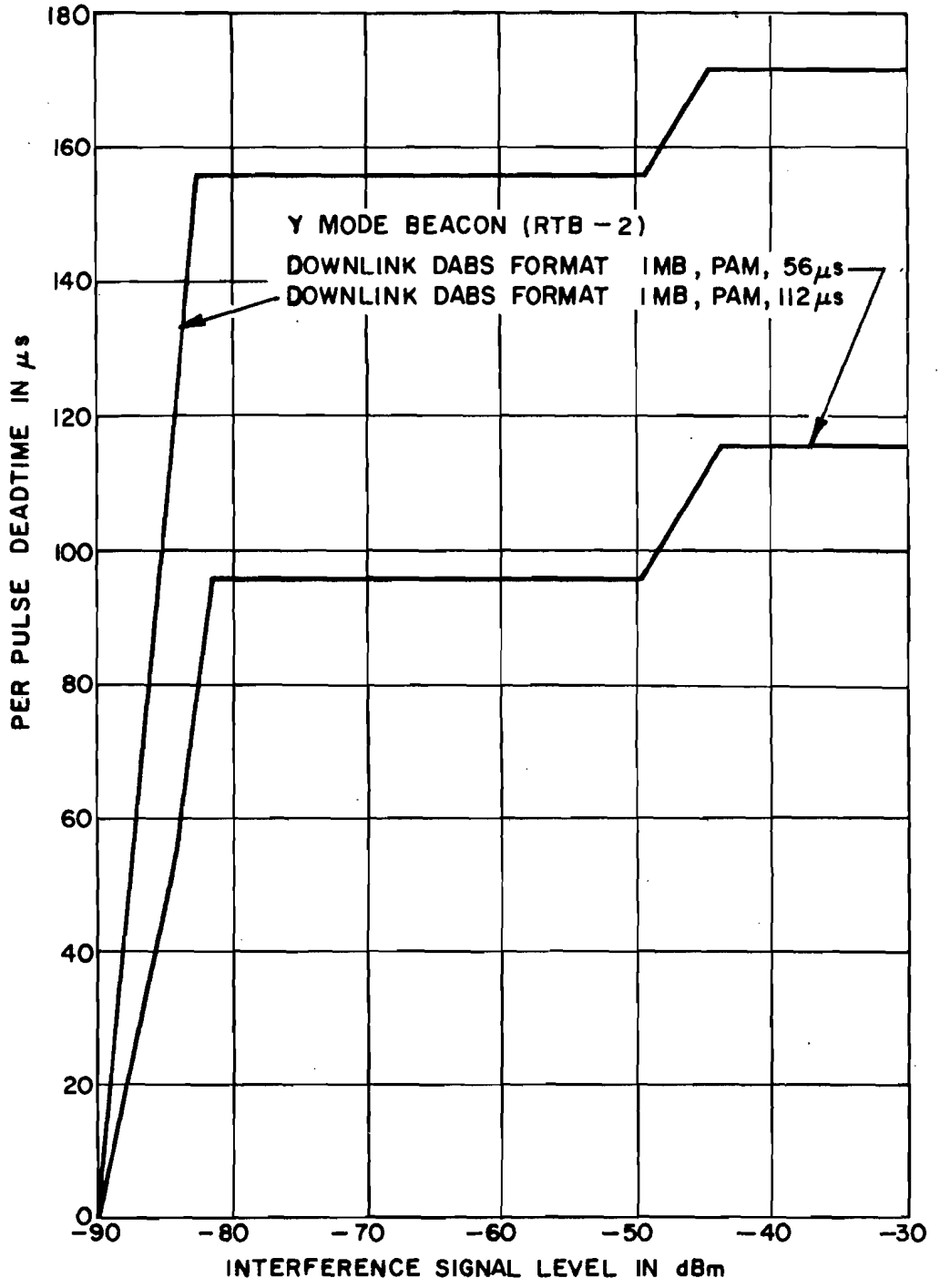


Figure 11. Deadtime per pulse generated in Y mode beacon by DABS downlink formats.

beacon (generation of deadtime) as on-tune signals at a different signal level. Beacon OFR values used in this analysis were taken from the test results for similar DABS formats, i.e., uplink: 4 MB, DPSK, 25 μs data block, and downlink: 2 MB, PAM, NRZ, 40 or 80 μs data block. These OFR curves are shown in Figures 12 and 13. The "measured" curve in Figure 12 refers to results obtained from tests which used rectangular pulses. The "computed" curve was calculated, based on the use of trapezoidal pulses with a rise time of 60 ns as specified by the SEC.

UPLINK ANALYSIS

The uplink analysis addressed the impact of DABS uplink formats on X and Y mode TACAN beacons and the X mode TACAN interrogator. The case of DABS uplink emissions acting upon the Y mode interrogator was addressed in previous testing, which showed the Y mode interrogator to be highly resistant to similar DABS formats. TABLE 6 displays typical test results for this case, indicating that no degradation would result from the provisional DABS uplink formats, since the combination of high power and high PRF necessary to cause azimuth breaklock would not occur under the specified operating conditions.

The effective DABS signal received at a victim TACAN equipment was generated by considering the DABS sensor PRF and antenna pattern, and the distance between the DABS sensor and the victim TACAN equipment. For the interrogator calculation, the average received DABS power level at a victim TACAN interrogator was calculated. The determination of whether or not an interference condition existed was made by comparison of the average DABS power received to the acquire-lock interference threshold levels previously determined. In the beacon analysis, the total amount of deadtime generated by the beacon in response to DABS signals was calculated. Additionally, calculations were made for the percentage of beacon loading produced as a result of DABS signals being received and decoded by the TACAN beacon. In both interrogator and beacon analyses, calculations were made representing two conditions of sensor operation: (1) all emissions at 800 watts and (2) with power programming (10% of emissions at 800 watts, 90% at 100 watts.)

From the percent-deadtime and the percent-loading curves for the beacon, frequency-distance curves were generated showing the combinations of frequency and distance separation necessary to limit the level of deadtime or beacon loading to certain discrete values (0.5%, 1.0%, etc., up to the maximum deadtime or loading observed.)

Results for all cases considered in this analysis are presented in APPENDIX A. In each case, calculations were made using both measured (rectangular pulses) and computed (trapezoidal pulses) OFR curves.

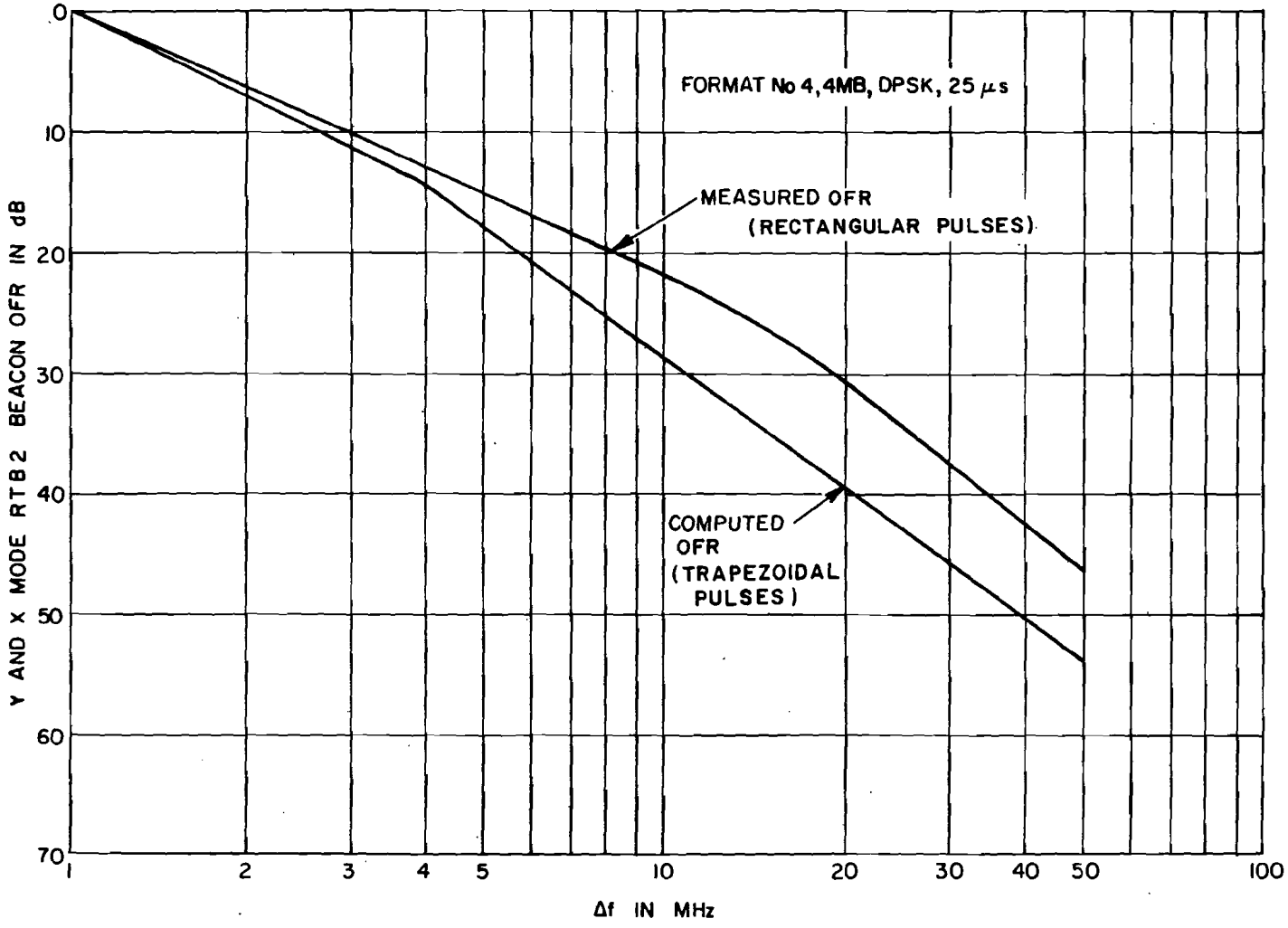


Figure 12. TACAN beacon OFR for DABS uplink format: 4MB, DPSK, 25μs data block.

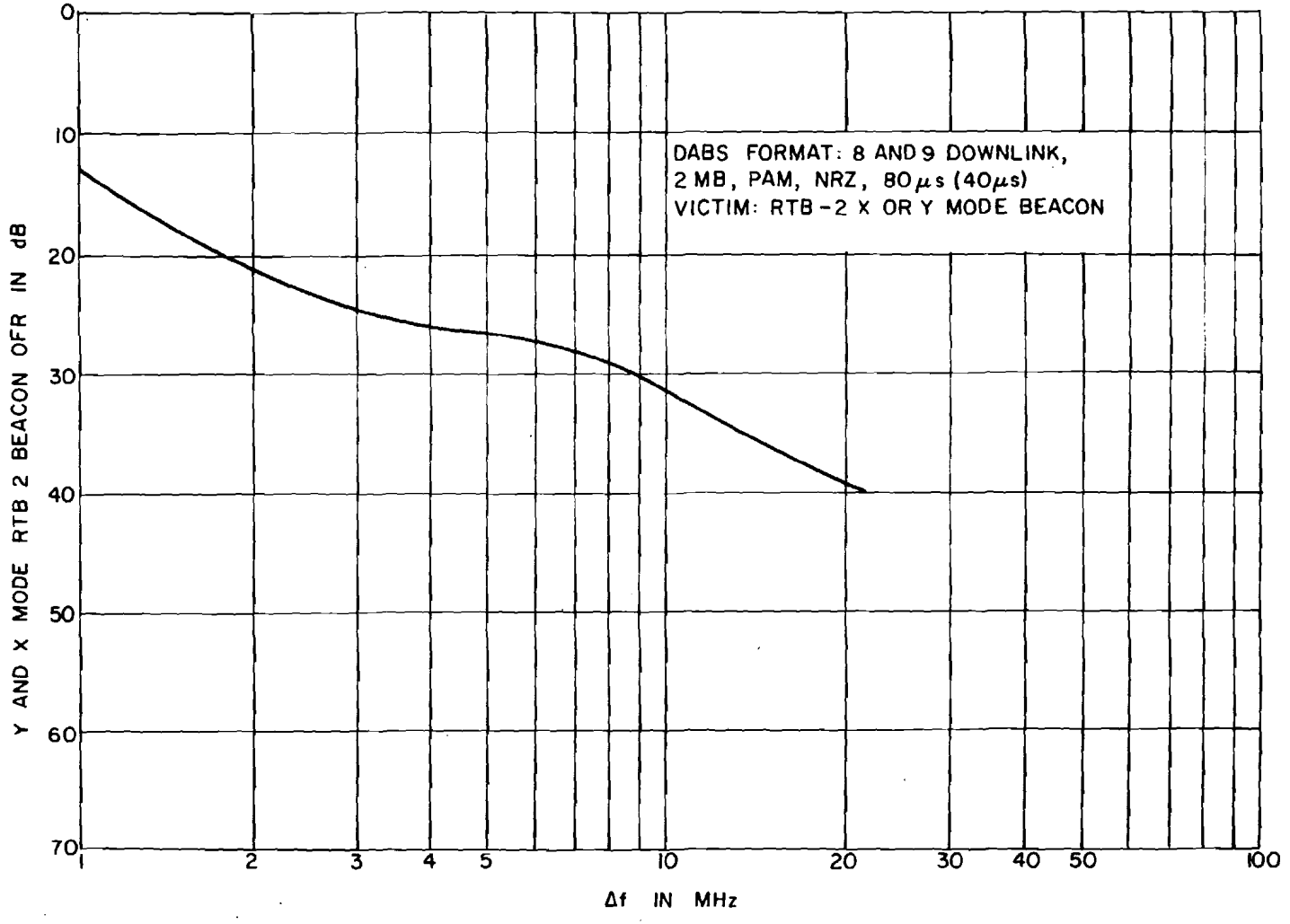


Figure 13. TACAN beacon OFR for DABS downlink format: 2MB, PAM NRZ, 40 or 80μs data block.

TABLE 6

DABS POWER LEVELS AND PRF NEEDED TO PRODUCE INTERFERENCE TO Y MODE TACAN INTERROGATOR SUFFICIENT TO CAUSE AZIMUTH BREAKLOCK

Sample I		Sample II	
DABS PRF	DABS Power Level (dBm)	DABS PRF	DABS Power Level (dBm)
10K	-63	10K	-59
7.5K	-53		
5.0K	-28	7.5K	-34
2.5K	-26		
1.0K	>-26	5.0K	>-26

NOTE: This data, taken in previous ECAC testing, represents the effects of the equivalent of short DABS uplink formats acting on two AN/ARN-21C TACAN interrogators. Since the mixture of formats is 90% short and 10% long, this data represents 90% of the DABS-TO-TACAN interaction. Since the maximum DABS PRF considered in this analysis is 500 per second, the maximum rate of long formats is 50 per second. Testing has shown that pulsed interference of the length and modulation type of the long DABS formats will not cause azimuth breaklock at PRF's lower than approximately 100 per second, regardless of signal strength.

Sample Calculations (TACAN Interrogator)

The total amount of DABS signal power received at a victim TACAN interrogator was calculated, using as a basis the DABS operating characteristics specified by the SEC. A typical calculation of this type is shown below. (Note that path loss calculations are based on free space propagation. The SEC requested that a less conservative propagation model be used only if an interference problem were found to exist.)

In this analysis, all DABS emissions are specified as consisting of a mixture of 90% short formats and 10% long formats. If one complete DABS interrogation (including preamble and data block) is considered to be a "pulse", the sensor may be considered to have a PRF of n "pulses" per second (pps). For a TACAN interrogator decoder, the effect of a long "pulse" (data block = 29 μs) has the same effect as two short "pulses". Thus, a nominal DABS PRF of 100 pps, composed of 90% short formats and 10% long formats is equivalent to

90 short "pulses" per second + 10 long "pulses" per second

or

90 short "pulses" per second + (2x10) short "pulses" per second = 110 short "pulses" per second.

The DABS uplink power (no power programming) is 800 watts, or +59 dBm, referred to the sensor port, and a coupling loss of 1.5 dB is incurred between the RF port and the antenna. If the TACAN interrogator is placed at an arbitrarily chosen slant range of 1 nautical mile from the DABS sensor, the free space path loss (for a 1030 MHz signal) is 98.5 dB. By incorporating the specified DABS sensor antenna gain, the total DABS signal received at a TACAN interrogator can be expressed as the sum of its component parts. The mainbeam component, for example, is

+59.0 dBm	(=800 watts)
-98.5	(path loss)
- 1.5	(coupling loss)
+26.0	(mainbeam gain)
-15.0 dBm.	

Power levels for each of the remaining portions of the antenna pattern can be similarly calculated, using the gain of each respective lobe.

The antenna pattern is also used to calculate the long term average pulse rate at each signal level. The mainbeam width is 3°, so the average pulse rate at a signal level of -15 dBm is

$$\frac{3^\circ}{360^\circ} \times 110 \text{ "pulses" per second} = 0.9 \text{ "pulses" per second.}$$

Similar calculations are used to find the number of pulses in each of the other lobes, corresponding to the previously calculated power levels. The breakdown of DABS signals received at a victim receiver one nautical mile away is shown in TABLE 7.

TABLE 7

COMPOSITE DABS SIGNAL (NO POWER PROGRAMMING)

Received DABS Signal Level (dBm)	Average Number of "pulses" per second
-57	82.5
-51	22.0
-46	4.6
-15	0.9

A similar set of data can be calculated to represent the received DABS signal levels when power programming is used. In this case, 10% of interrogations are transmitted at 800 watts (+59 dBm), and 90% are transmitted at 100 watts (+50 dBm). The breakdown of signals for power programming is shown in TABLE 8.

TABLE 8

COMPOSITE DABS SIGNAL (POWER PROGRAMMING)

Received DABS Signal Level (dBm)	Average Number of "pulses" per second
-66	74.3
-60	19.8
-57	8.2
-55	4.1
-51	2.2
-46	.5
-24	.8
-15	.1

To illustrate how the total received average DABS power may be obtained, TABLE 9 shows calculations for the total power received at an X mode interrogator one nautical mile away from the DABS sensor when Δf = 6 MHz, PRF = 100/pps (nominal), and power programming is used. The "computed" OFR curve, representing the use of trapezoidal pulses, is used in this example.

TABLE 9

CALCULATION OF TOTAL RECEIVED AVERAGE POWER

I	II	III	IV	V
Average Pulse Rate (pps)	DABS Peak Power Level (dBm)	Peak-Average Conversion Factor (dB)	Average Power (dBm)	Average Power (watts)
74.3	-86	-29.5	-115.5	2.7×10^{-15}
19.8	-80	-35.3	-115.3	2.8×10^{-15}
8.2	-77	-39	-116	2.4×10^{-15}
4.1	-75	-42	-117	2.0×10^{-15}
2.2	-71	-44.8	-115.8	2.5×10^{-15}
.5, .8, .1 } 1.4	-66, -44, -35 } -68	-46.8	-114.8	3.3×10^{-15}
Total average power (watts) = 15.7×10^{-15}				
Total average power (dBm) = -108.0				

The OFR at Δf = 6 MHz, obtained from the curve for the interrogator (Figure 5), is 20 dB. The calculated signal levels from TABLE 8 are shifted by this amount, resulting in the levels shown in Column II of TABLE 9. All signals at or above -68 dBm (the receiver saturation level) are set equal to -68 dBm. To convert the signal levels in Column II to average power, a conversion factor (based on PRF and pulse width) is added. Column III contains the conversion factors for the respective DABS PRFs. For example, a PRF of 74.3 pps and pulse width of 15 μs (nominal value for short DABS uplink format) produces a conversion factor of -29.5 dBm. The total PRF of all DABS signals stronger than -68 dBm is 1.4 pps, yielding a conversion

factor of -46.8. The conversion factors in Column III are added to the respective peak power levels in Column II, producing the average power levels in Column IV. These levels are converted from dBm to watts in Column V. The power levels in Column V are then added together, and the total is converted back to dBm, in this case, a total of -108.0 dBm. This represents the total received average DABS power level for a nominal PRF of 100 pps. For PRF's of 200 pps and 500 pps, the power level for 100 pps is incremented by +3 dBm and +7 dBm, respectively, since the amount of total average received power is directly proportional to the PRF. Repeating these calculations for a range of Δf values produces the data in TABLE 10. These data are plotted in Figure A-25.

TABLE 10

TOTAL RECEIVED AVERAGE DABS POWER LEVELS

	Total received average DABS power (dBm)		
Δf (MHz)	PRF = 100 pps	PRF = 200 pps	PRF = 500 pps
6	-108	-105	-101
7	-109.5	-106.5	-102.5
8	-111	-108	-104
9	-112.4	-109.4	-105.4
10	-114	-111	-107
11	-115.5	-112.5	-108.5
12	-117	-114	-110
13	-119	-116	-112
14	-120	-117	-113
15	-121	-118	-114

Sample Calculation (TACAN Beacon)

In order to calculate the amount of deadtime generated in a TACAN beacon as a result of DABS signals, it was necessary to describe the total DABS signal received by the victim beacon in terms of its component parts. The example shown below uses the case of an X mode TACAN beacon located 1 nautical mile away from the DABS sensor.

The DABS transmitter output is 800 watts, or +59 dBm. Over a distance of one nautical mile, the free space path loss is 98.5 dBm. The coupling loss between the RF port and antenna is 1.5 dB. The antenna gain for the 3° mainbeam is 20 dBi (ground-to-ground). This means that the level of the mainbeam component of the DABS received signal is

+59.0 (=800 watts)
-98.5 (path loss)
- 1.5 (coupling loss)
+20.0 (mainbeam antenna gain)

-21.0 dBm.

The long term average pulse rate at this level is represented by the proportion of the total "pulses" found in an area representative of the mainbeam width; i.e.,

$$\frac{3^\circ}{360^\circ} \times 100 \text{ "pulses" per second} = 0.8 \text{ "pulses" per second.}$$

Repeating similar calculations for the remainder of the sensor antenna pattern, the total DABS signal received at a victim beacon one nautical mile away is shown in TABLE 11.

TABLE 11

DABS PULSE DENSITY (NO POWER PROGRAMMING)

DABS Power Level (dBm)	Average Number of "pulses" per second
-57	75
-51	20
-46	4.2
-21	0.8

Similarly, calcualtions for an identical situation with power programming yield the data in TABLE 12.

TABLE 12

DABS PULSE DENSITY (POWER PROGRAMMING)

DABS Power Level (dBm)	Average Number of "pulses" per second
-66	67.5
-60	18.0
-57	7.5
-55	3.7
-51	2.0
-46	0.4
-30	0.8
-21	0.1

The total deadtime generated by the beacon is the sum of the deadtimes generated as a result of each component of the DABS signal. The specified mixture of short and long DABS formats is 90% and 10%, respectively, so for each component DABS level, the deadtime generated is

$$[(.9)(DT_S) + (.1)(DT_L)][N],$$

where

DT_S = deadtime per pulse for short format

DT_L = deadtime per pulse for long format

N = number of "pulses".

The deadtime per pulse generated by an X mode beacon for DABS uplink formats is found in Figure 8. For instance, a DABS signal level of -66 dBm produces a deadtime per pulse of 34 μs for the short DABS format, and 72 μs for the long format. The number of "pulses" at this signal level is 67.5 pps, from TABLE 12. Thus, for a DABS signal level of -66 dBm, the amount of deadtime generated is

$$[(.9)(34 \frac{\mu s}{\text{"pulse"}}) + (.1)\ (72 \frac{\mu s}{\text{"pulse"}})][67.5 \frac{\text{"pulses"}}{s}]$$

$$= 2551.5 \frac{\mu s}{s}$$

The deadtime for the total DABS signal is the composite deadtime from all components of the signal, in this case, 4202.4 μs/s, or 0.4% deadtime, as shown in TABLE 13.

TABLE 13

CALCULATION OF TOTAL DEADTIME

Per Pulse Deadtime (μs)		Received DABS Signal Level (dBm)	Pulse Density (PPS)	Total Deadtime (μs)
Short format	Long format			
34	72	-66	67.5	2551.5
43	72	-60	18.0	826.2
49	72	-57	7.5	384.8
54	72	-55	3.7	209.2
66	81	-51	2.0	135.0
75	90	-46	0.4	31.9
75	90	-30	0.8	57.4
75	90	-21	0.1	6.4
			Total	4202.4

This represents the deadtime generated when DABS and the TACAN beacon are co-channel. Similar calculations were repeated for a range of Δf values, using the beacon OFR to adjust the component signal levels, and the resulting data were plotted in Figure 14. In each case, the deadtime generated for a PRF of 200 pps or 500 pps is simply a multiple (two times and five times, respectively) of the value obtained for a PRF of 100 pps.

Beacon loading by DABS signals was calculated using the relationship previously defined (page 27),

$$\text{Percent TACAN Beacon Loading} = \frac{N}{2600} \times 100,$$

where N is the total number of DABS signals received and decoded by the beacon. It is important to note that, while all downlink DABS signals could be decoded by both X and Y mode TACAN beacons, neither short nor long uplink DABS signals were decoded by the Y mode beacon, so that Y mode loading is essentially zero. Further, only the long uplink DABS formats (10% of the total) could be decoded by the X mode beacon.

It was determined in the test program that the 10% of DABS signals which could be decoded by the TACAN beacon would be decoded if the level of the signal were at or above -85 dBm. For example, in the situation described by TABLE 12 (X mode TACAN beacon 1 nmi from the DABS sensor using power programming, DABS co-channel with TACAN), all DABS signals received by the beacon are above -85 dBm. Thus, N = 100, but only 10% of this total could be decoded, so that

$$\begin{aligned}\text{Percent TACAN Beacon Loading} &= \frac{N/10}{2600} \times 100 \\ &= \frac{10}{2600} \times 100 \\ &= 0.385 \simeq 0.4\%.\end{aligned}$$

Similar calculations were made with the received DABS signal level adjusted by the appropriate OFR for several values of Δf. Typical results are displayed in Figure 15.

For any desired value of percent deadtime or percent loading, a curve may be drawn showing the combination of frequency and distance separations necessary to maintain that value of deadtime or loading. From a graph of percent deadtime vs Δf, the value of Δf can be determined for any discrete value of percent deadtime. These two values can be used in conjunction with OFR curves and path loss curves to generate frequency-distance curves.

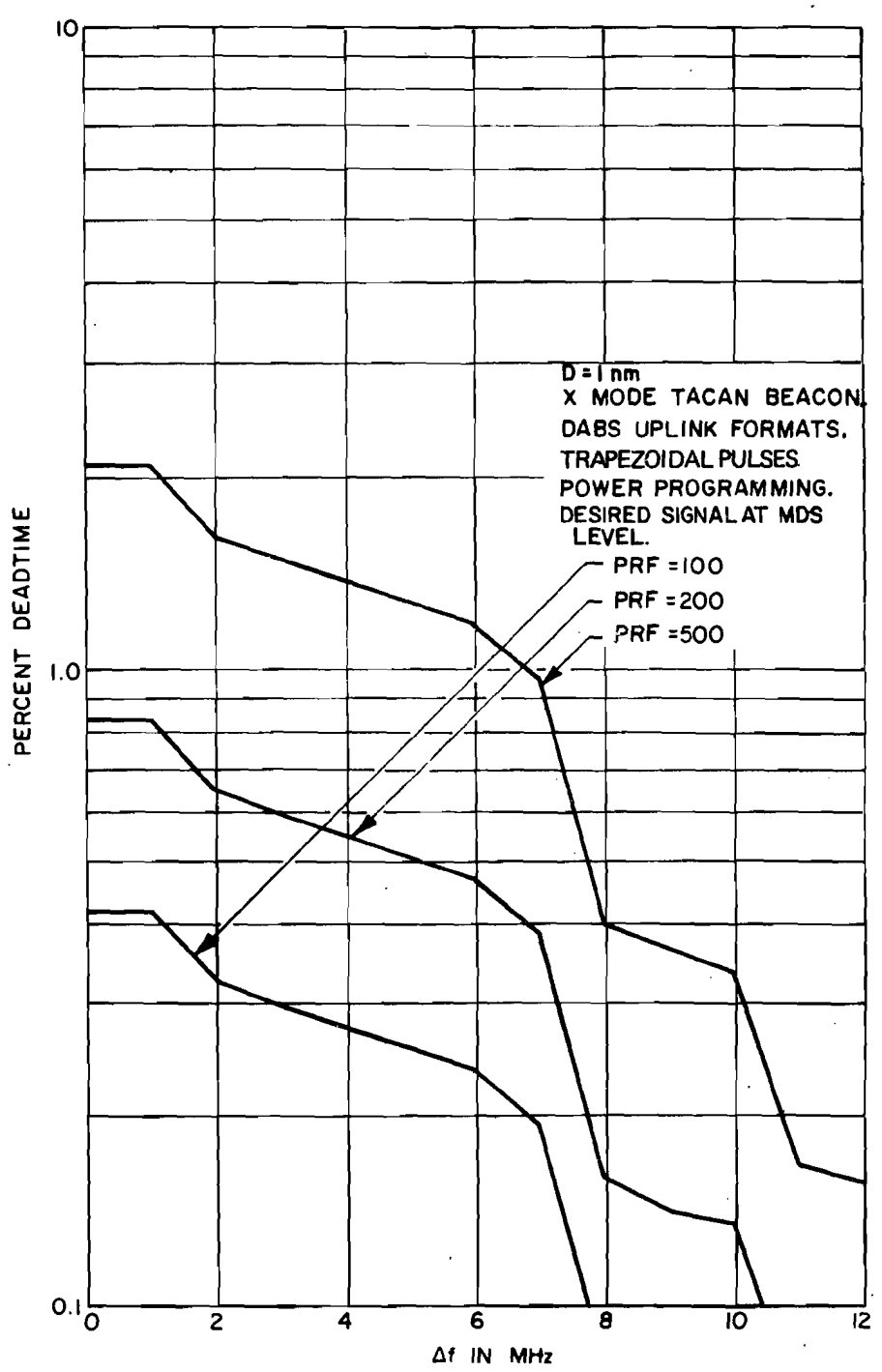


Figure 14. Percent deadtime generated by X mode TACAN beacon as a result of DABS uplink formats.

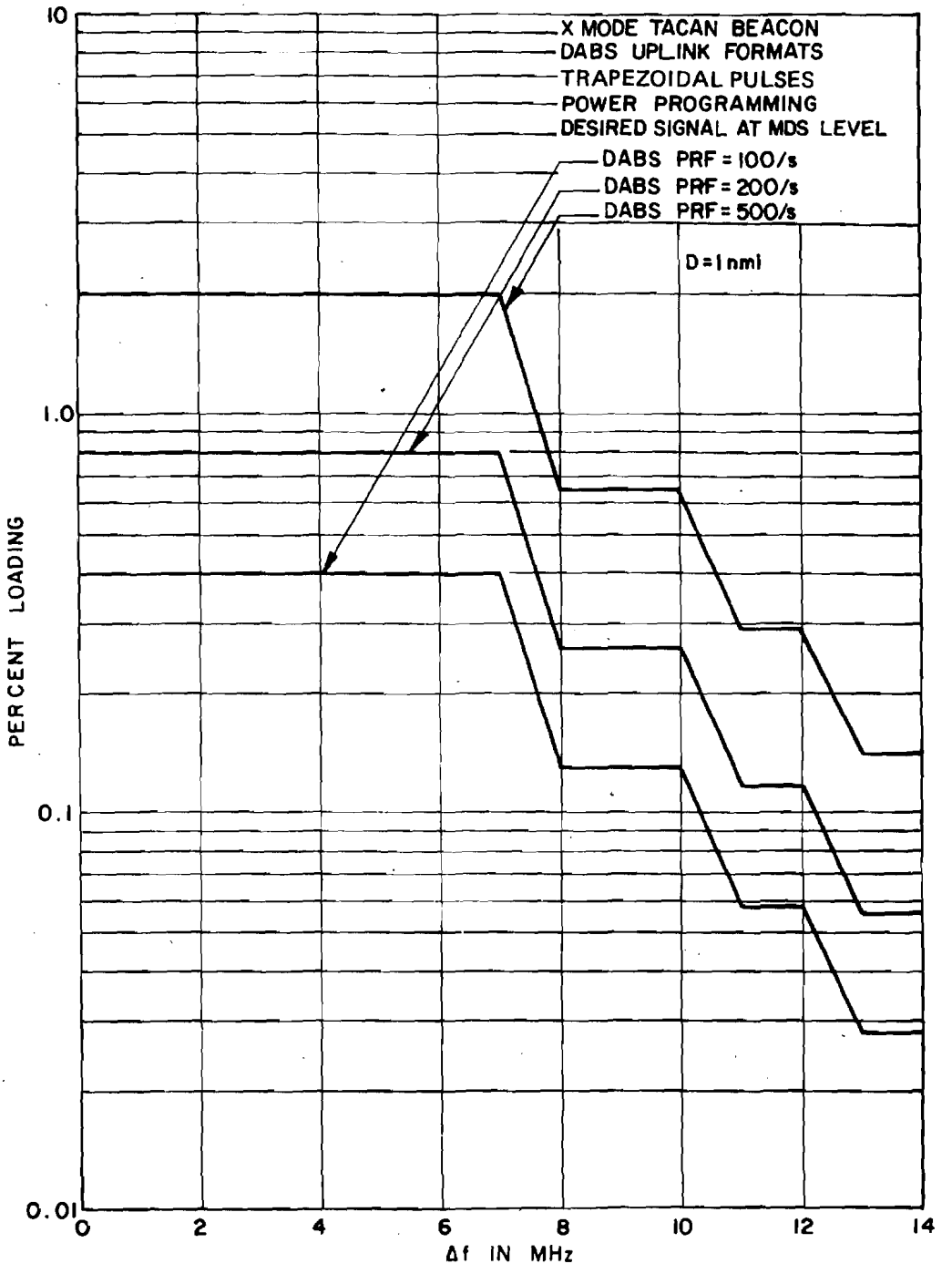


Figure 15. Percent loading of X mode TACAN beacon as a result of DABS uplink formats.

If, for example, a graph of F-D for 0.5% deadtime (PRF = 200/s) is desired for the example used above, Δf is found to be 5.3 MHz (Figure 14). From the OFR curve for the beacon, Figure 12, the OFR at 5.3 MHz is -18.5 dB. The distance separation is one nautical mile, corresponding to -98 dB path loss (Figure 16). The effective signal level at the beacon is

$$(-18.5) + (-98) = -116.5 \text{ dB},$$

corresponding to a distance separation of 8.7 nmi for $\Delta f = 0$. To plot each additional point, the OFR corresponding to the value of Δf is taken from the OFR curve and subtracted from the point (D = 8.7, Loss = 116.5), on the path loss curve to obtain the corresponding distance separation for that particular Δf. A typical F-D curve generated in this manner is shown in Figure 17. Similar methods were used to generate F-D curves for beacon loading.

DOWNLINK ANALYSIS

The downlink analysis dealt with the impact of DABS downlink formats on X and Y mode TACAN beacons and the Y mode TACAN interrogator. (DABS was not considered a threat to the X mode TACAN interrogator operation, since the TACAN channel with the receive frequency closest to the DABS downlink frequency, Channel 64X at 1151 MHz, is 61 MHz away.)

The effects of DABS downlink interference formats were evaluated by using a hypothetical deployment of DABS-equipped aircraft supplied by Lincoln Laboratory (the SEC). The deployment consists of 1152 aircraft inside a 200-nmi radius of New York City within line-of-sight of the beacon, at altitudes between 1,000 and 45,000 feet, and is considered by the SEC to be representative of the environment in the 1980 time frame. The victim TACAN beacon, for purposes of this analysis, was located at JFK airport, while the victim interrogator was located 10,000 feet above JFK. TABLES 14 and 15 show the DABS signal levels and the number of contributors received at each of the victim TACAN equipments.

The assessment of DABS interference to the TACAN equipments was performed in essentially the same manner as the DABS uplink analysis: the effect of DABS signals to the TACAN beacon was measured in terms of deadtime generated and beacon loading; the total received average DABS power level at the victim TACAN interrogator was compared to the maximum level allowed for azimuth acquire lock. In the downlink analysis, however, the number of DABS "pulses" (interrogations or replies) received at a victim TACAN receiver was taken directly from the tables describing the DABS environment, rather than being calculated as in the uplink analysis.

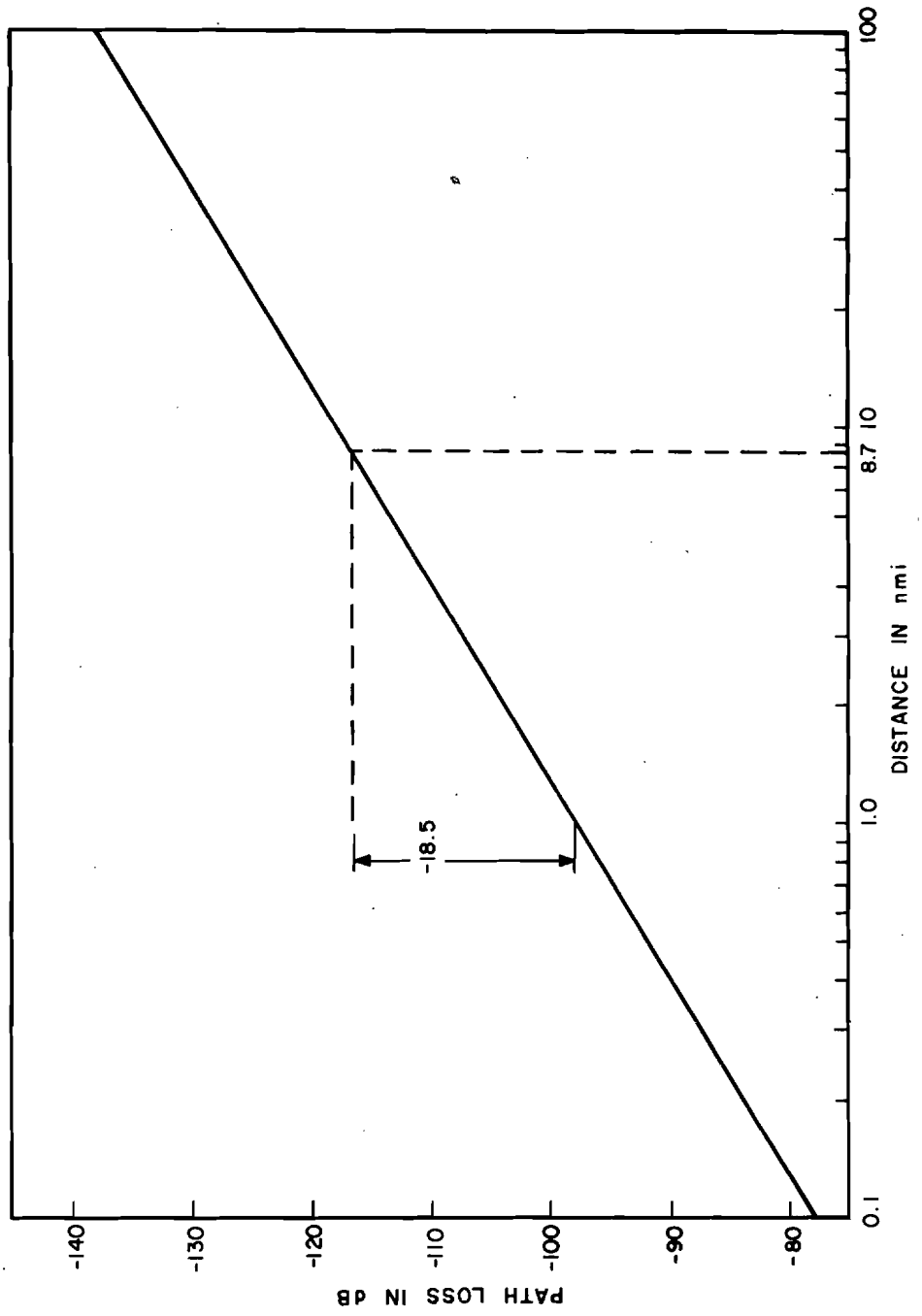


Figure 16. Free space path loss, f = 1030 MHz.

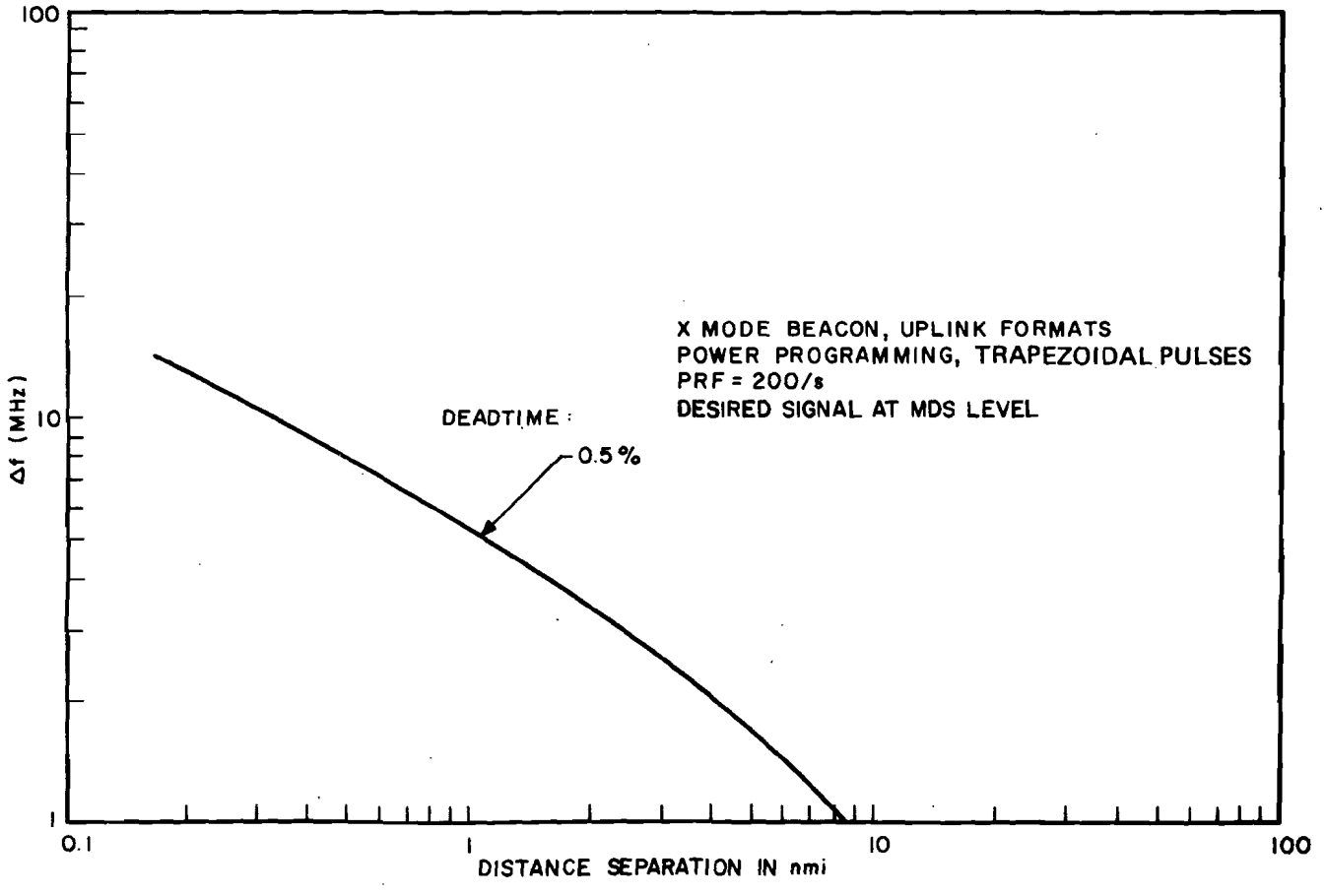


Figure 17. Frequency-distance separations for X mode TACAN beacon, DABS sensor.

TABLE 14

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

Received Signal Level (dBm)[a]	No. of contributing DABS-Equipped Aircraft	Received Signal Level (dBm)[a]	No. of contributing DABS-Equipped Aircraft
-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 15

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

Received Signal Level (dBm)[a]	No. of contributing DABS-Equipped Aircraft	Received Signal Level (dBm)[a]	No. of contributing DABS-Equipped Aircraft
-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	55	-97	3

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

As in the uplink analysis, frequency-distance curves were generated to show the separations necessary to limit deadtime and loading in the beacon.

APPENDIX A contains the results of calculations for the various interactions considered in this analysis.

INTERFERENCE POTENTIAL FROM PROJECTED DABS SITING

Frequency-distance scattergrams generated by ECAC in FY 74 were used for comparison with the F-D curves generated in this analysis to ascertain the likelihood of potential DABS interference to TACAN beacon receivers from DABS sensors on the ground. Figure 18 is a scattergram of the frequency-distance separations between projected ATCRBS sites and TACAN beacon sites in the 1980 time frame. Frequency differential (Δf) refers to the difference (in MHz) between the DABS sensor transmit frequency, 1030 MHz, and the TACAN beacon receive frequency. It is assumed that each existing or projected ATCRBS site will be replaced by a DABS sensor.

The frequency-distance curves for deadtime and loading produced in TACAN beacons as a result of DABS uplink signals are contained in the appendix. A comparison of the scattergram to these curves, as in Figure 19, shows that projected equipment siting will provide at least the minimum frequency-distance separations defined in the results of this analysis as being necessary for limiting deadtime generated in the TACAN beacon by DABS to less than one percent. Similarly, loading of the beacon by DABS is limited to less than two percent by projected siting.

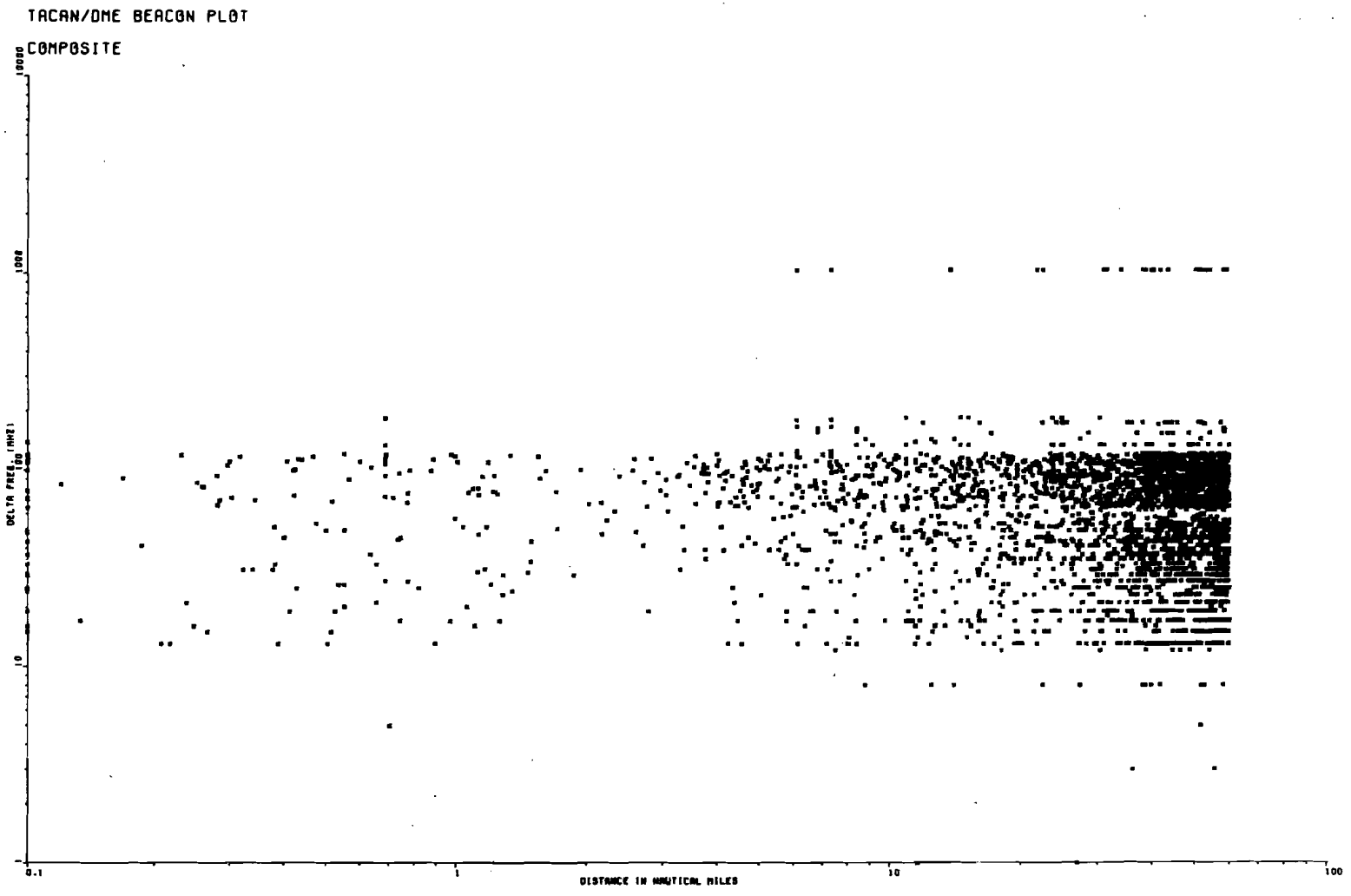


Figure 18. Composite Δf vs ΔD plot for ASR/ARSR's in 1980 CONUS IFF file and TACAN beacons (1980) within 60 nmi of each ASR/ARSR.

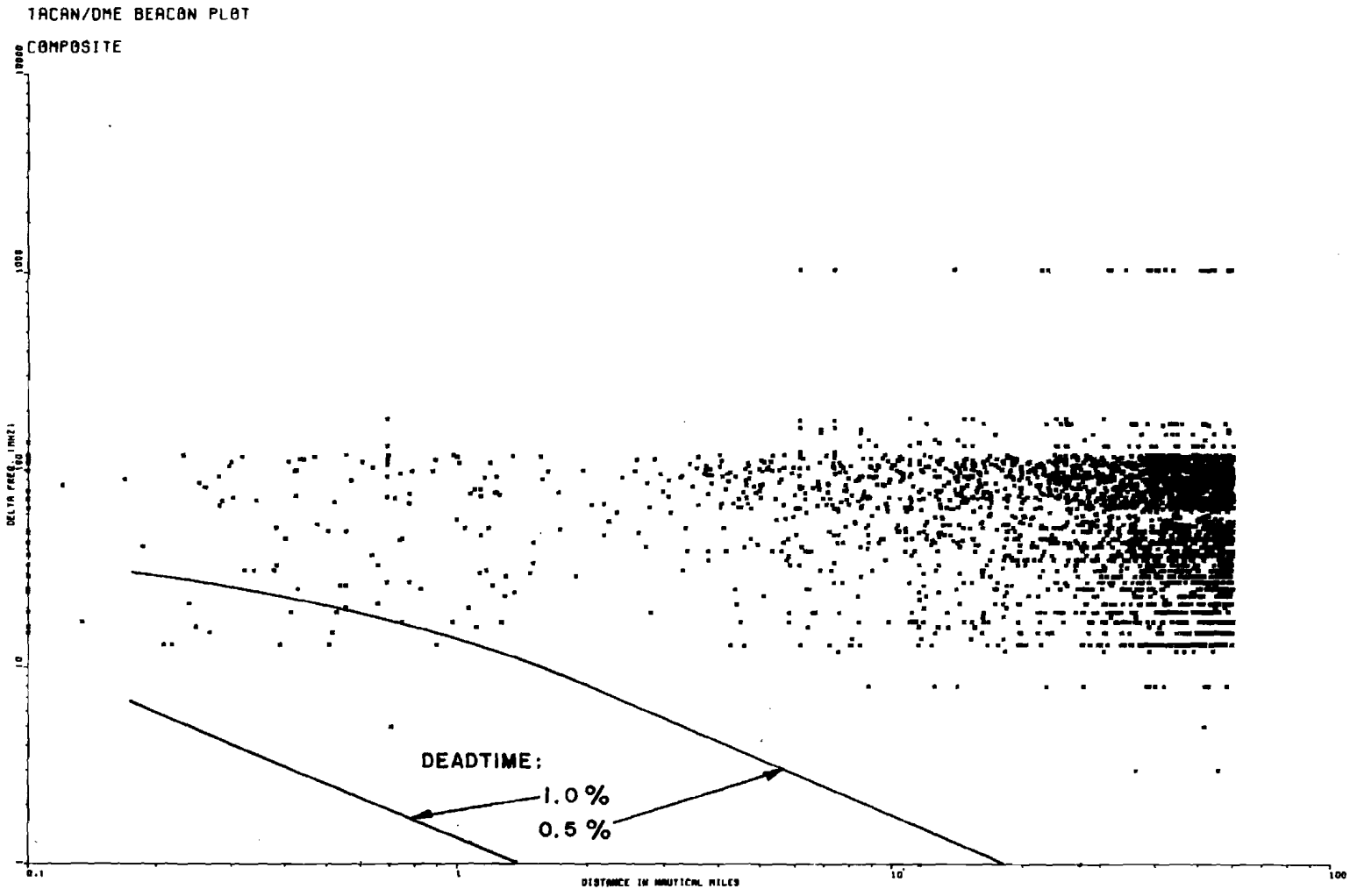


Figure 19. Comparison of frequency-distance separation requirements for ASR/ARSR-to-TACAN beacon and DABS-to-TACAN beacon, 1980 time frame. (Note: Desired signal at MDS level.)

SECTION 3

RESULTS

The results of all calculations performed in this analysis are presented in APPENDIX A. Results for the specific cases involving trapezoidal DABS pulses and DABS uplink power programming are found in Figures A-25, A-32, A-39, A-49, A-50, and A-51.

CONCLUSIONS

1. By observing the frequency-distance separations in APPENDIX A, deadtime and loading in the TACAN beacon in the presence of DABS signals can be limited as indicated in the applicable curves.

2. The ability of the TACAN interrogator to acquire azimuth lock would be unaffected by DABS signals with the specified operating characteristics.

3. The use of power programming is an effective method of limiting the impact of DABS on TACAN performance.

APPENDIX A

CALCULATED RESULTS BASED ON EXTRAPOLATED DATA

This appendix contains the results of the calculations made in an analytical determination of DABS interference effects upon TACAN/DME equipment operation. The effects of the prototype uplink and downlink formats were investigated, using results of equipment tests with similar formats, as well as results extrapolated from the test data to fit these specific formats.

Results are displayed in three separate sections. The first two deal with interference effects of the DABS uplink formats, and represent calculations which are identical except that measured OFR curves were used for Section I, while Section II represents the use of computed OFR curves. ("Measured" OFR curves were taken from equipment testing using rectangular pulses, while "computed" OFR curves were calculated, based on trapezoidal pulse shapes with specified rise and fall times.) Section III deals with the interference effects of DABS downlink formats.

The contents of this appendix are as follows:

Section I: Uplink Formats, Measured OFR

Figures A-1 and A-2 show the total average DABS power level received at the X-mode TACAN interrogator as a function of Δf (difference between DABS frequency, 1030 MHz, and the TACAN interrogator receiver frequency) if the DABS sensor is one nautical mile (slant range) away. Results for both full power transmissions and power programming are shown, and are compared to the maximum DABS power level which can be received without affecting the azimuth acquire lock function of the interrogator (-91 dBm, extrapolated from the data in Reference 1).

Figures A-3 and A-4 show average DABS power level received at the TACAN interrogator as a function of distance, when Δf = 6 MHz, the minimum frequency separation between 1030 MHz and the X mode TACAN receiver frequency (channel 63X, 1024 MHz). Here again, results are compared to the maximum allowable DABS power level for interrogator azimuth acquire lock (-91 dBm), and are shown for both full power DABS and power programming.

Figure A-5 displays the percentage of deadtime generated in the X mode TACAN beacon as a result of the uplink DABS formats with no power programming.

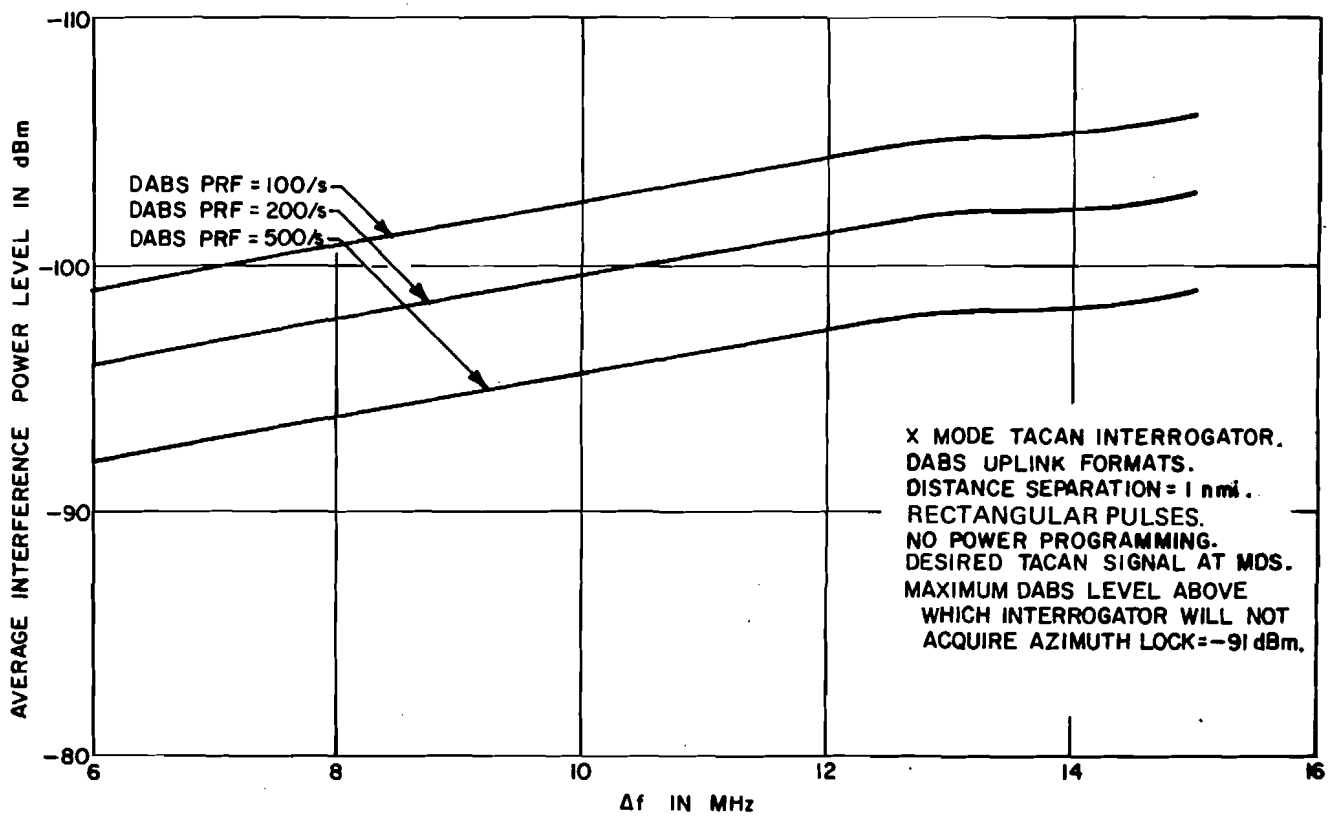

-110
-100
-90
-80
6
8
10
12
14
16
AVERAGE INTERFERENCE POWER LEVEL IN dBm
Δf IN MHz
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR.
DABS UPLINK FORMATS.
DISTANCE SEPARATION = 1 nmi.
RECTANGULAR PULSES.
NO POWER PROGRAMMING.
DESIRED TACAN SIGNAL AT MDS.
MAXIMUM DABS LEVEL ABOVE
WHICH INTERROGATOR WILL NOT
ACQUIRE AZIMUTH LOCK = -91 dBm.

Figure A-1.

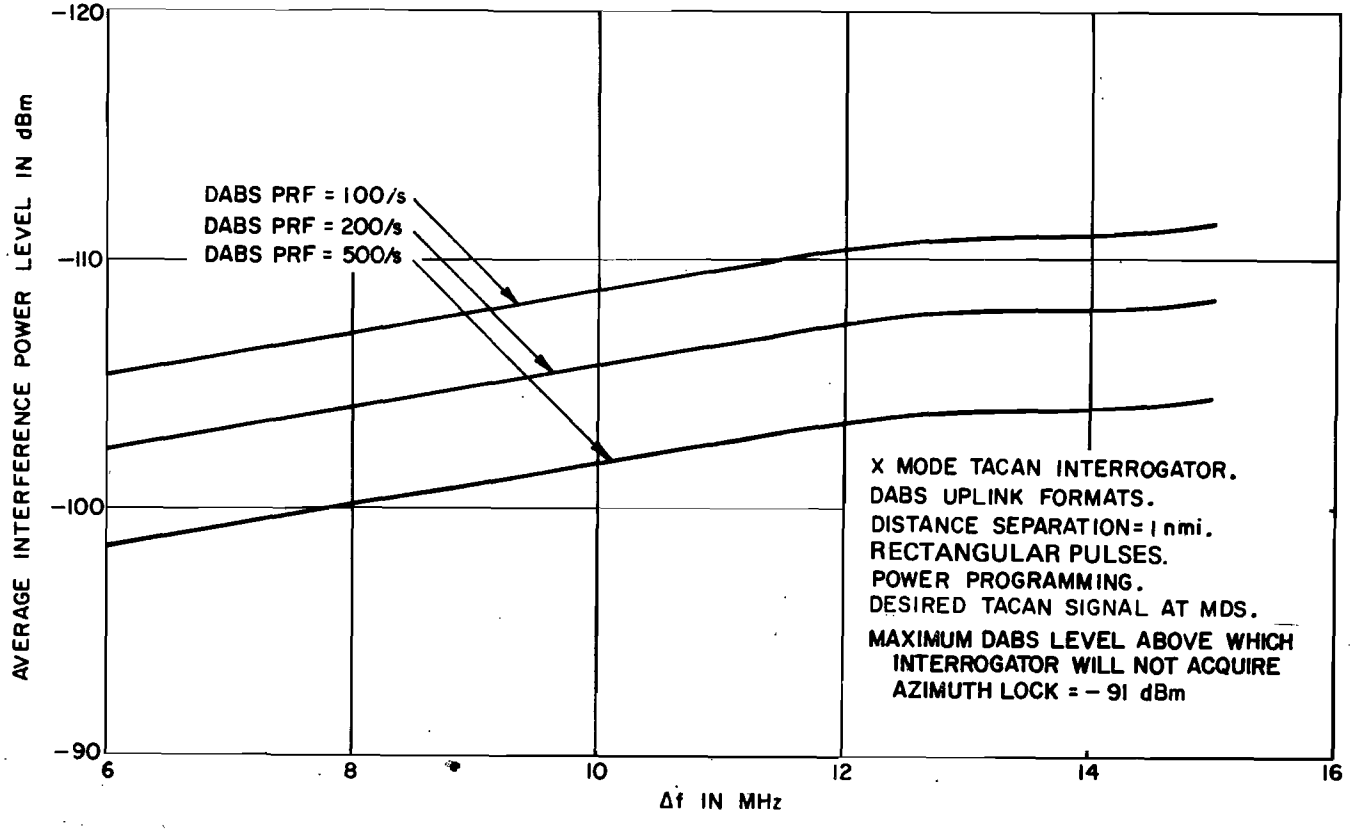

AVERAGE INTERFERENCE POWER LEVEL IN dBm
-120
-110
-100
-90
6
8
10
12
14
16
Δf IN MHz
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR.
DABS UPLINK FORMATS.
DISTANCE SEPARATION = 1 nmi.
RECTANGULAR PULSES.
POWER PROGRAMMING.
DESIRED TACAN SIGNAL AT MDS.
MAXIMUM DABS LEVEL ABOVE WHICH INTERROGATOR WILL NOT ACQUIRE AZIMUTH LOCK = - 91 dBm

Figure A-2.

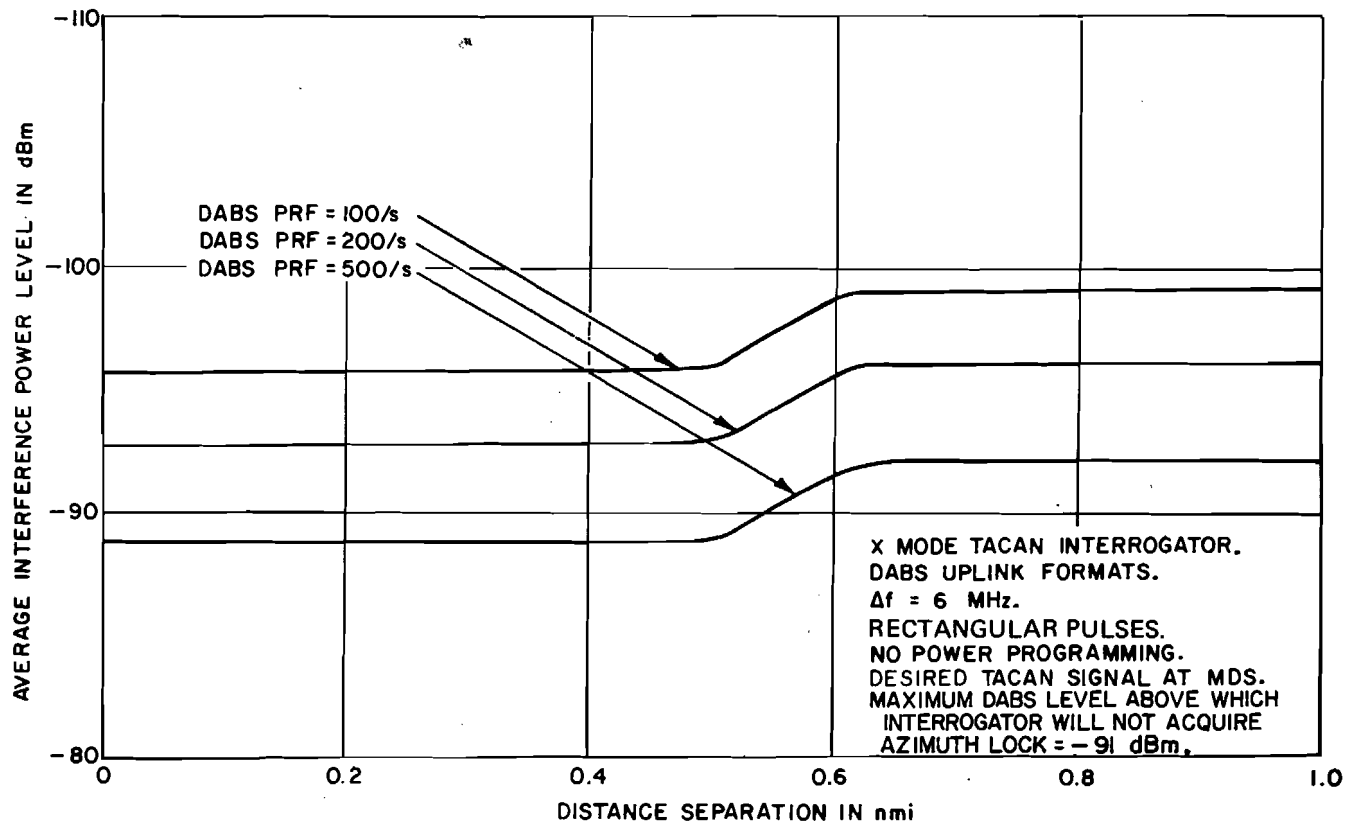

-110
-100
-90
-80
AVERAGE INTERFERENCE POWER LEVEL IN dBm
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR.
DABS UPLINK FORMATS.
Δf = 6 MHz.
RECTANGULAR PULSES.
NO POWER PROGRAMMING.
DESIRED TACAN SIGNAL AT MDS.
MAXIMUM DABS LEVEL ABOVE WHICH
INTERROGATOR WILL NOT ACQUIRE
AZIMUTH LOCK = -91 dBm.
0
0.2
0.4
0.6
0.8
1.0
DISTANCE SEPARATION IN nmi

Figure A-3.

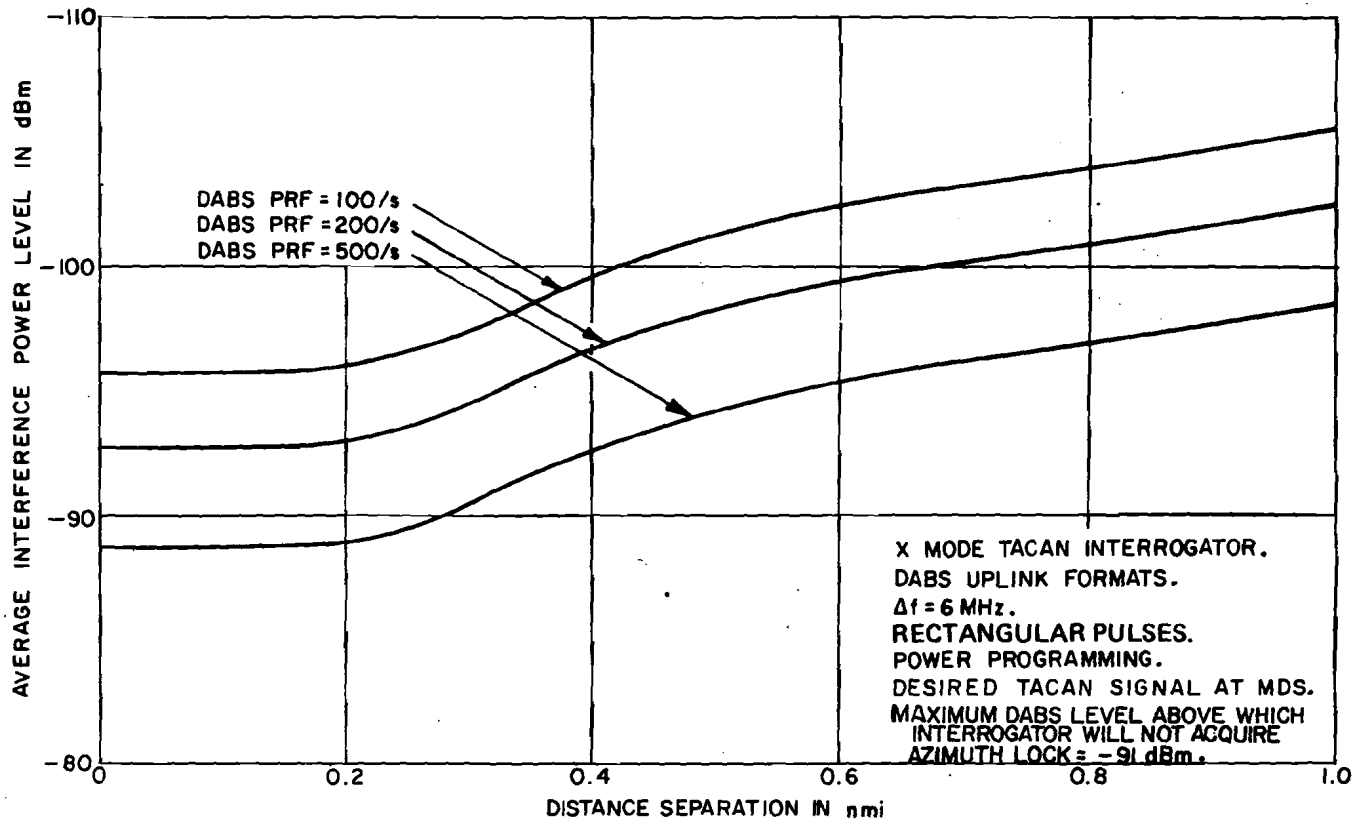

-110
-100
-90
-80
AVERAGE INTERFERENCE POWER LEVEL IN dBm
0
0.2
0.4
0.6
0.8
1.0
DISTANCE SEPARATION IN nmi
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR.
DABS UPLINK FORMATS.
Δf = 6 MHz.
RECTANGULAR PULSES.
POWER PROGRAMMING.
DESIRED TACAN SIGNAL AT MDS.
MAXIMUM DABS LEVEL ABOVE WHICH
INTERROGATOR WILL NOT ACQUIRE
AZIMUTH LOCK = -91 dBm.

Figure A-4.

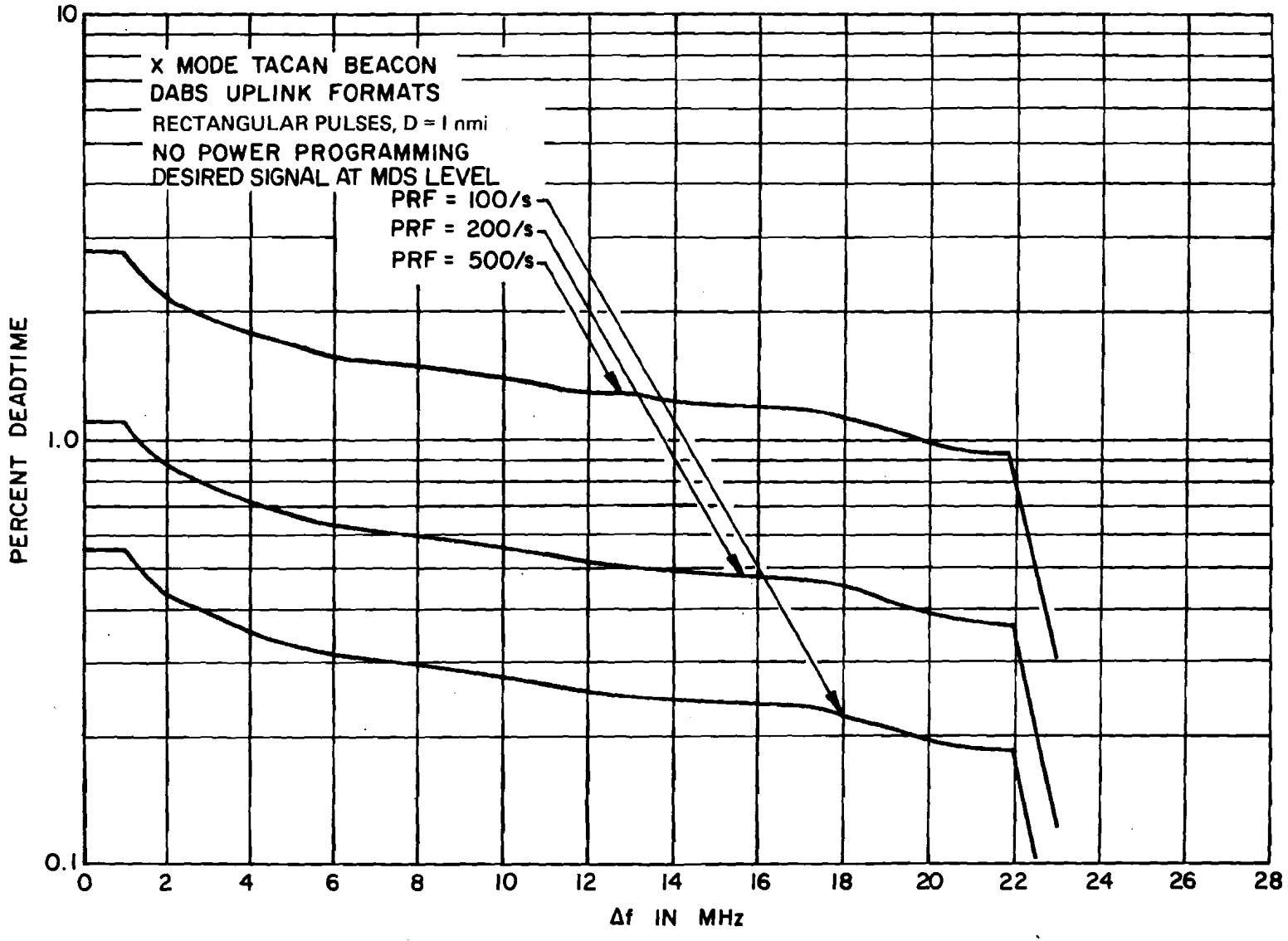

X MODE TACAN BEACON
DABS UPLINK FORMATS
RECTANGULAR PULSES, D = 1 nmi
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
PRF = 100/s
PRF = 200/s
PRF = 500/s
PERCENT DEADTIME
10
1.0
0.1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Δf IN MHz

Figure A-5.

Figures A-6, A-7, and A-8 depict (for PRF's of 100 pps, 200 pps, and 500 pps, respectively) the frequency-distance separations required to maintain beacon deadtime at or below the indicated levels, for the conditions described in Figure A-5.

Figures A-9 through A-11 are similar to Figures A-5 through A-8, except that the DABS source uses power programming.

Figures A-12 through A-18 deal with the effects of DABS uplink formats on the Y mode TACAN beacon, under conditions as described for Figures A-5 through A-11.

Figure A-19 shows the percentage loading of the X mode TACAN beacon by the receipt of DABS uplink formats. Three values of DABS PRF, each for both full power and power programming, are displayed.

Figures A-20 through A-23 depict (for DABS PRF of 200 pps and 500 pps, full power and power programming, respectively) the frequency-distance separations required to maintain beacon loading at or below the indicated levels, for the conditions described for Figure A-19.

Section II: Uplink Formats, Ideal OFR

Figures A-24 through A-47 represent conditions identical to those described for Figures A-1 through A-23, except that computed OFR curves were used in the calculations, representing the use of trapezoidal pulses.

Section III: Downlink Formats

Figure A-48 shows the total average DABS power level received at the Y mode TACAN interrogator as a function of Δf. Received DABS signal is compared to the maximum DABS level which the interrogator can tolerate and still acquire azimuth lock.

Figures A-49 and A-50 show the percentage of deadtime generated in X and Y mode TACAN beacons, respectively, as a result of DABS downlink signals.

Figure A-51 shows the percent loading of the X and Y mode TACAN beacons by the receipt of DABS downlink formats.

Figures A-48 through A-51 use the SEC-provided DABS deployment as a source of DABS interference, with the victim TACAN interrogator located at 10,000 feet above JFK Airport, NY, and the victim TACAN beacon at JFK airport.

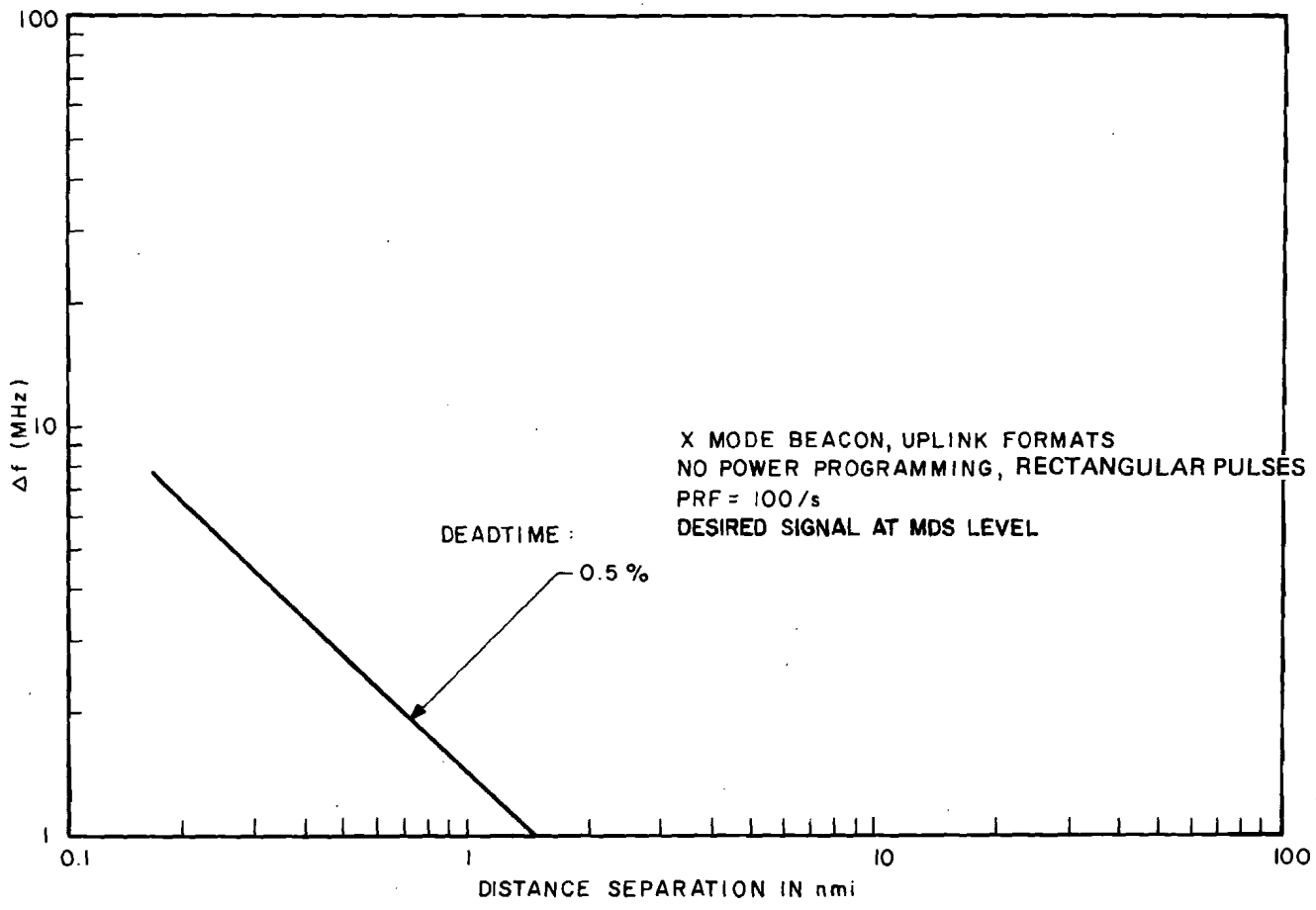

100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi
X MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 100/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
0.5 %

Figure A-6.

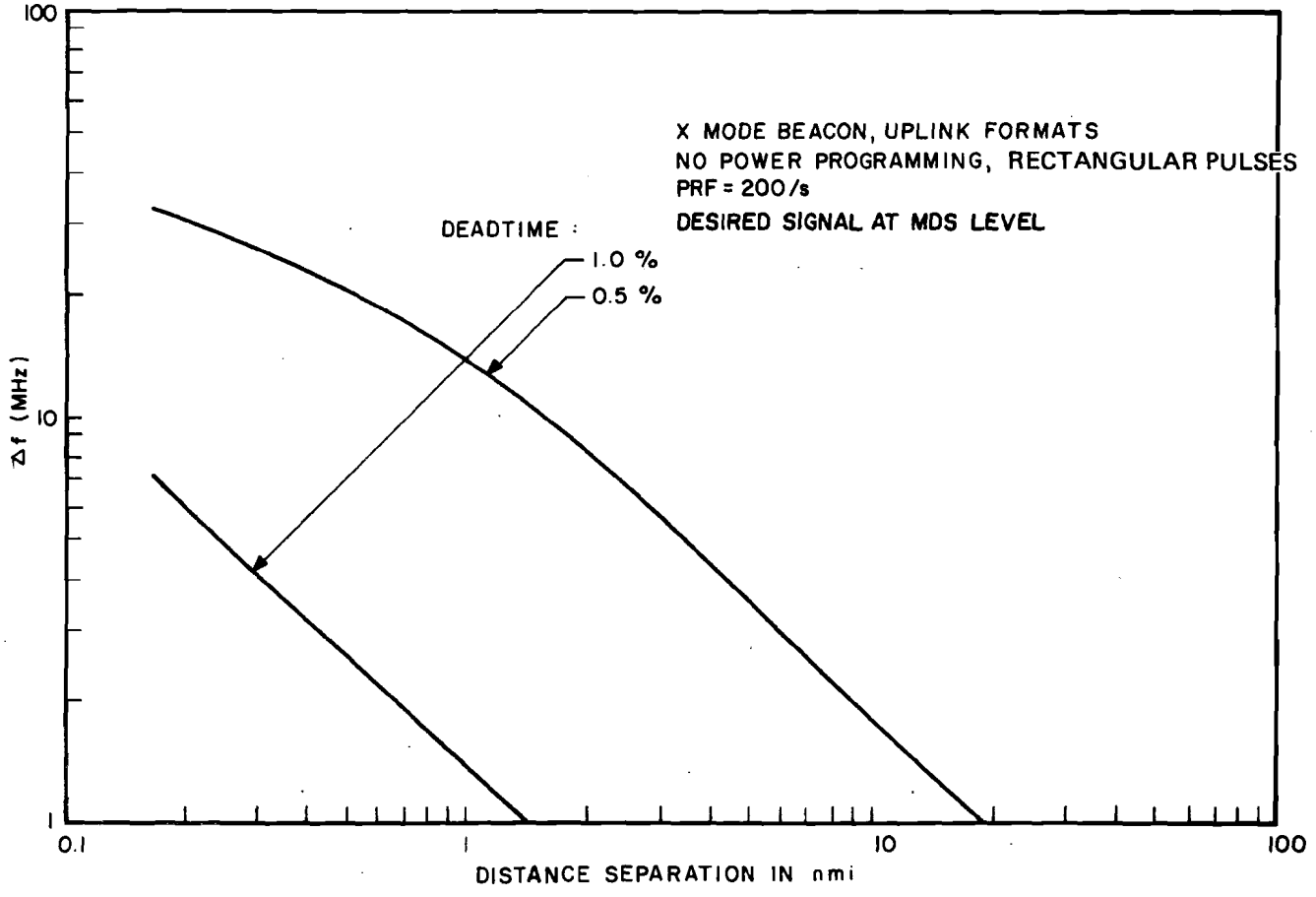

X MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-7.

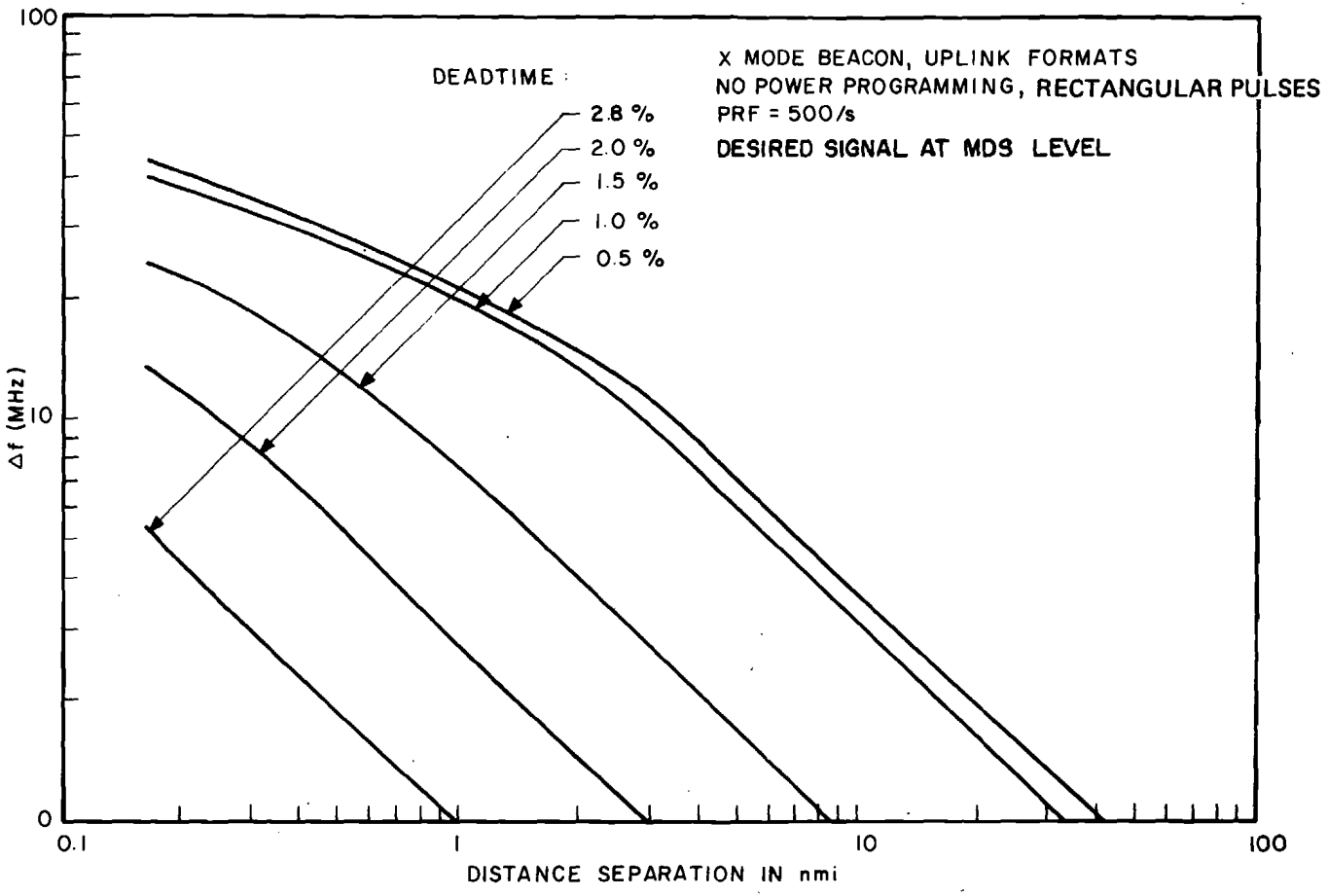

X MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
2.8 %
2.0 %
1.5 %
1.0 %
0.5 %
100
10
0
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-8.

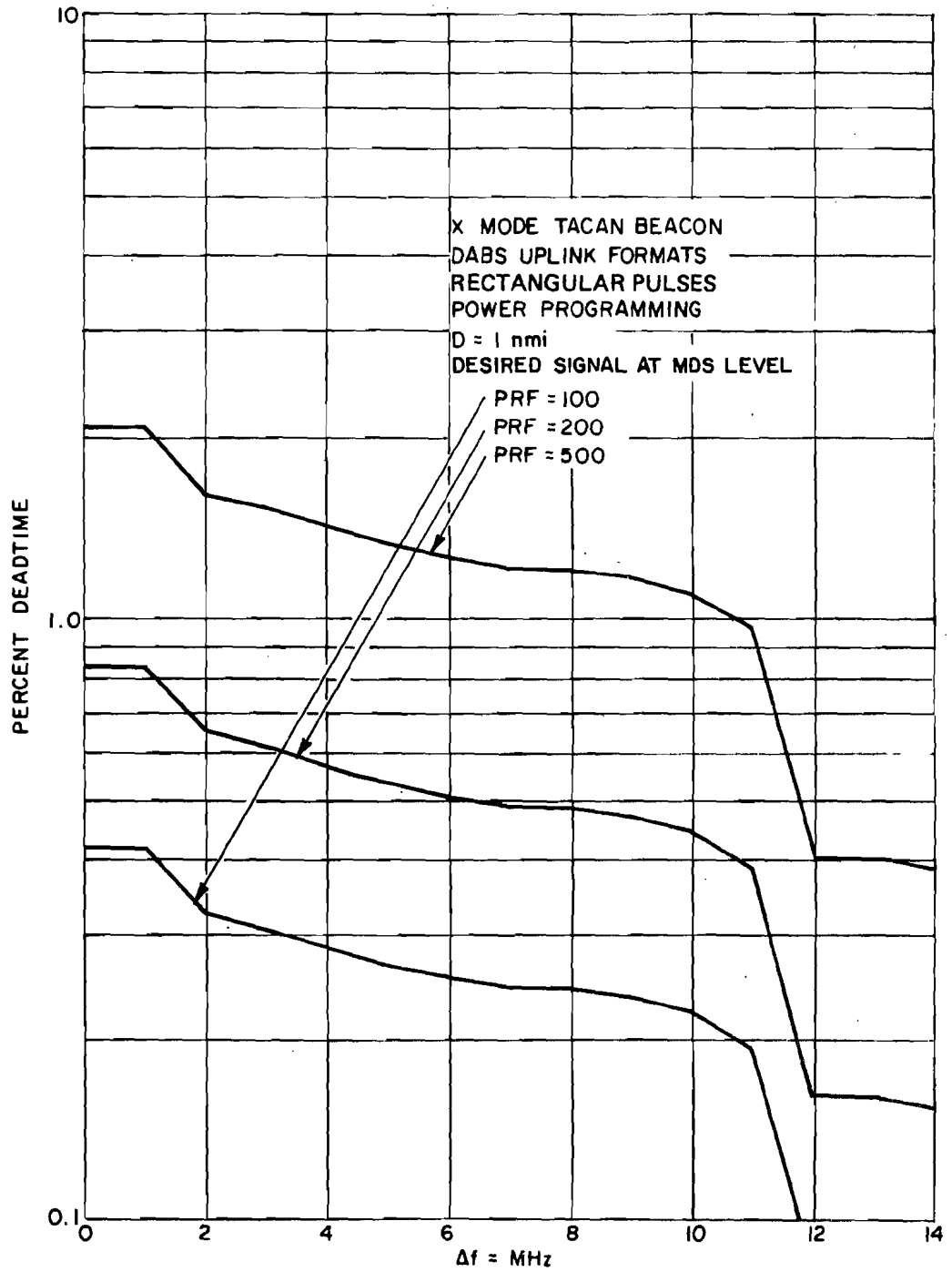

X MODE TACAN BEACON
DABS UPLINK FORMATS
RECTANGULAR PULSES
POWER PROGRAMMING
D = 1 nmi
DESIRED SIGNAL AT MDS LEVEL
PRF = 100
PRF = 200
PRF = 500
PERCENT DEADTIME
10
1.0
0.1
0
2
4
6
8
10
12
14
Δf = MHz

Figure A-9.

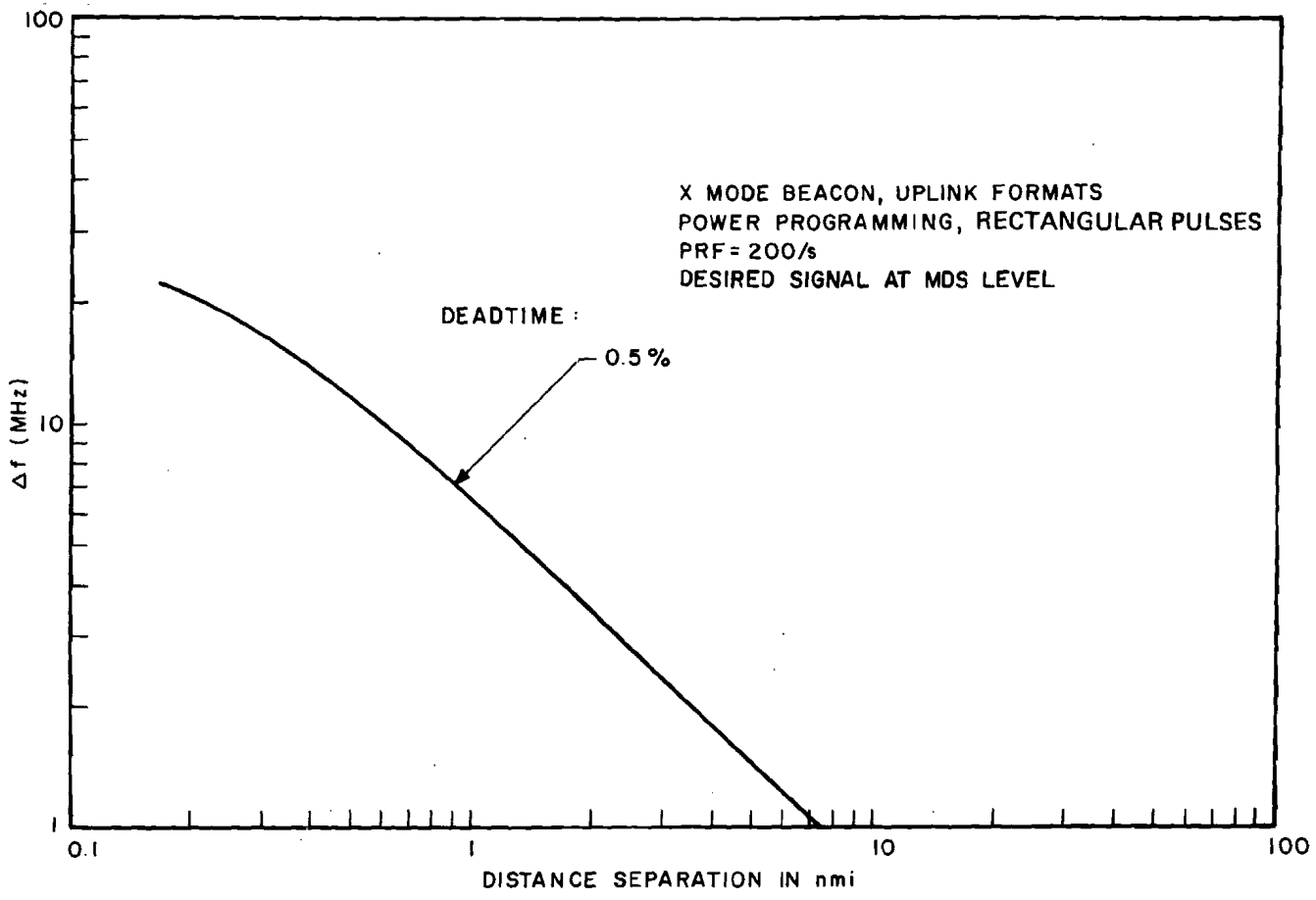

X MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-10.

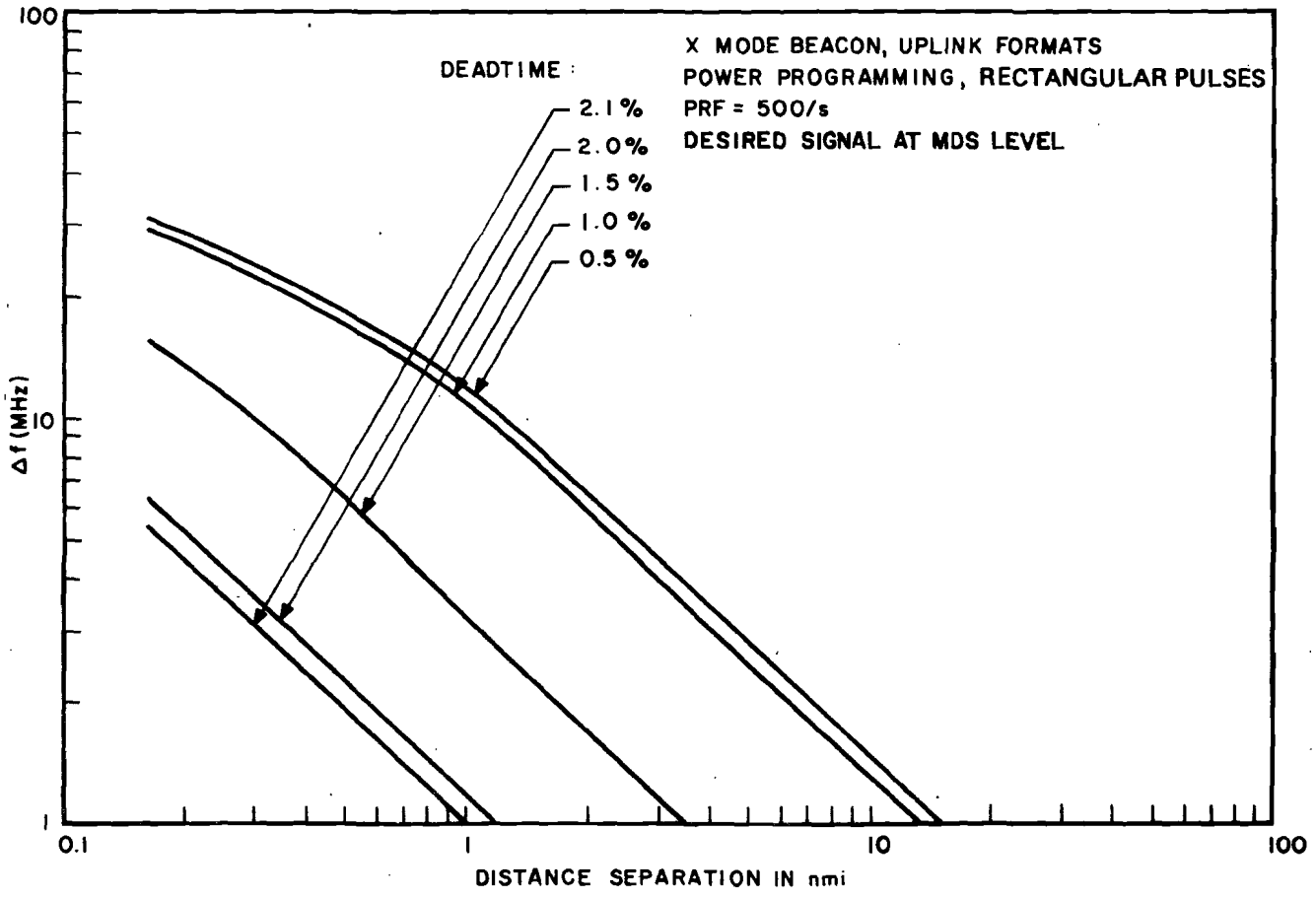

X MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
2.1 %
2.0 %
1.5 %
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-11.

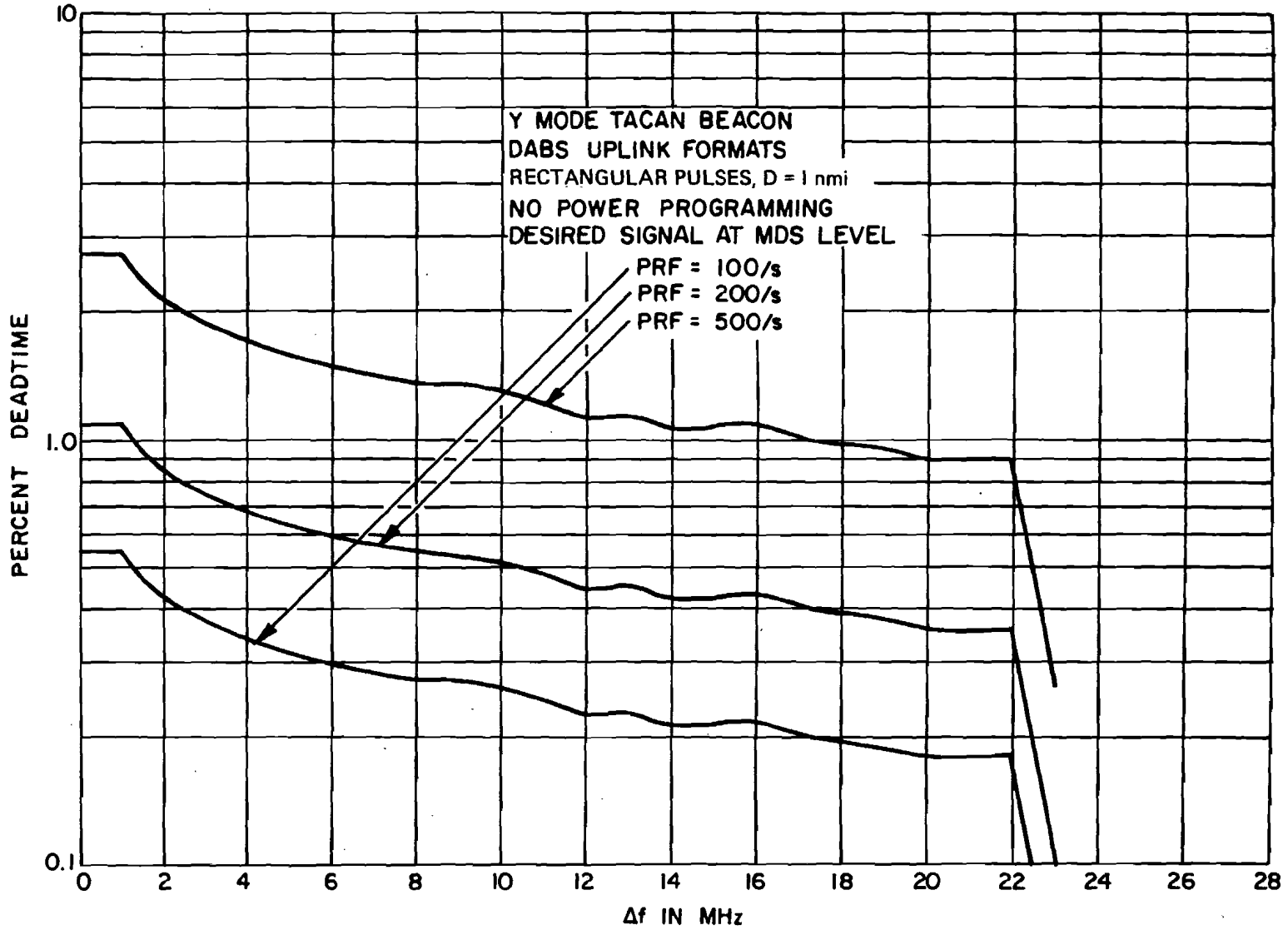

Y MODE TACAN BEACON
DABS UPLINK FORMATS
RECTANGULAR PULSES, D = 1 nmi
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
PRF = 100/s
PRF = 200/s
PRF = 500/s
PERCENT DEADTIME
10
1.0
0.1
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Δf IN MHz

Figure A-12.

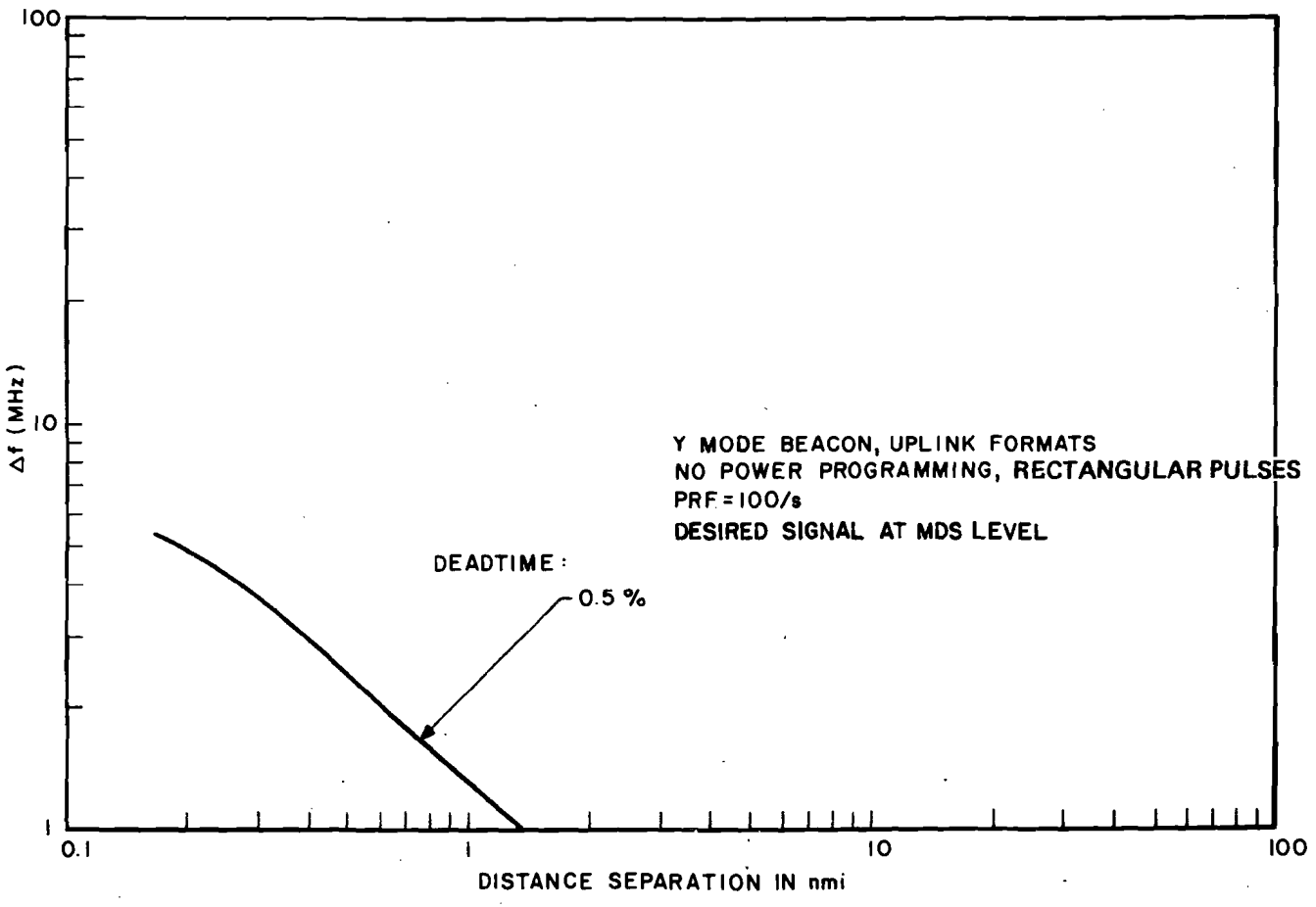

100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi
Y MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 100/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME:
0.5 %

Figure A-13.

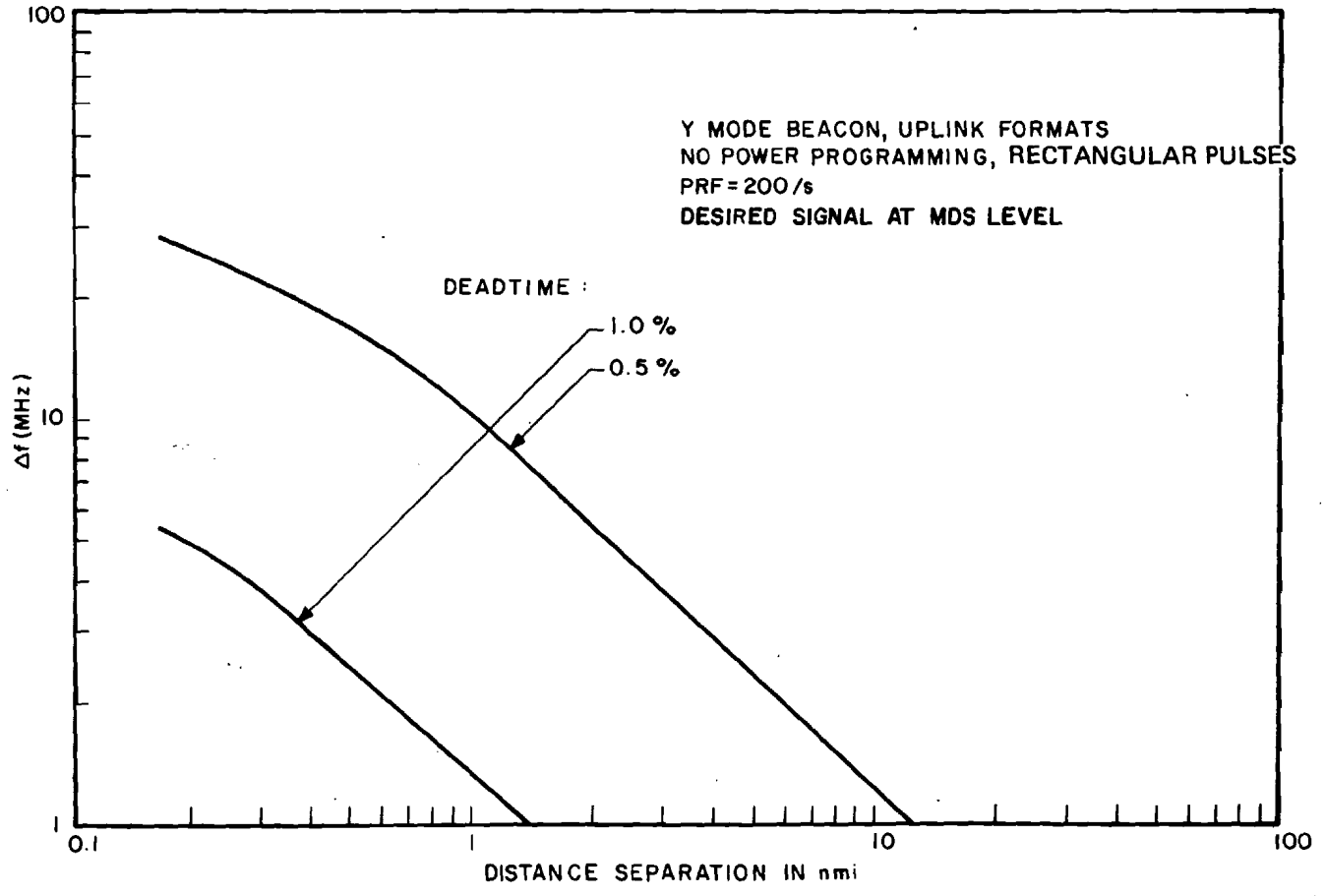

Y MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-14.

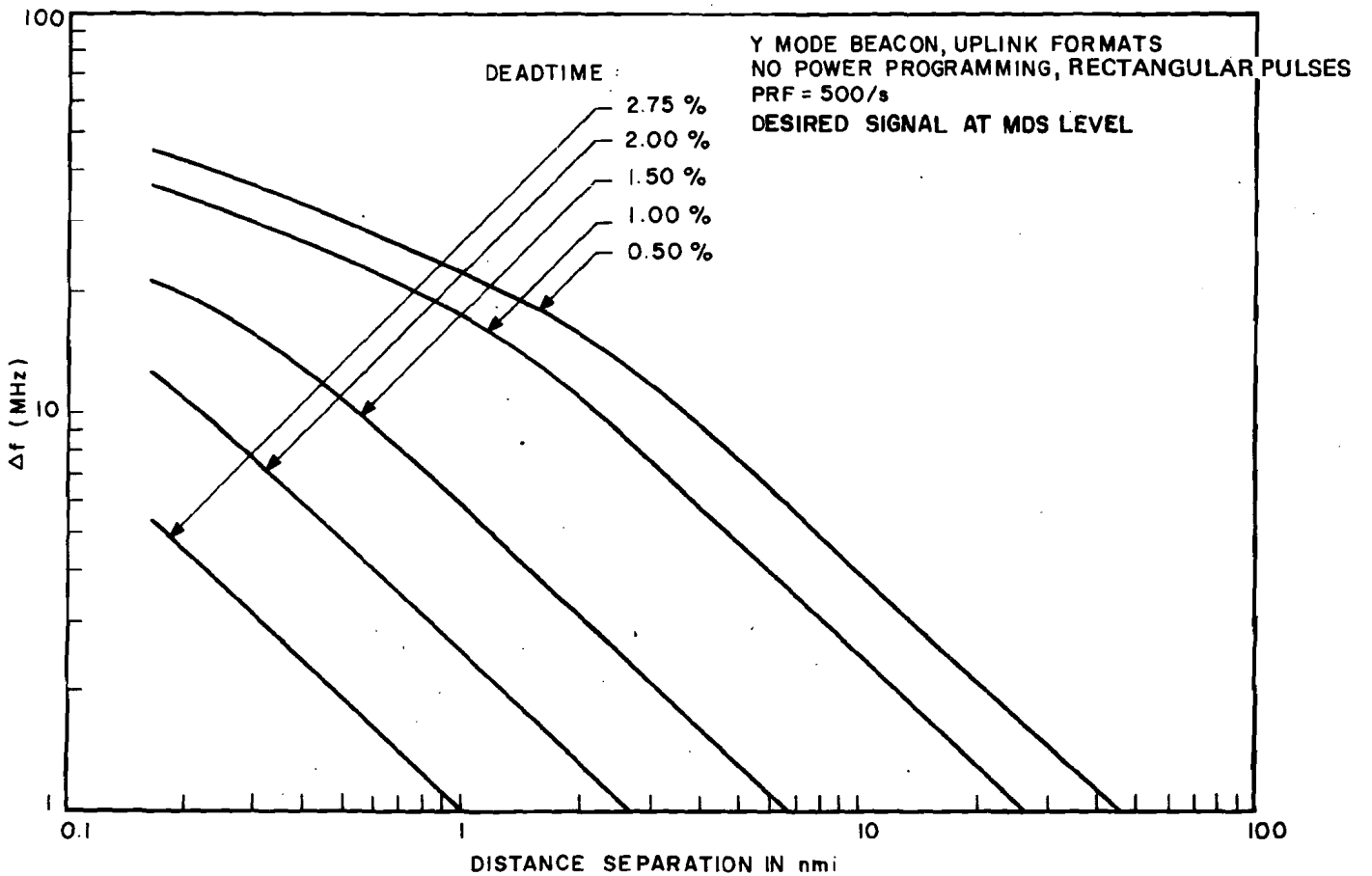

Y MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME
2.75 %
2.00 %
1.50 %
1.00 %
0.50 %
100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-15.

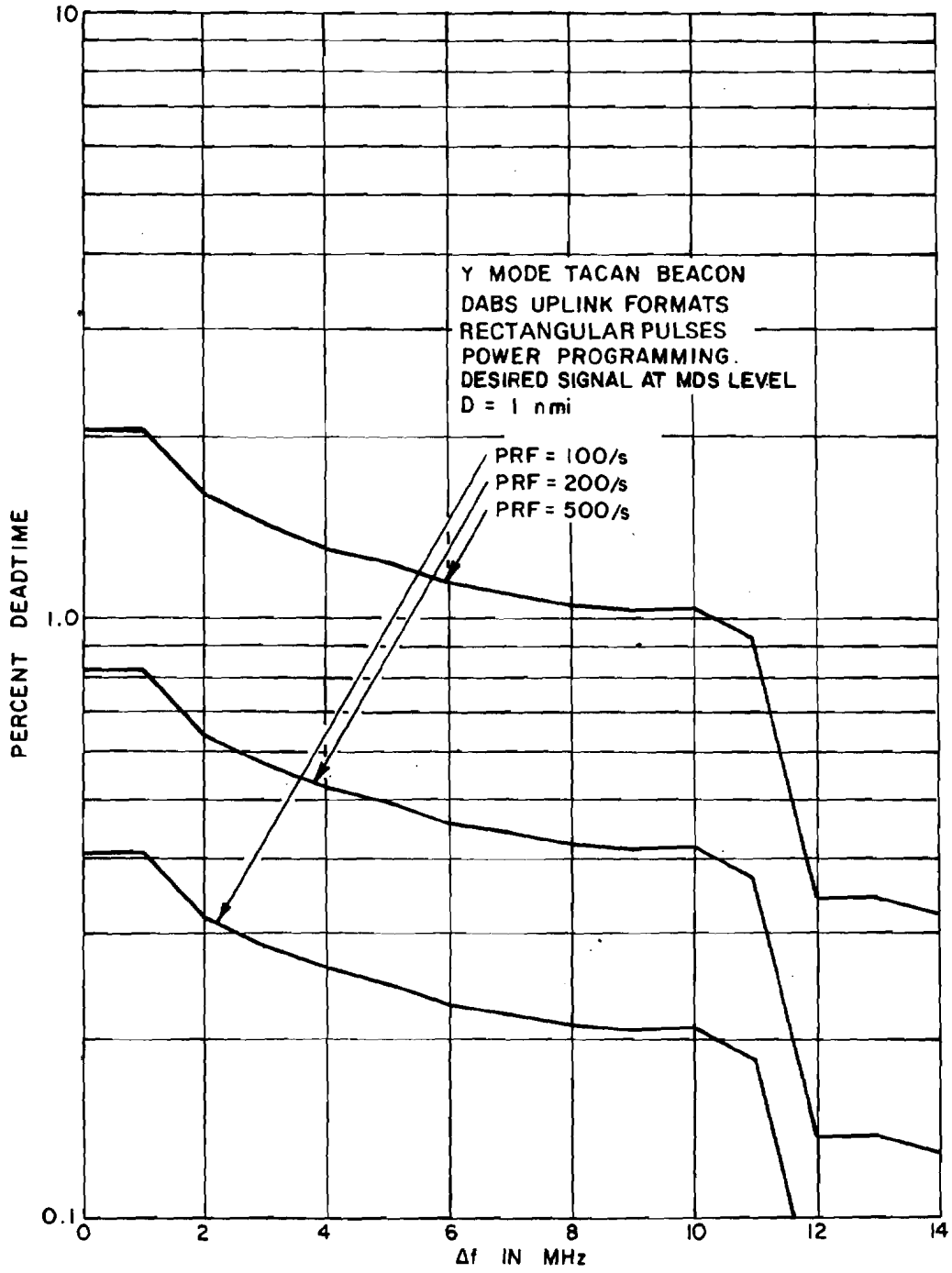

Y MODE TACAN BEACON
DABS UPLINK FORMATS
RECTANGULAR PULSES
POWER PROGRAMMING.
DESIRED SIGNAL AT MDS LEVEL
D = 1 nmi
PRF = 100/s
PRF = 200/s
PRF = 500/s
PERCENT DEADTIME
10
1.0
0.1
0
2
4
6
8
10
12
14
Δf IN MHz

Figure A-16.

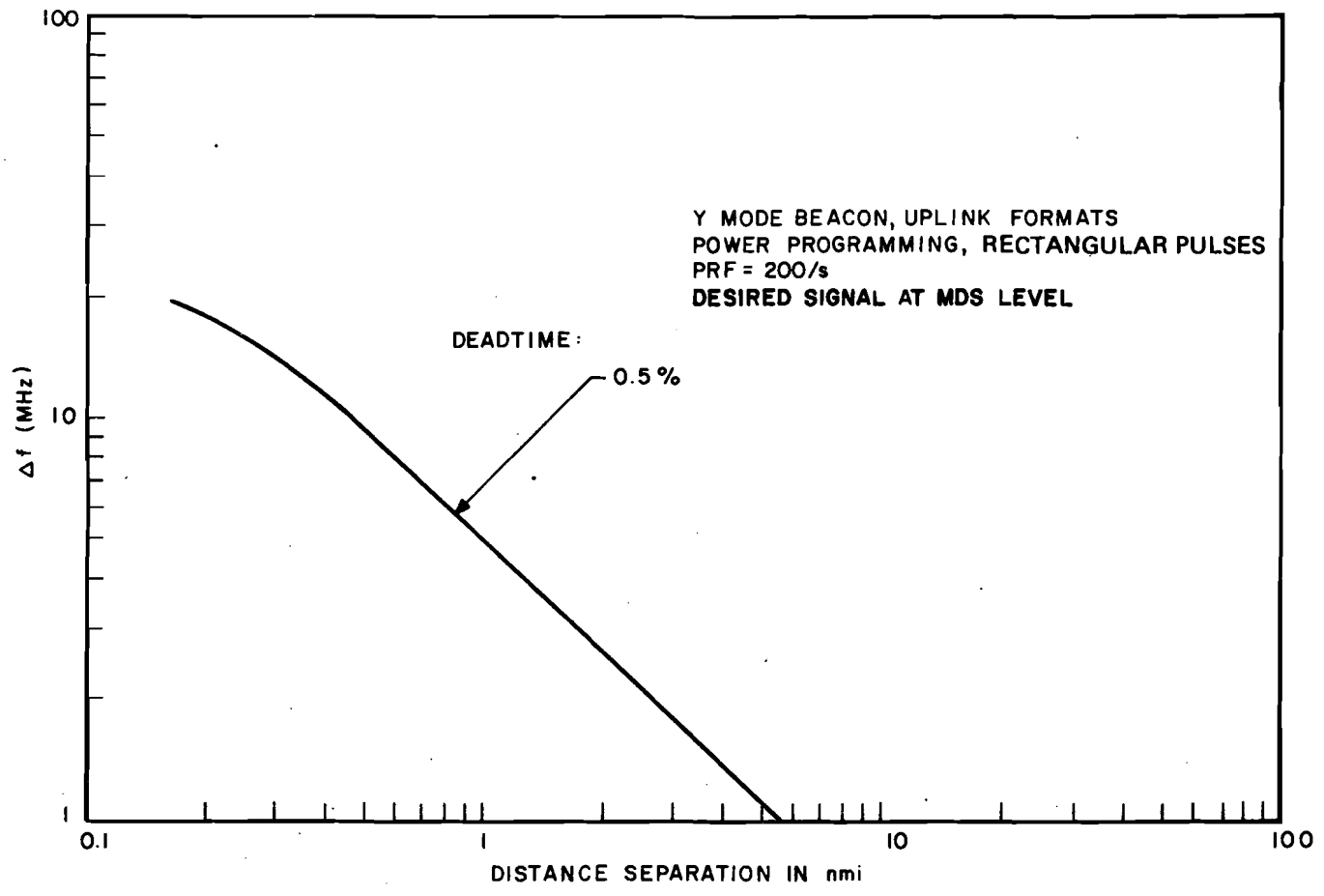

Y MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME:
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-17.

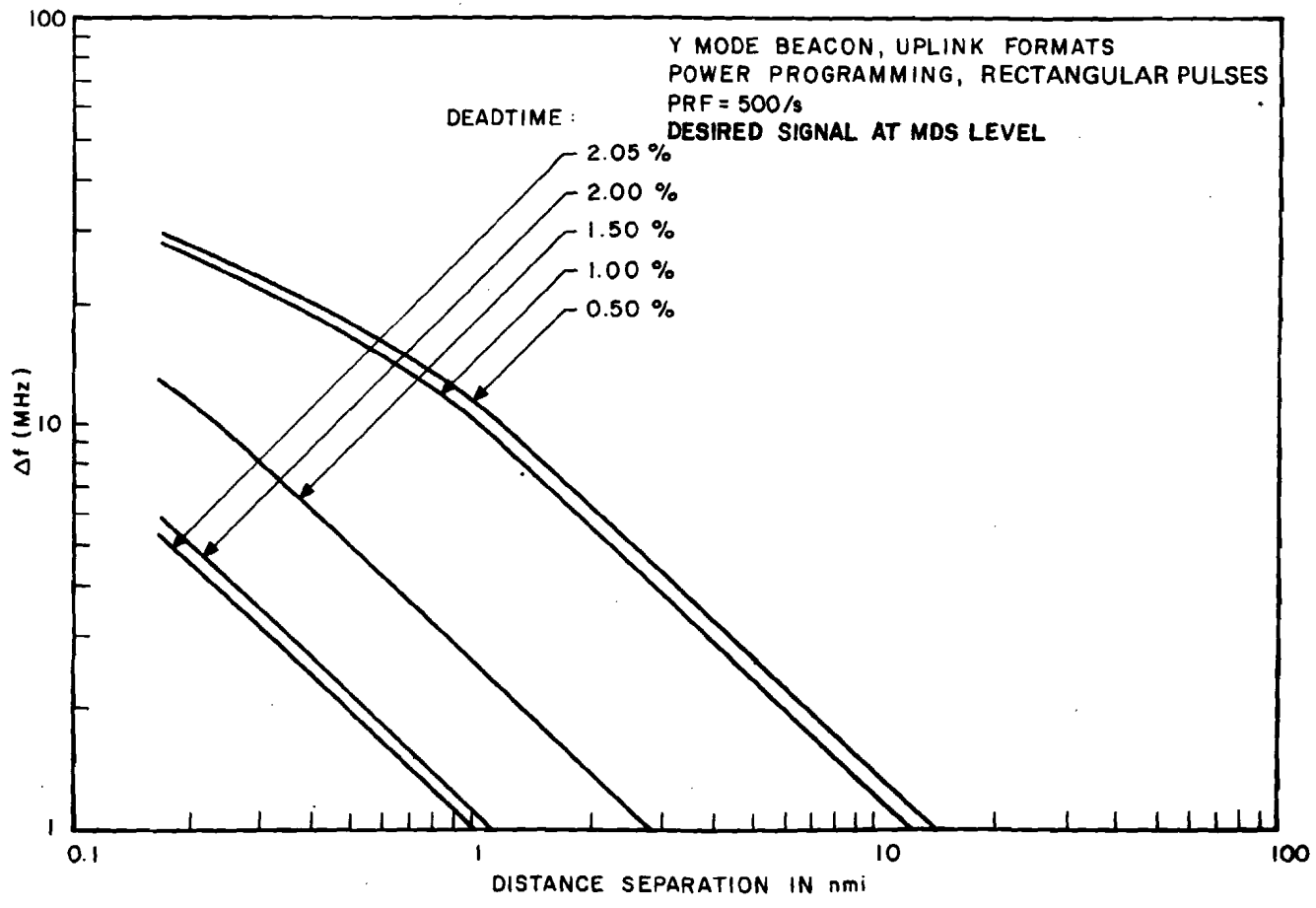

Y MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, RECTANGULAR PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
2.05 %
2.00 %
1.50 %
1.00 %
0.50 %
100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-18.

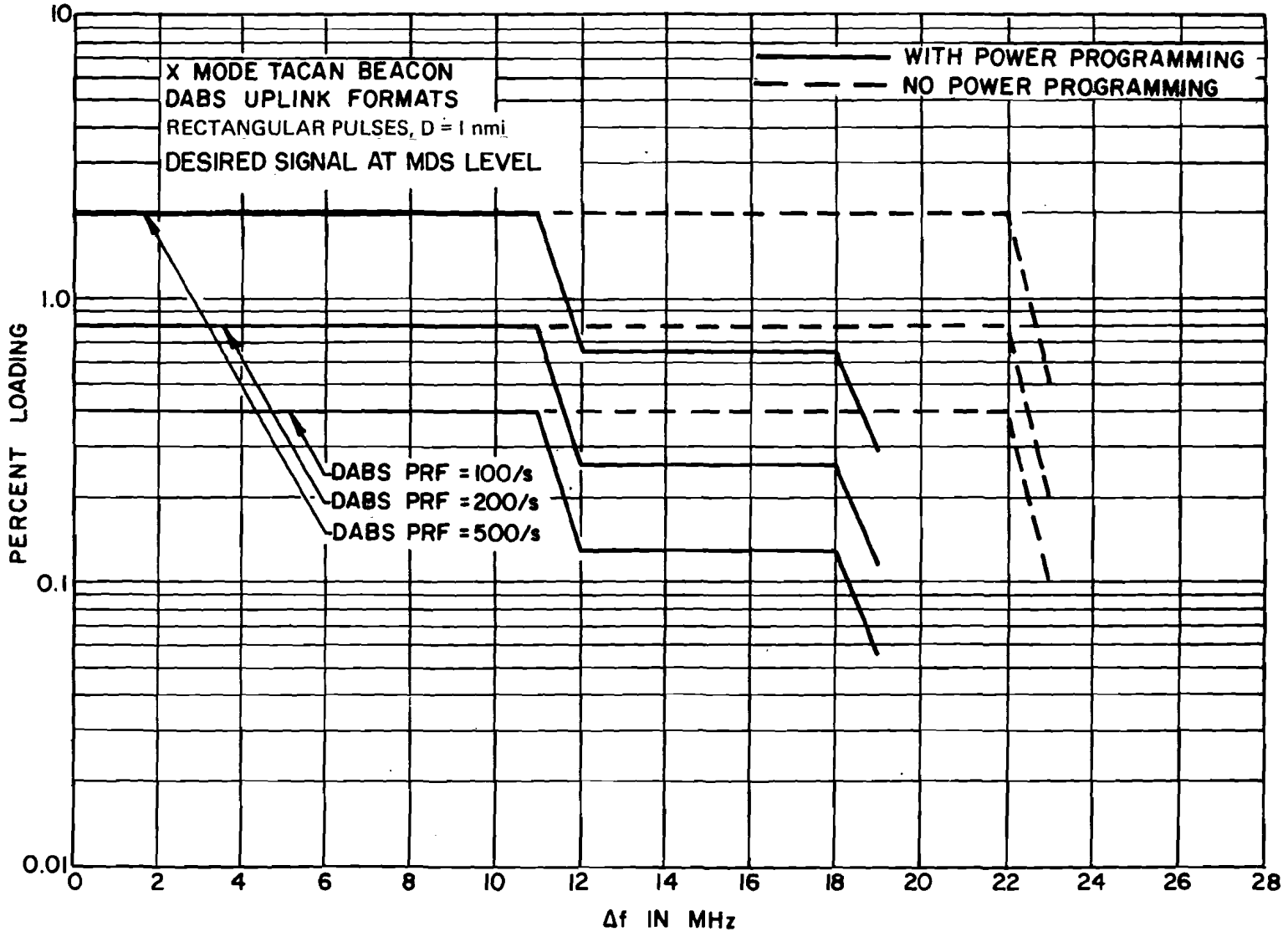

X MODE TACAN BEACON
DABS UPLINK FORMATS
RECTANGULAR PULSES, D = 1 nmi
DESIRED SIGNAL AT MDS LEVEL
WITH POWER PROGRAMMING
NO POWER PROGRAMMING
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
PERCENT LOADING
10
1.0
0.1
0.01
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
Δf IN MHz

Figure A-19.

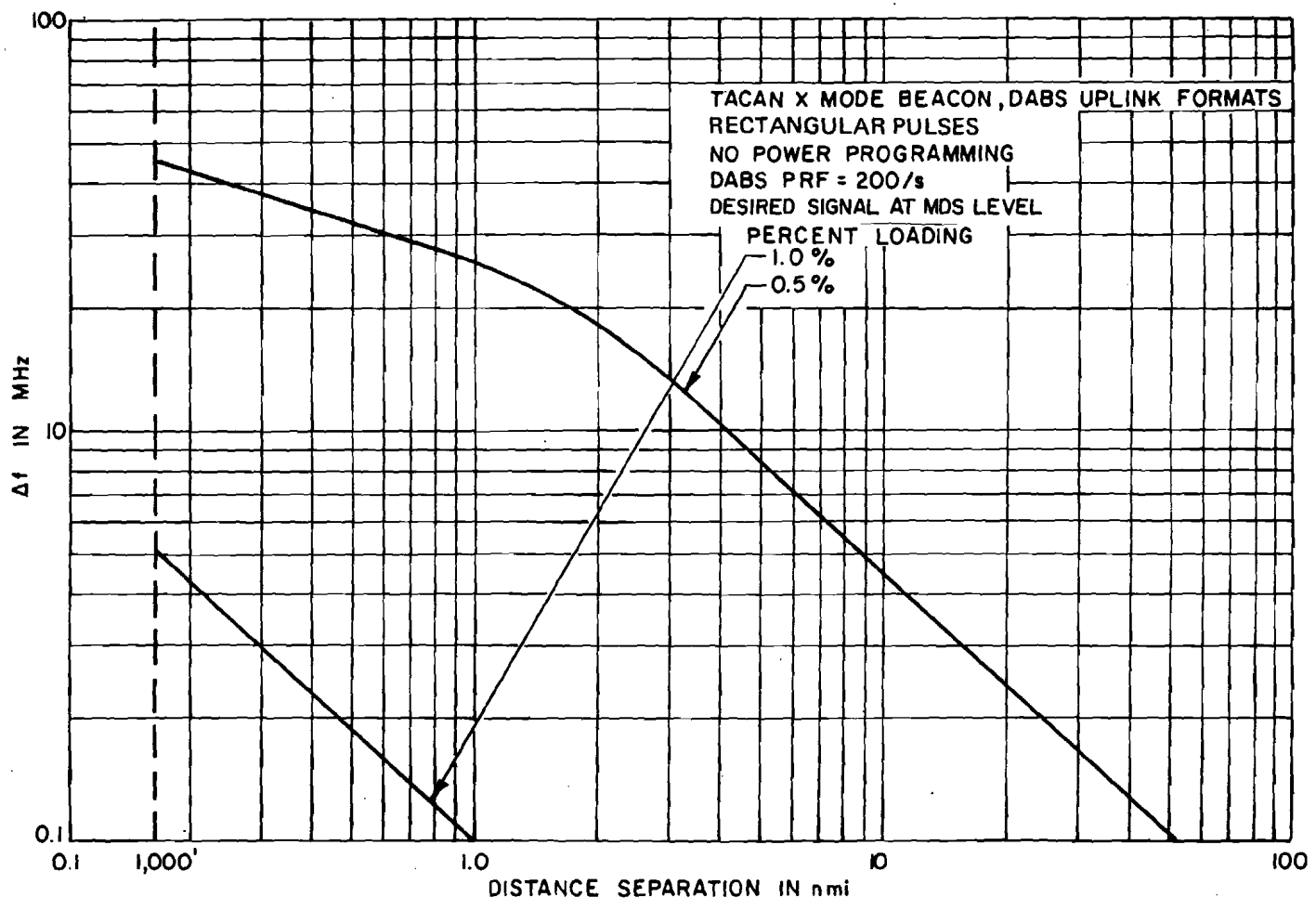

TACAN X MODE BEACON, DABS UPLINK FORMATS
RECTANGULAR PULSES
NO POWER PROGRAMMING
DABS PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
PERCENT LOADING
1.0 %
0.5 %
100
10
0.1
Δf IN MHz
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi

Figure A-20.

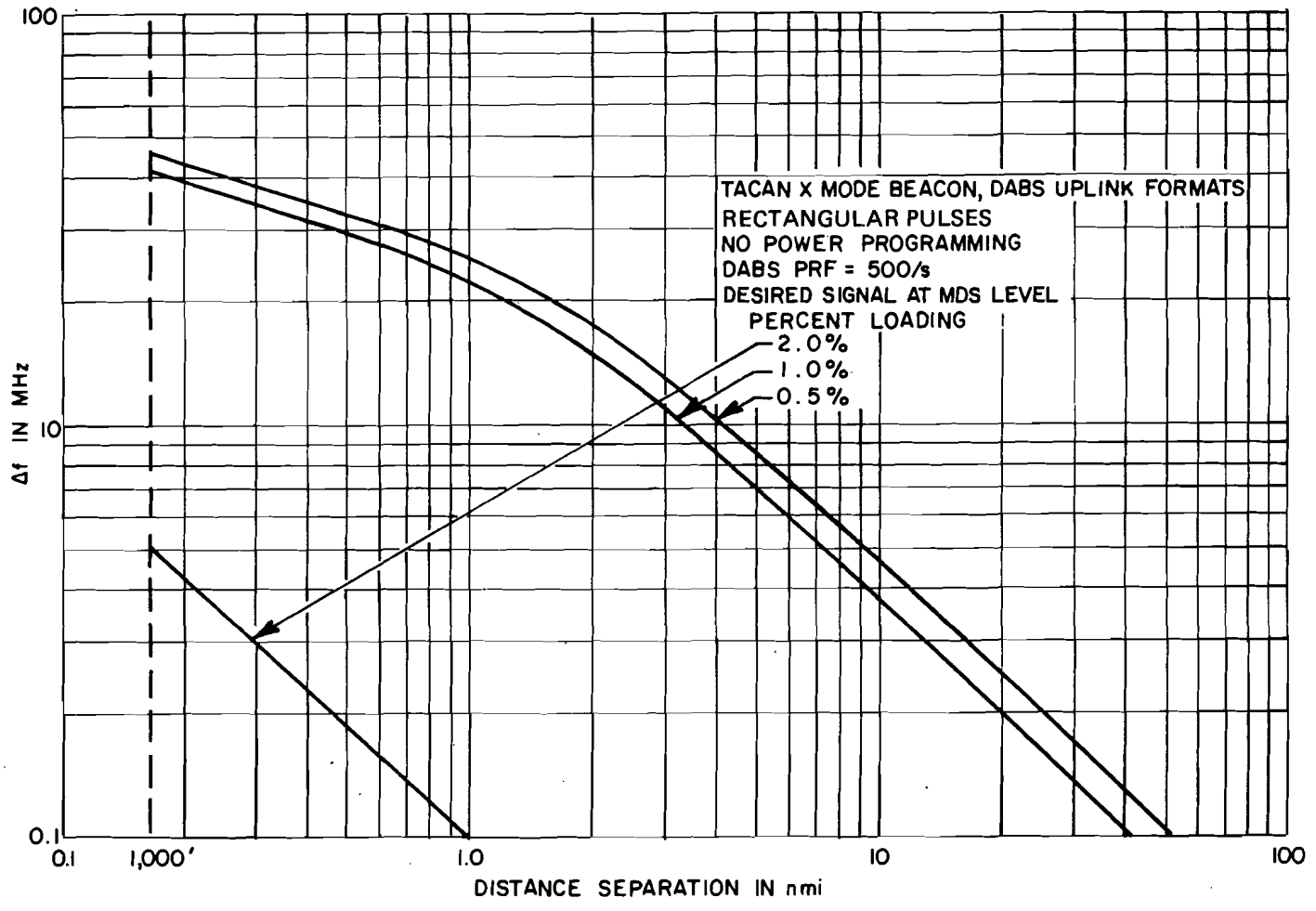

TACAN X MODE BEACON, DABS UPLINK FORMATS
RECTANGULAR PULSES
NO POWER PROGRAMMING
DABS PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
PERCENT LOADING
2.0%
1.0%
0.5%
100
10
0.1
Δf IN MHz
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi

Figure A-21.

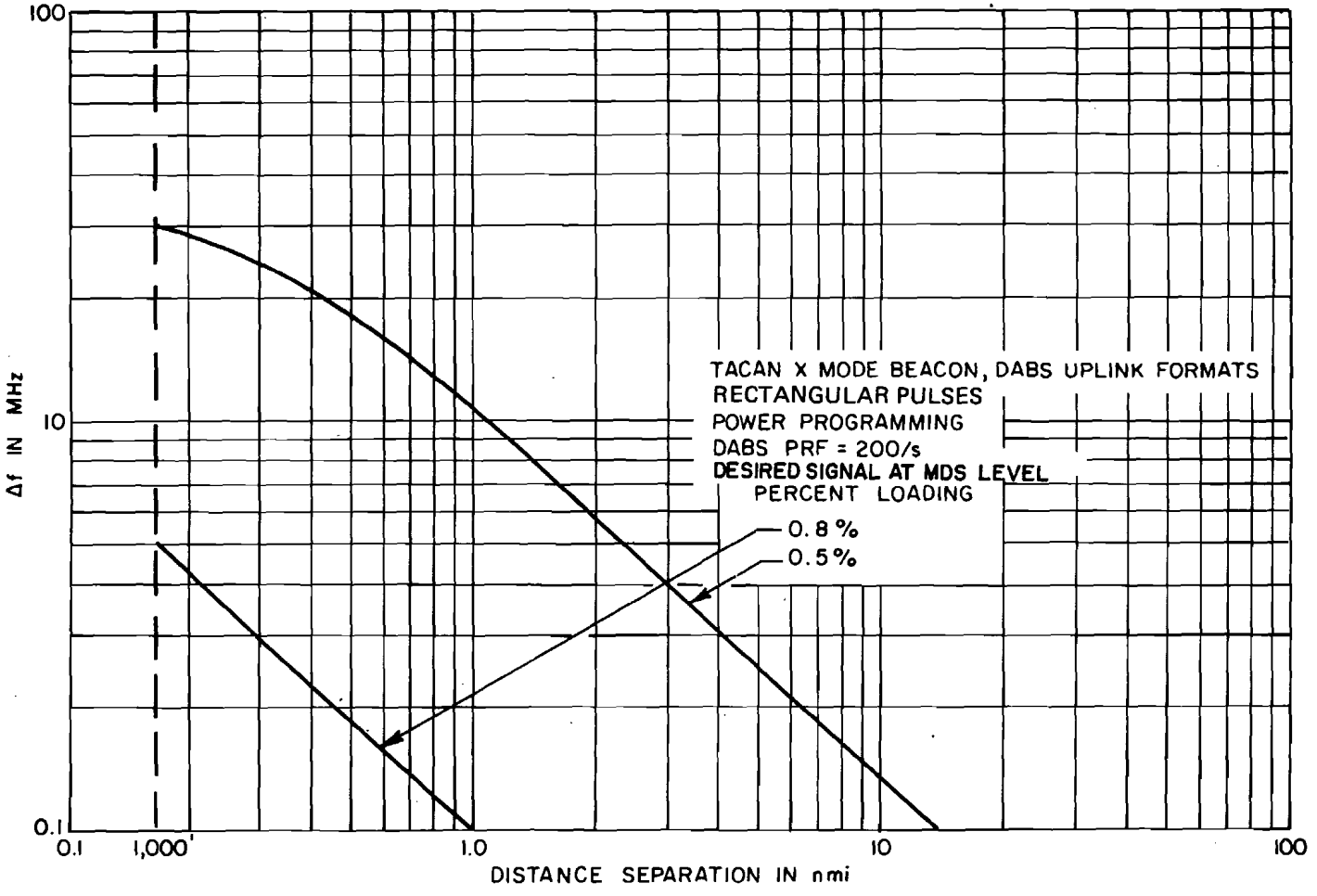

100
10
0.1
Δf IN MHz
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi
TACAN X MODE BEACON, DABS UPLINK FORMATS
RECTANGULAR PULSES
POWER PROGRAMMING
DABS PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
PERCENT LOADING
0.8 %
0.5 %

Figure A-22.

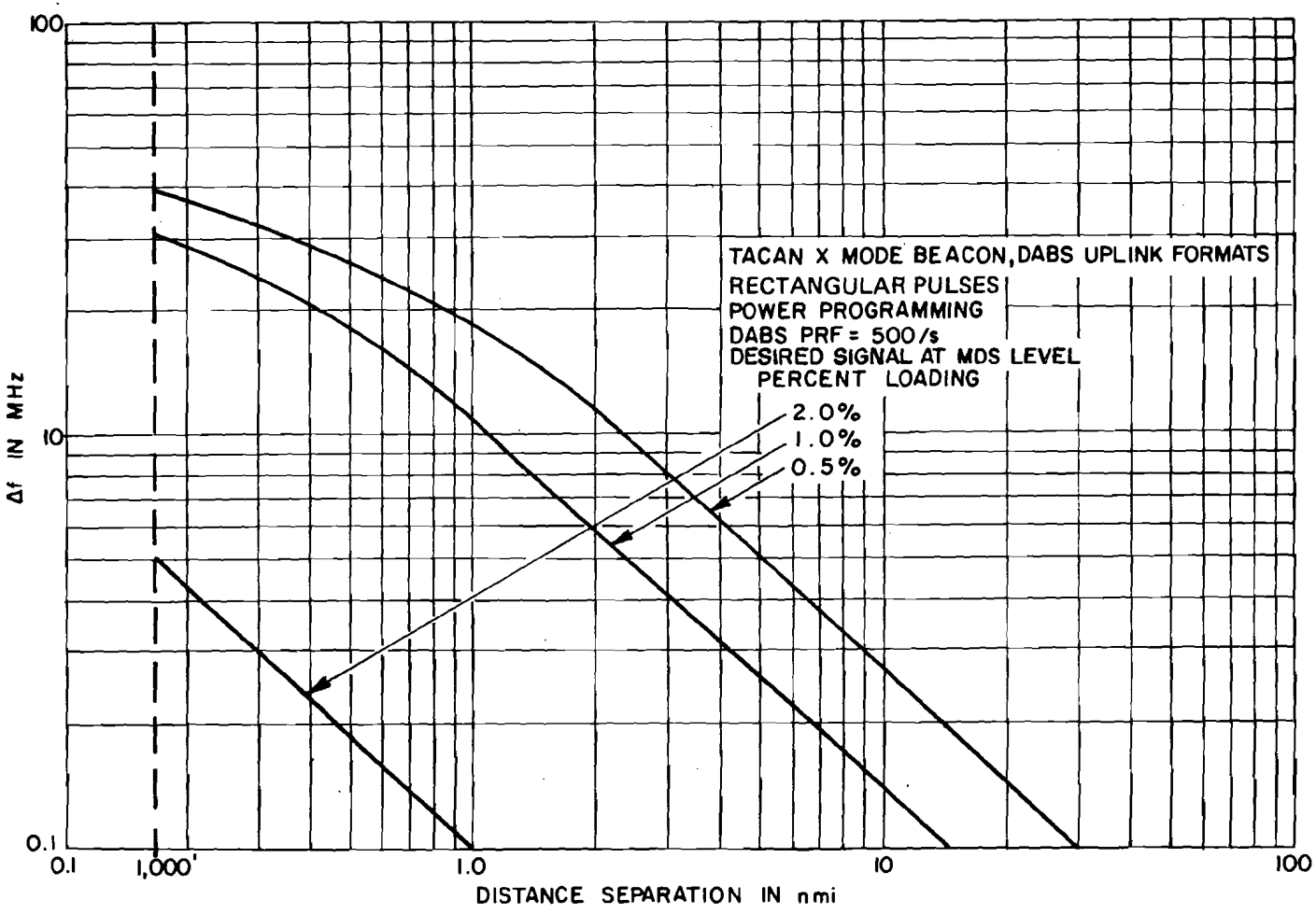

TACAN X MODE BEACON, DABS UPLINK FORMATS
RECTANGULAR PULSES
POWER PROGRAMMING
DABS PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
PERCENT LOADING
2.0%
1.0%
0.5%
Δf IN MHz
100
10
0.1
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi

Figure A-23.

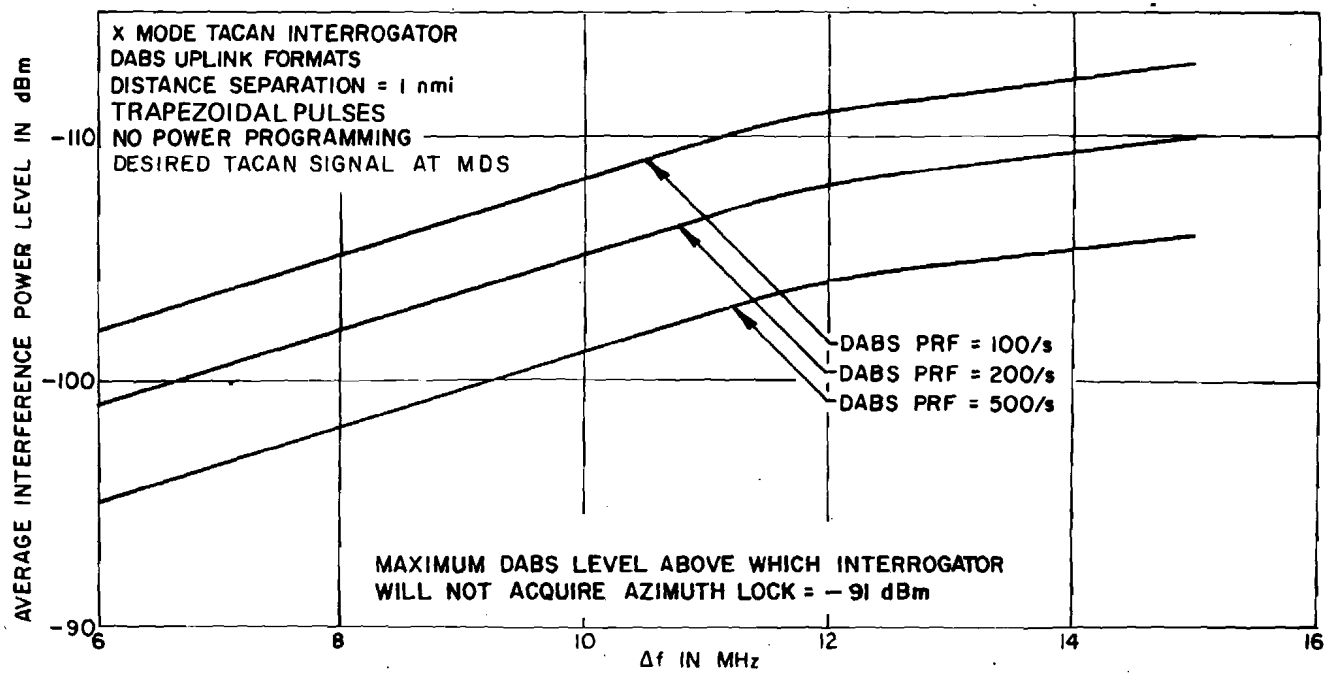

X MODE TACAN INTERROGATOR
DABS UPLINK FORMATS
DISTANCE SEPARATION = 1 nmi
TRAPEZOIDAL PULSES
NO POWER PROGRAMMING
DESIRED TACAN SIGNAL AT MDS
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
MAXIMUM DABS LEVEL ABOVE WHICH INTERROGATOR
WILL NOT ACQUIRE AZIMUTH LOCK = −91 dBm
AVERAGE INTERFERENCE POWER LEVEL IN dBm
−110
−100
−90
6
8
10
12
14
16
Δf IN MHz

Figure A-24.

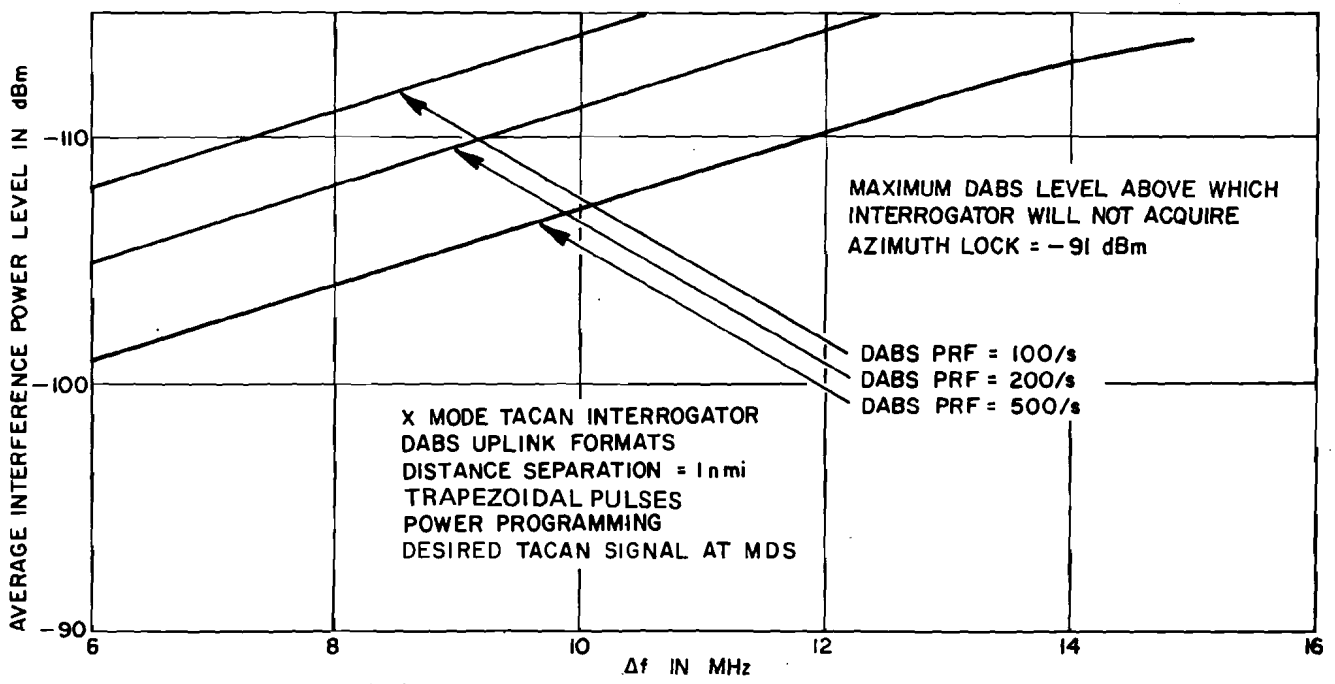

AVERAGE INTERFERENCE POWER LEVEL IN dBm
-110
-100
-90
6
8
10
12
14
16
Δf IN MHz
MAXIMUM DABS LEVEL ABOVE WHICH
INTERROGATOR WILL NOT ACQUIRE
AZIMUTH LOCK = -91 dBm
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR
DABS UPLINK FORMATS
DISTANCE SEPARATION = 1nmi
TRAPEZOIDAL PULSES
POWER PROGRAMMING
DESIRED TACAN SIGNAL AT MDS

Figure A-25.

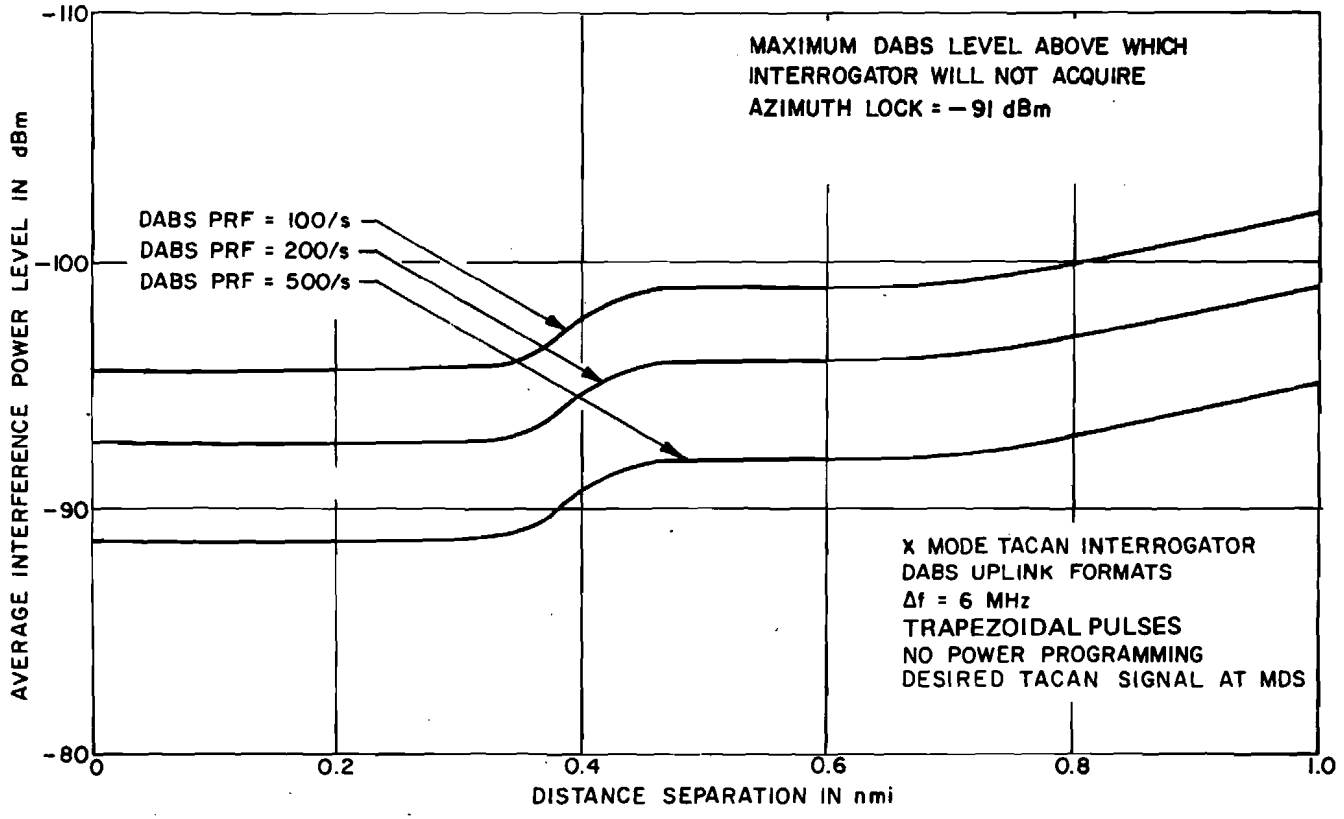

MAXIMUM DABS LEVEL ABOVE WHICH
INTERROGATOR WILL NOT ACQUIRE
AZIMUTH LOCK = −91 dBm
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR
DABS UPLINK FORMATS
Δf = 6 MHz
TRAPEZOIDAL PULSES
NO POWER PROGRAMMING
DESIRED TACAN SIGNAL AT MDS
AVERAGE INTERFERENCE POWER LEVEL IN dBm
-110
-100
-90
-80
0
0.2
0.4
0.6
0.8
1.0
DISTANCE SEPARATION IN nmi

Figure A-26.

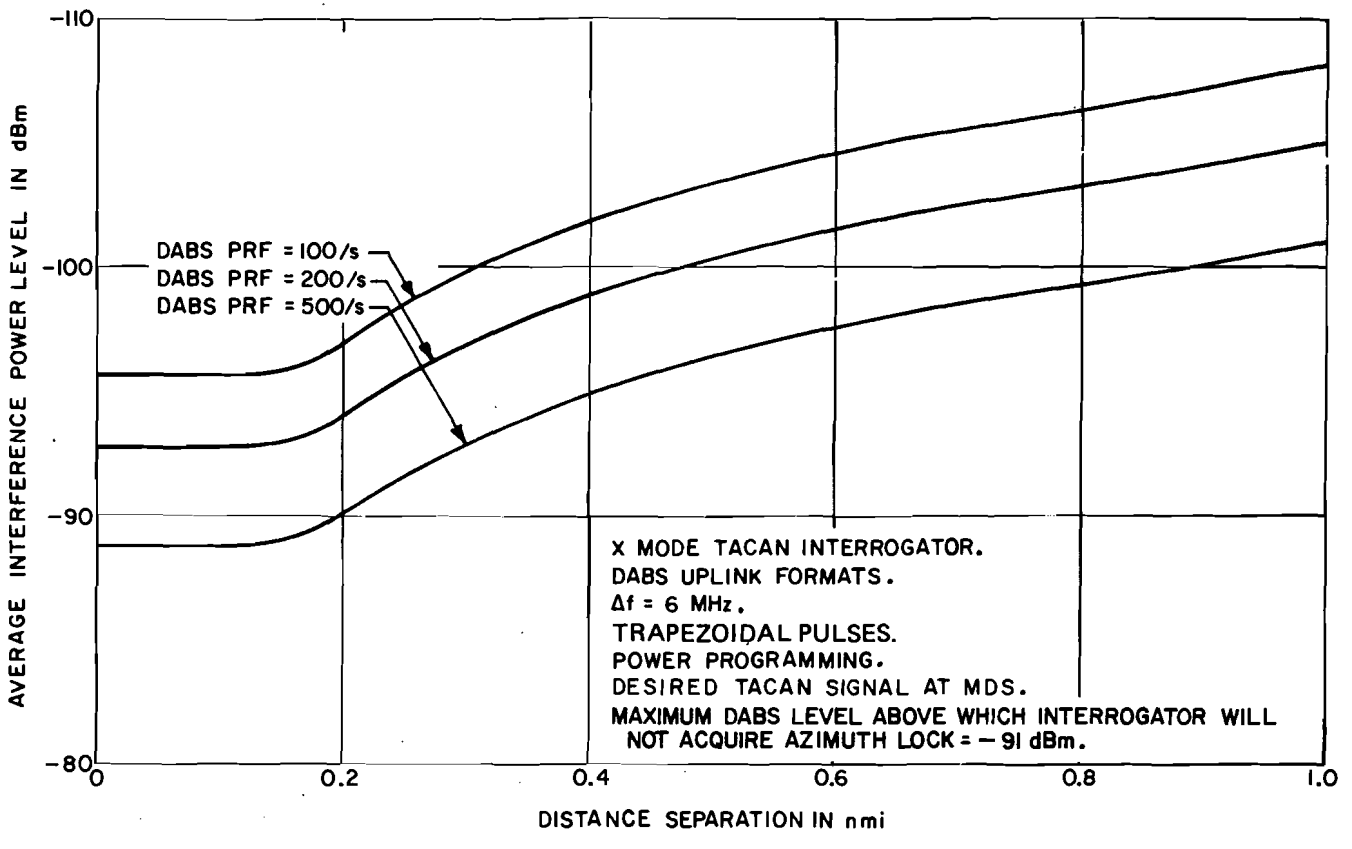

-110
-100
-90
-80
AVERAGE INTERFERENCE POWER LEVEL IN dBm
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
X MODE TACAN INTERROGATOR.
DABS UPLINK FORMATS.
Δf = 6 MHz.
TRAPEZOIDAL PULSES.
POWER PROGRAMMING.
DESIRED TACAN SIGNAL AT MDS.
MAXIMUM DABS LEVEL ABOVE WHICH INTERROGATOR WILL NOT ACQUIRE AZIMUTH LOCK = −91 dBm.
0
0.2
0.4
0.6
0.8
1.0
DISTANCE SEPARATION IN nmi

Figure A-27.

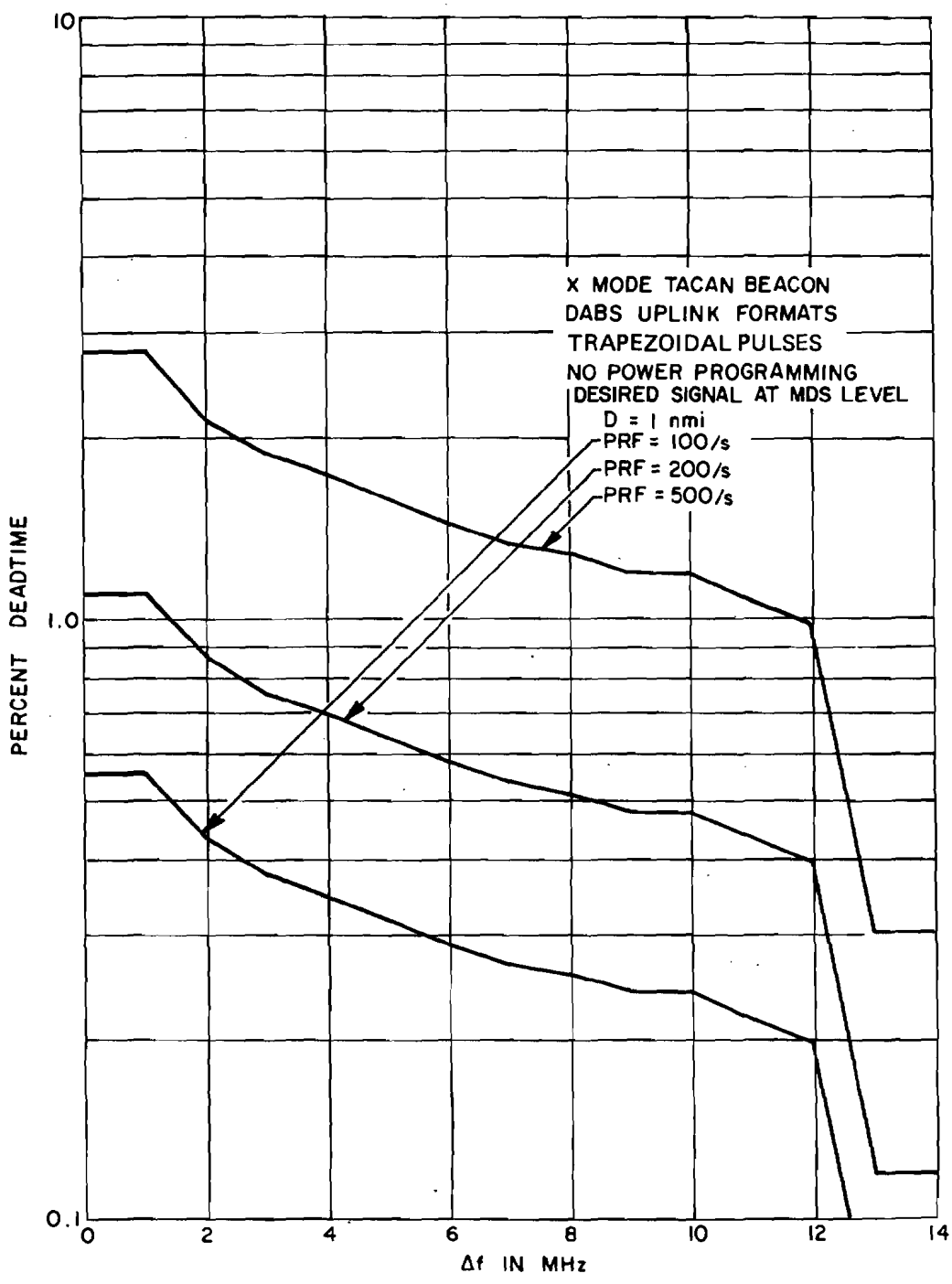

10
1.0
0.1
PERCENT DEADTIME
0
2
4
6
8
10
12
14
Δf IN MHz
X MODE TACAN BEACON
DABS UPLINK FORMATS
TRAPEZOIDAL PULSES
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
D = 1 nmi
PRF = 100/s
PRF = 200/s
PRF = 500/s

Figure A-28.

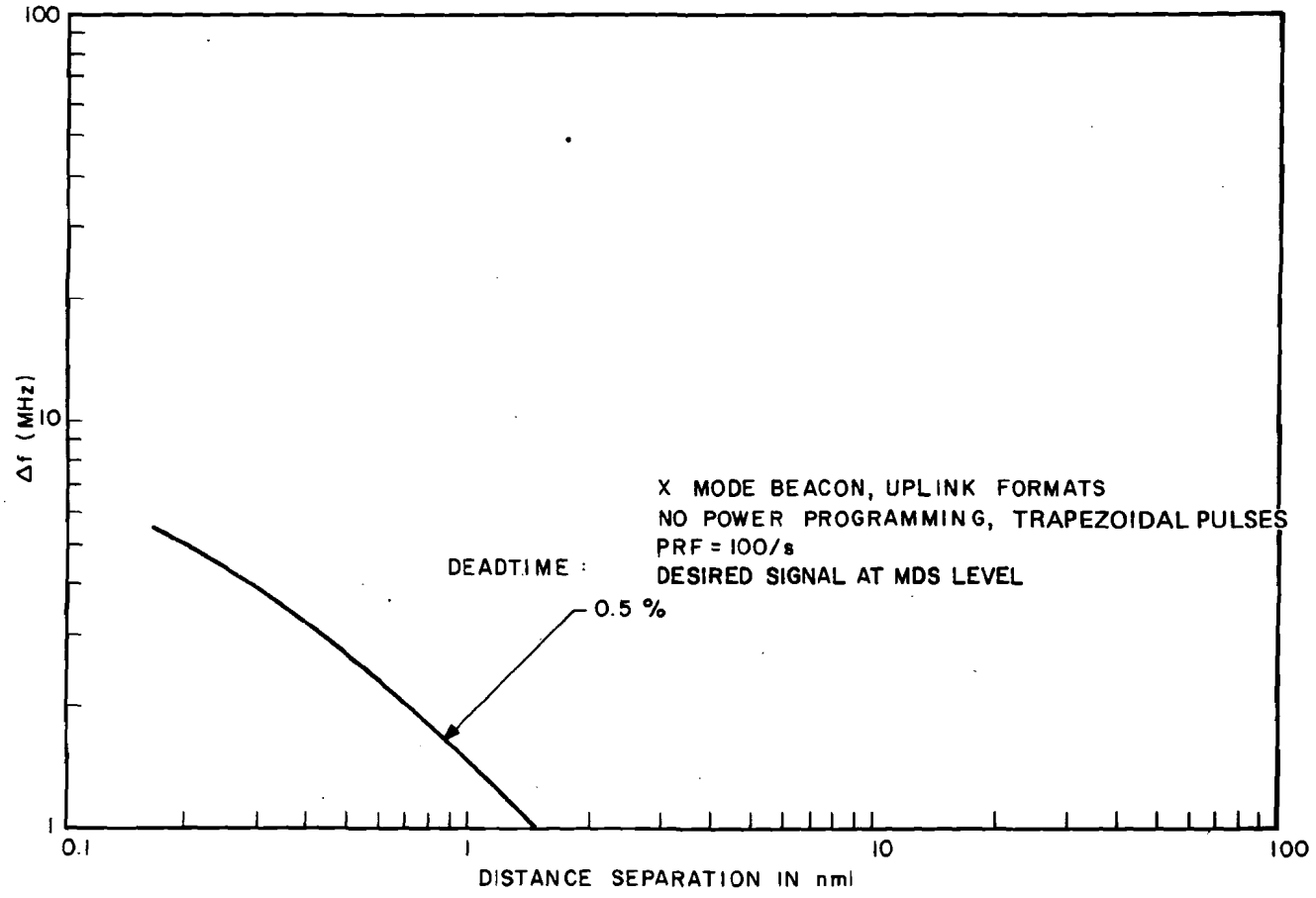

100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi
X MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 100/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
0.5 %

Figure A-29.

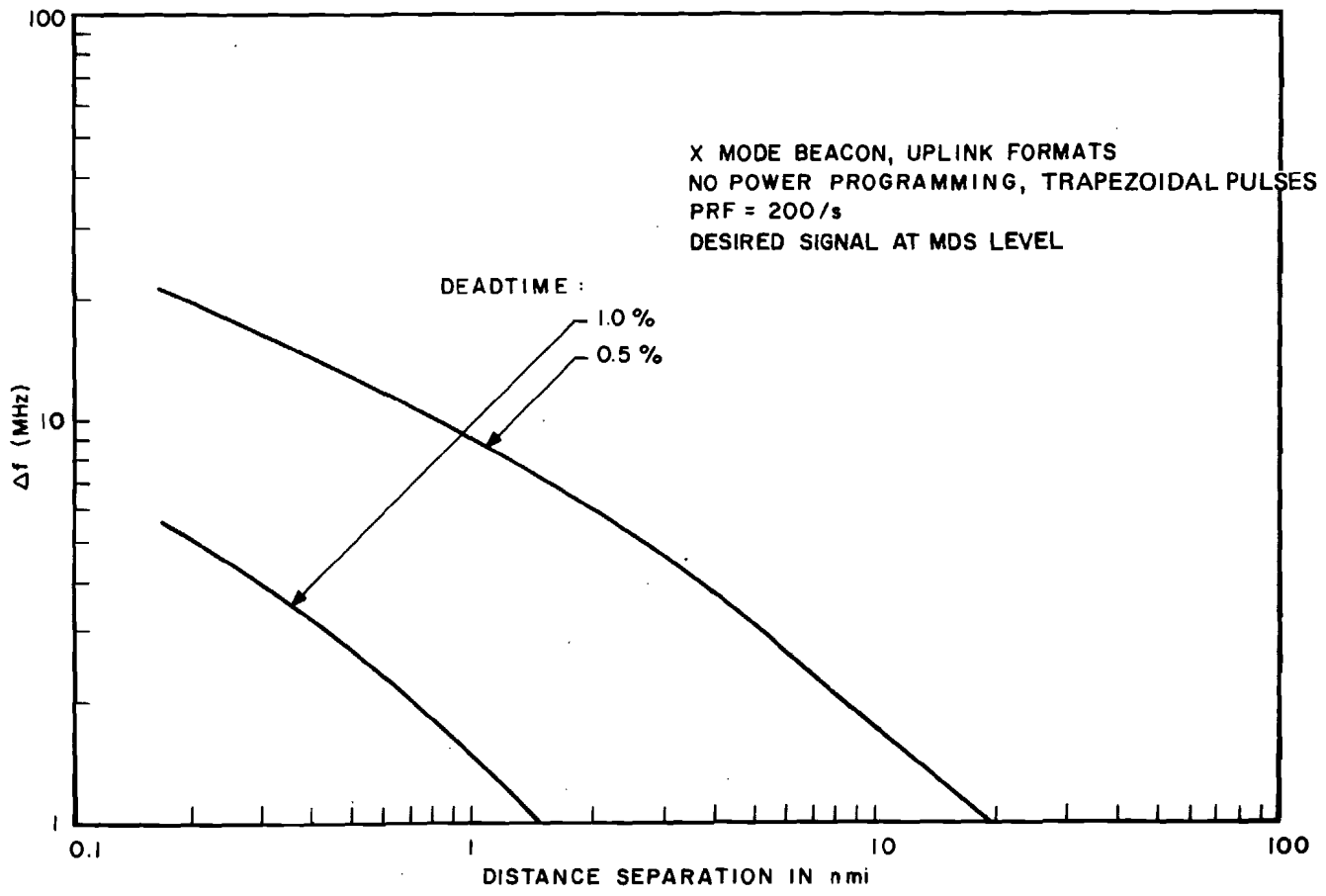

X MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-30.

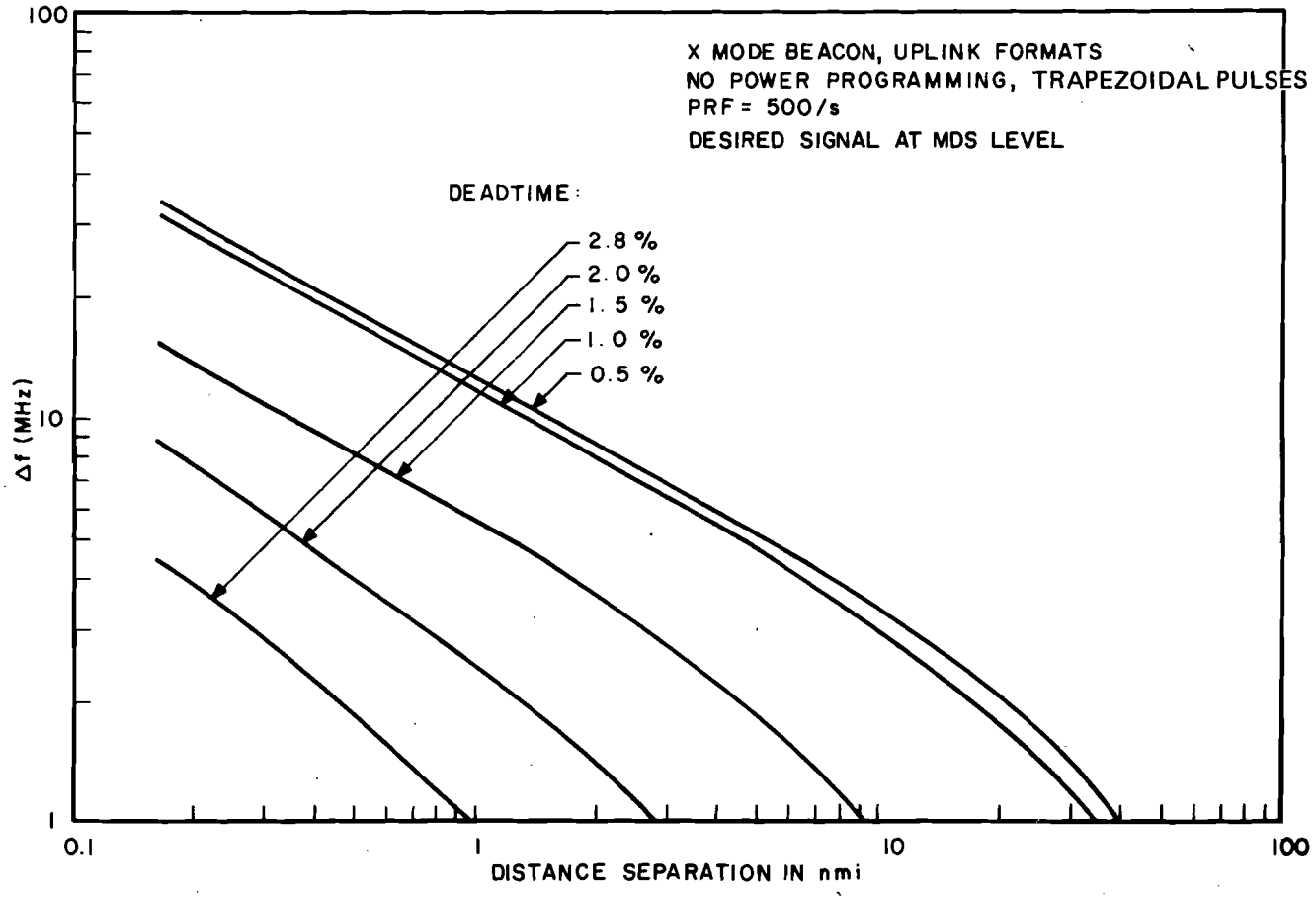

X MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME:
2.8 %
2.0 %
1.5 %
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-31.

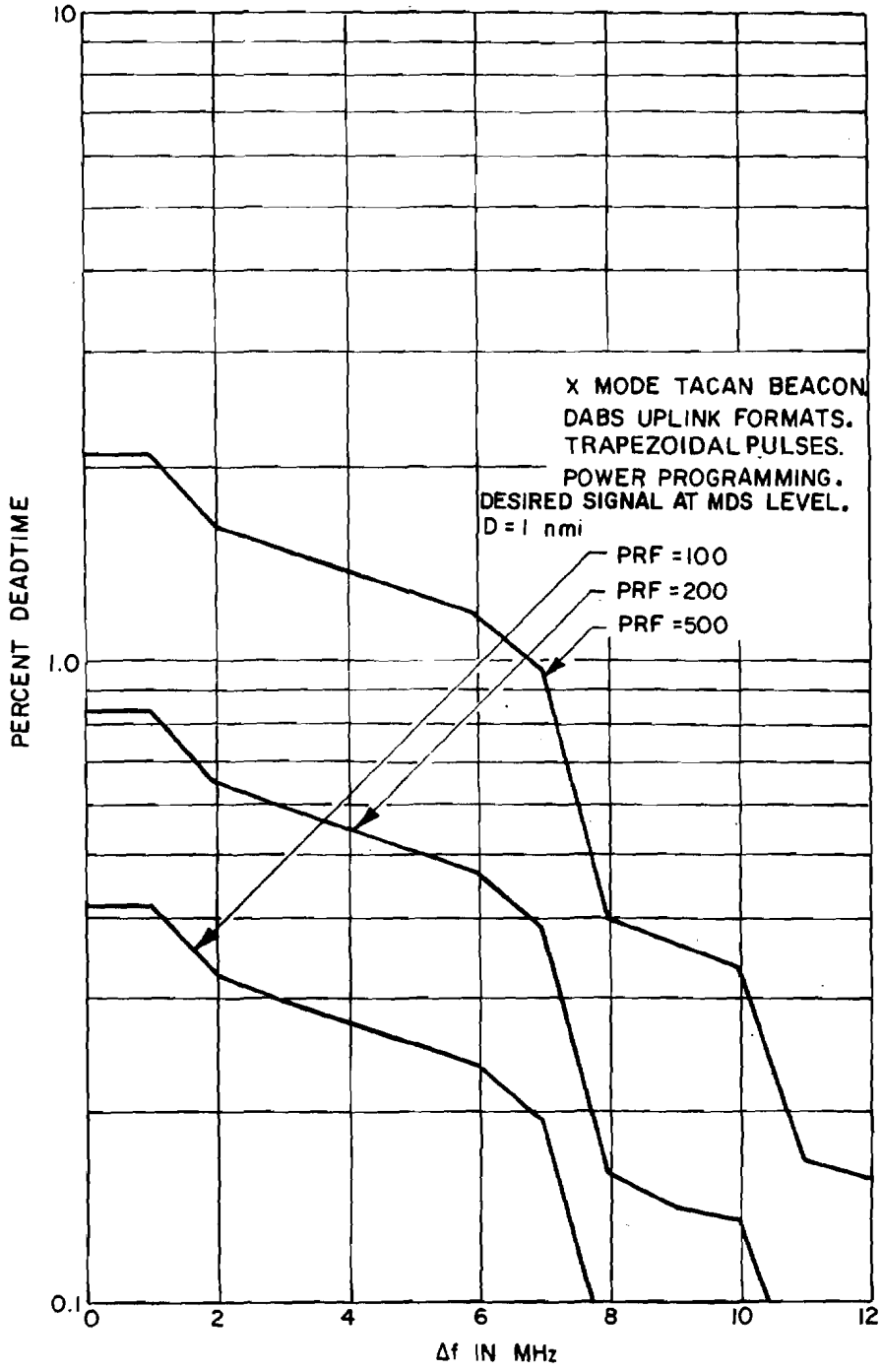

10
1.0
0.1
PERCENT DEADTIME
0
2
4
6
8
10
12
Δf IN MHz
X MODE TACAN BEACON
DABS UPLINK FORMATS.
TRAPEZOIDAL PULSES.
POWER PROGRAMMING.
DESIRED SIGNAL AT MDS LEVEL.
D = 1 nmi
PRF = 100
PRF = 200
PRF = 500

Figure A-32.

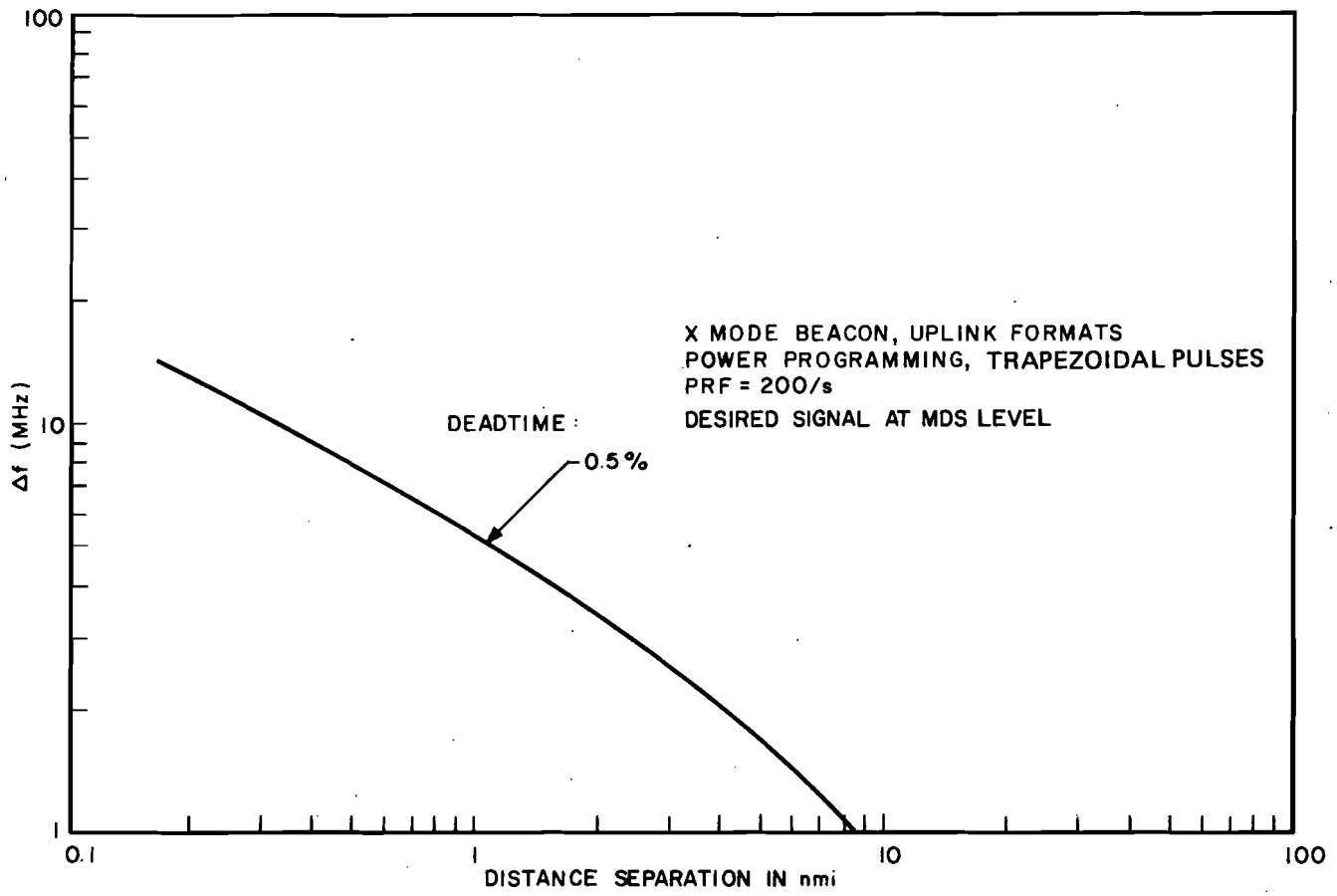

100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi
X MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
0.5%

Figure A-33.

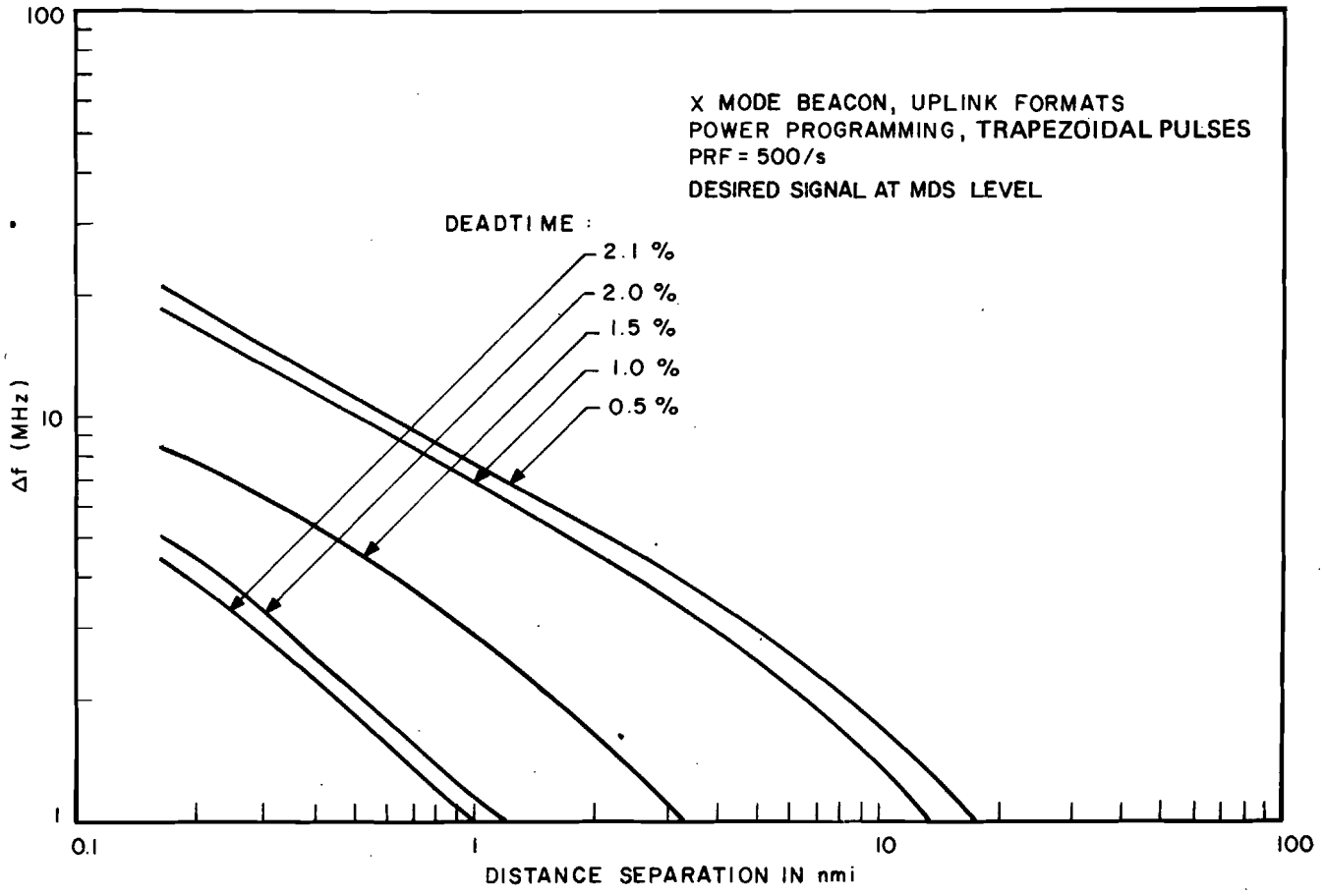

X MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
2.1 %
2.0 %
1.5 %
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-34.

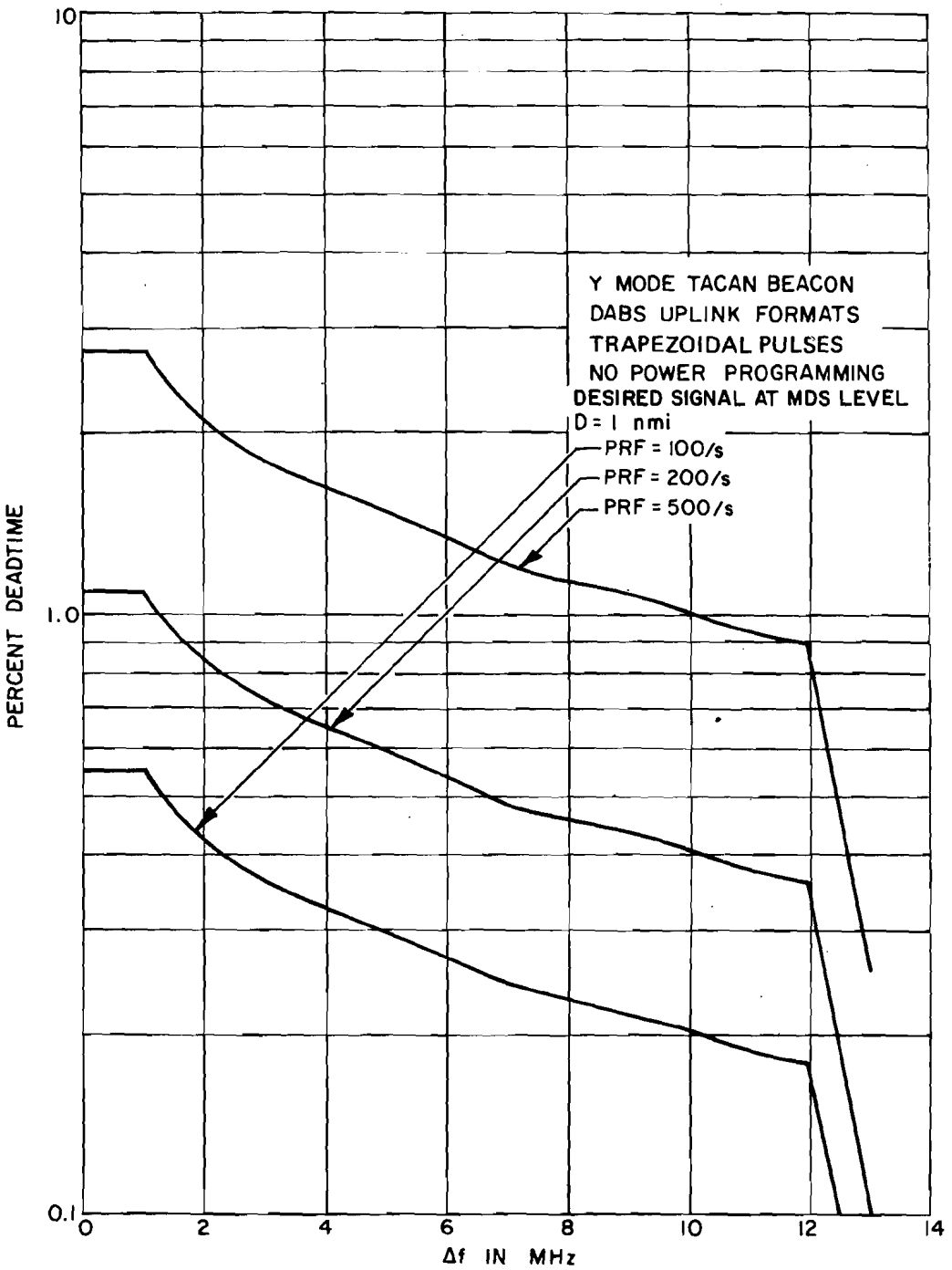

Y MODE TACAN BEACON
DABS UPLINK FORMATS
TRAPEZOIDAL PULSES
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
D = 1 nmi
PRF = 100/s
PRF = 200/s
PRF = 500/s
PERCENT DEADTIME
10
1.0
0.1
0
2
4
6
8
10
12
14
Δf IN MHz

Figure A-35.

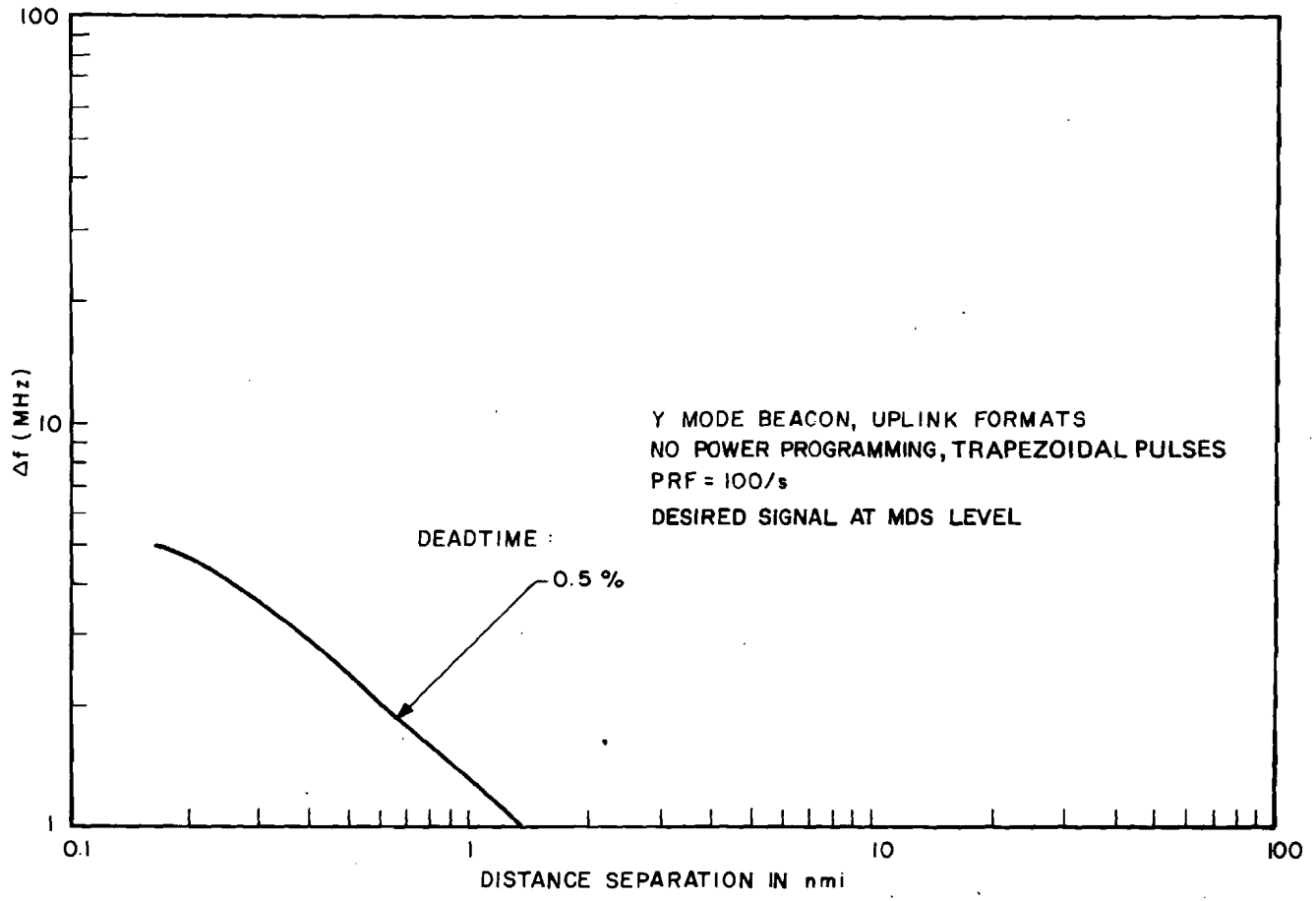

100
10
1
Δf (MHz)
0.1
1
10
100
DISTANCE SEPARATION IN nmi
Y MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 100/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
0.5 %

Figure A-36.

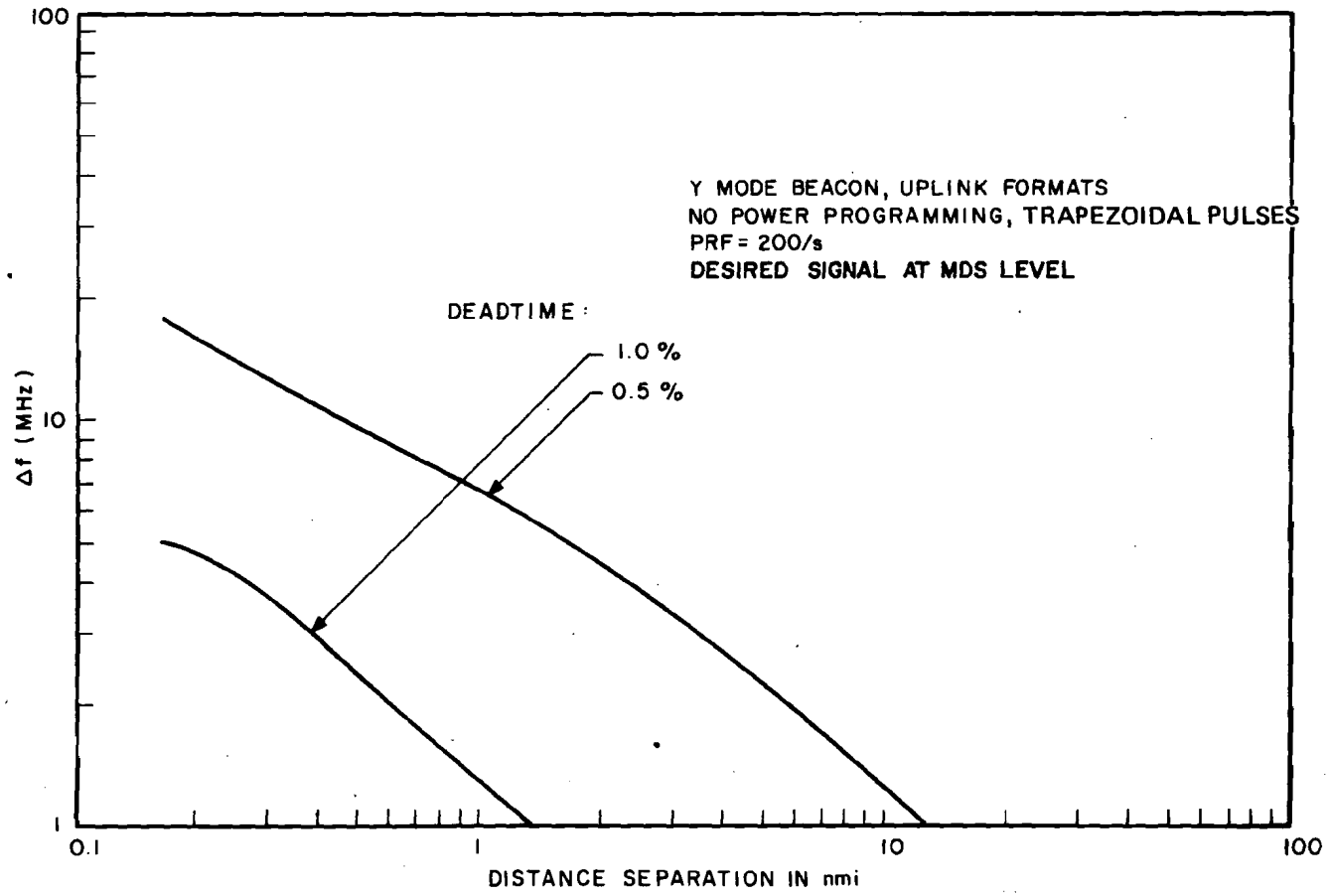

Y MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME:
1.0 %
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-37.

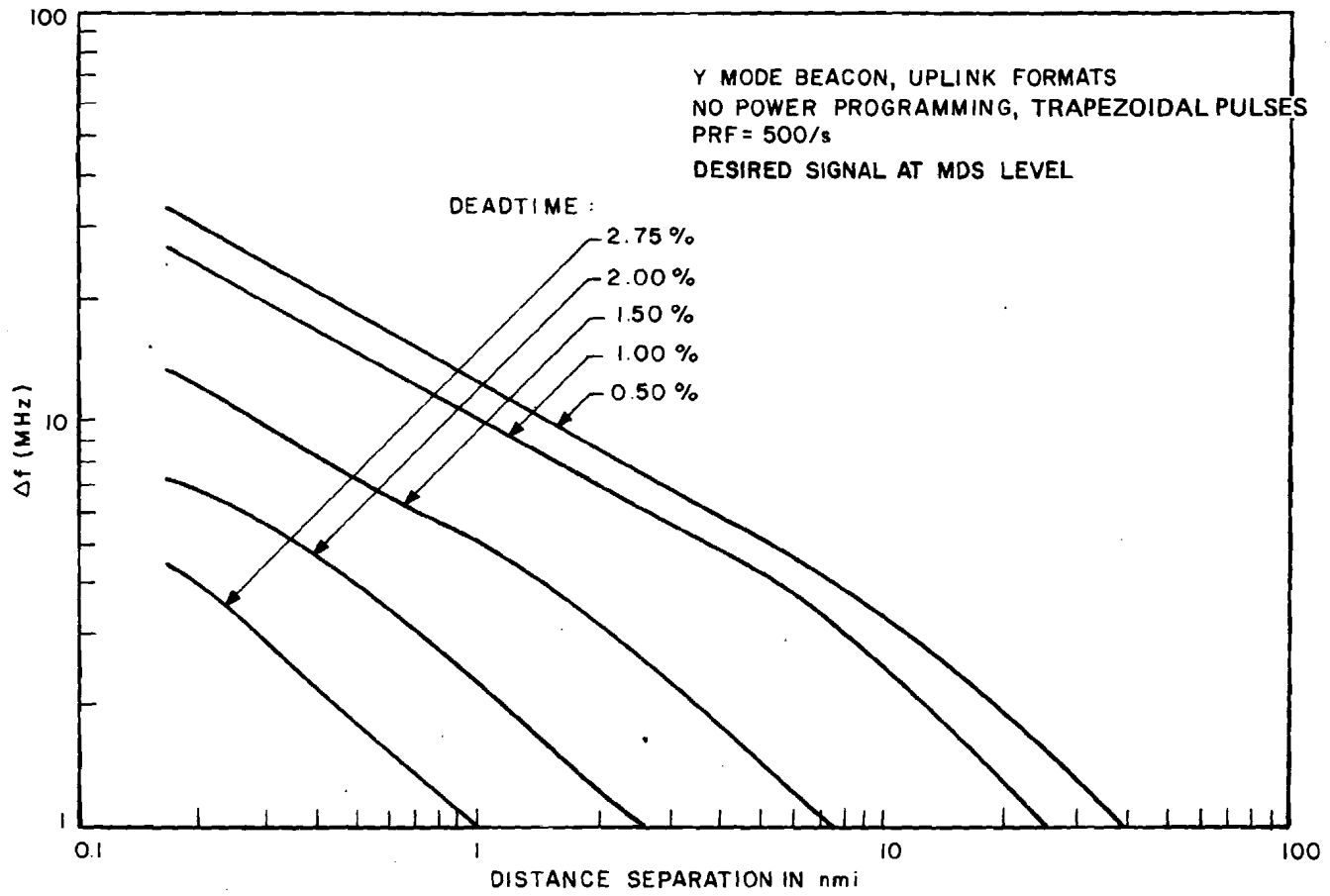

Y MODE BEACON, UPLINK FORMATS
NO POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
2.75 %
2.00 %
1.50 %
1.00 %
0.50 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-38.

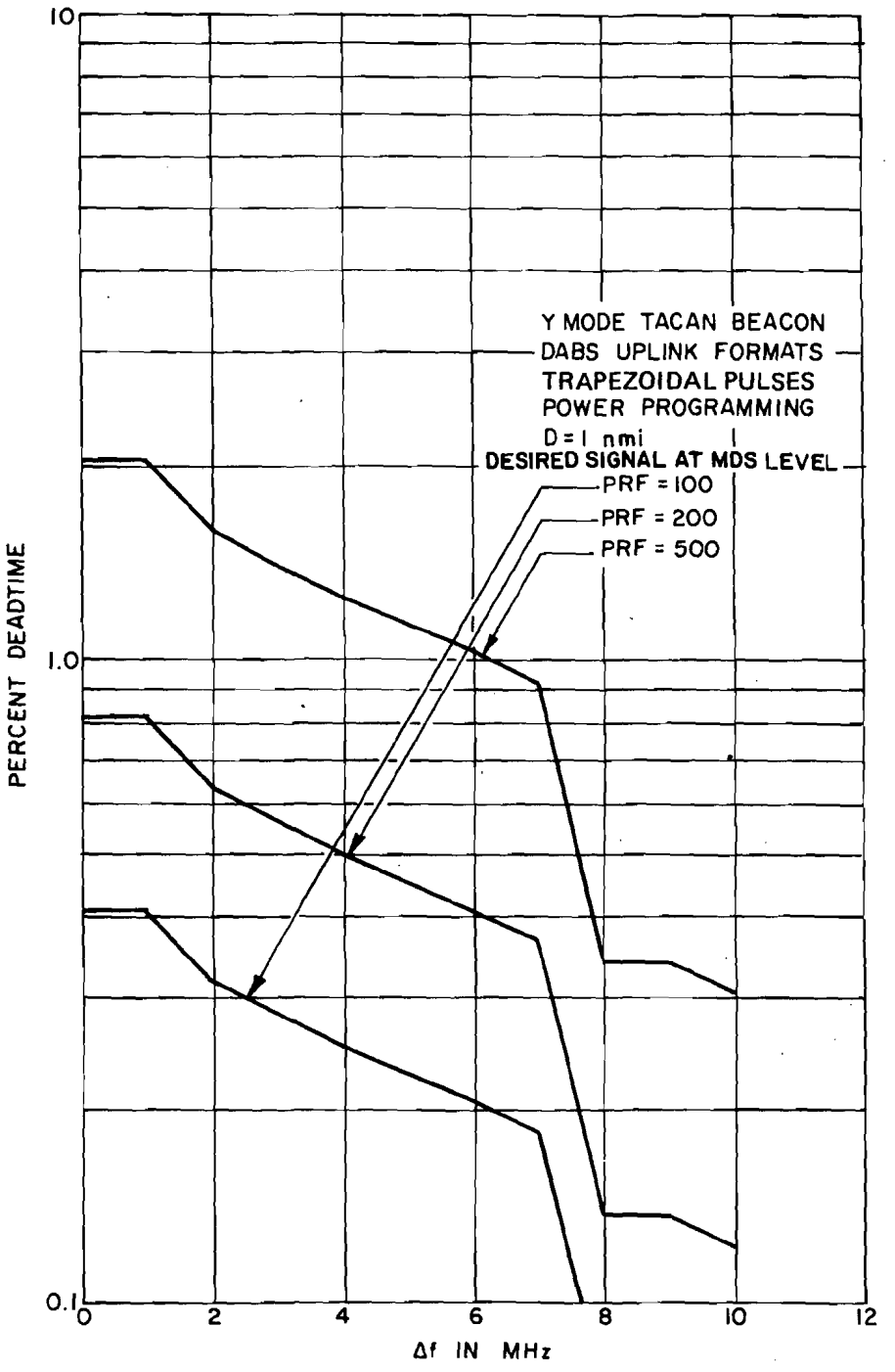

10
1.0
0.1
PERCENT DEADTIME
0
2
4
6
8
10
12
Δf IN MHz
Y MODE TACAN BEACON
DABS UPLINK FORMATS
TRAPEZOIDAL PULSES
POWER PROGRAMMING
D = 1 nmi
DESIRED SIGNAL AT MDS LEVEL
PRF = 100
PRF = 200
PRF = 500

Figure A-39.

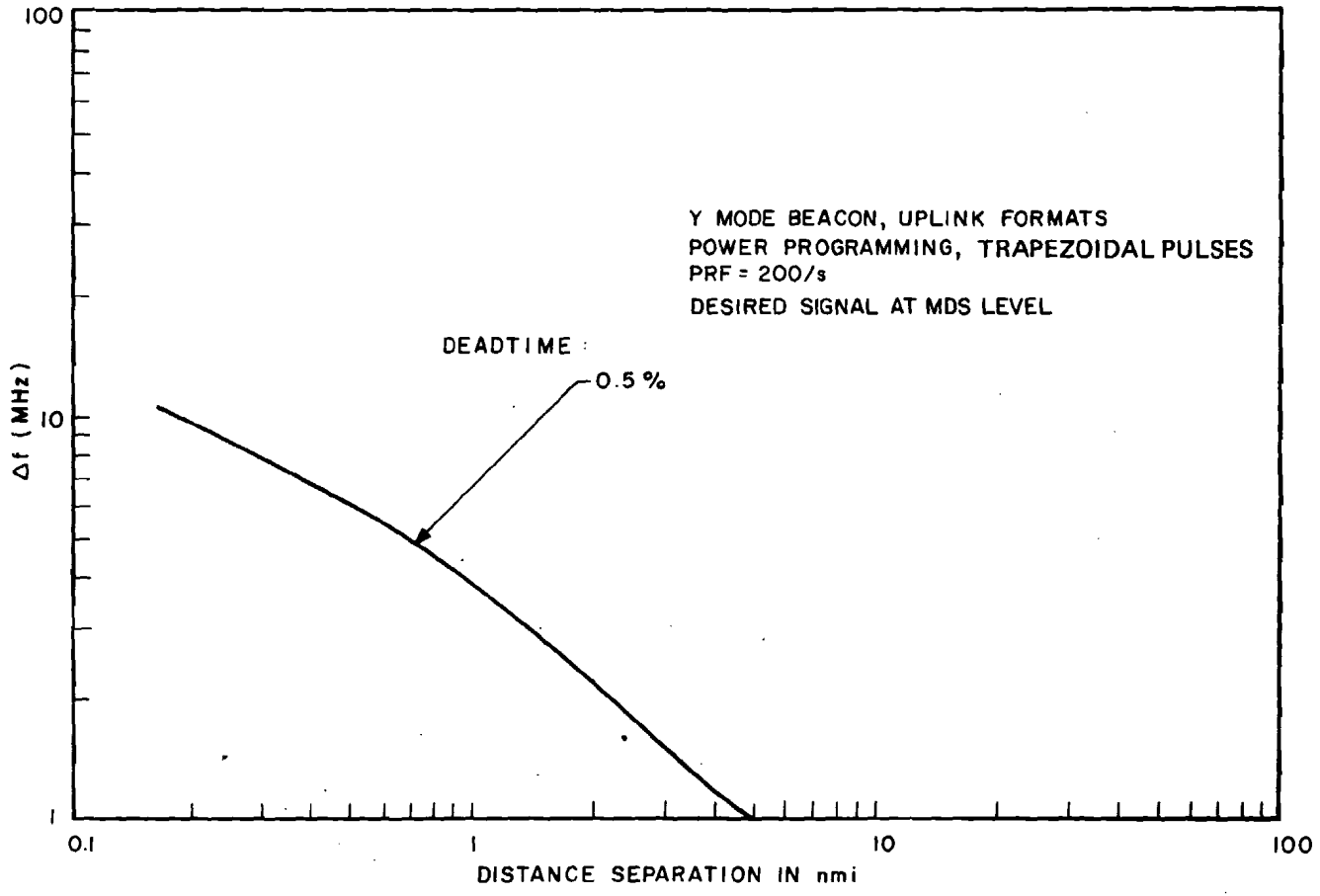

Y MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 200/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME :
0.5 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-40.

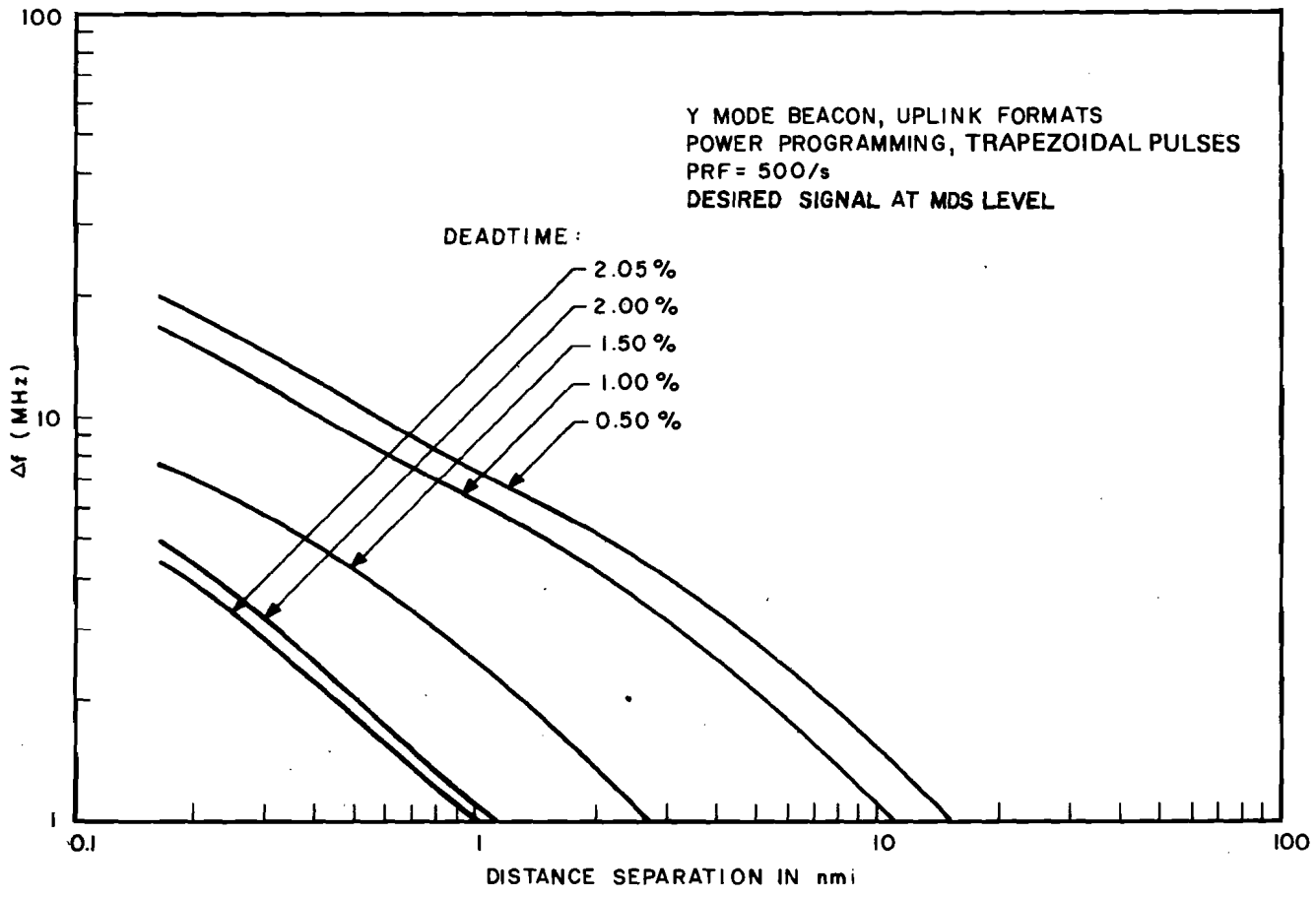

Y MODE BEACON, UPLINK FORMATS
POWER PROGRAMMING, TRAPEZOIDAL PULSES
PRF = 500/s
DESIRED SIGNAL AT MDS LEVEL
DEADTIME:
2.05 %
2.00 %
1.50 %
1.00 %
0.50 %
Δf (MHz)
100
10
1
0.1
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-41.

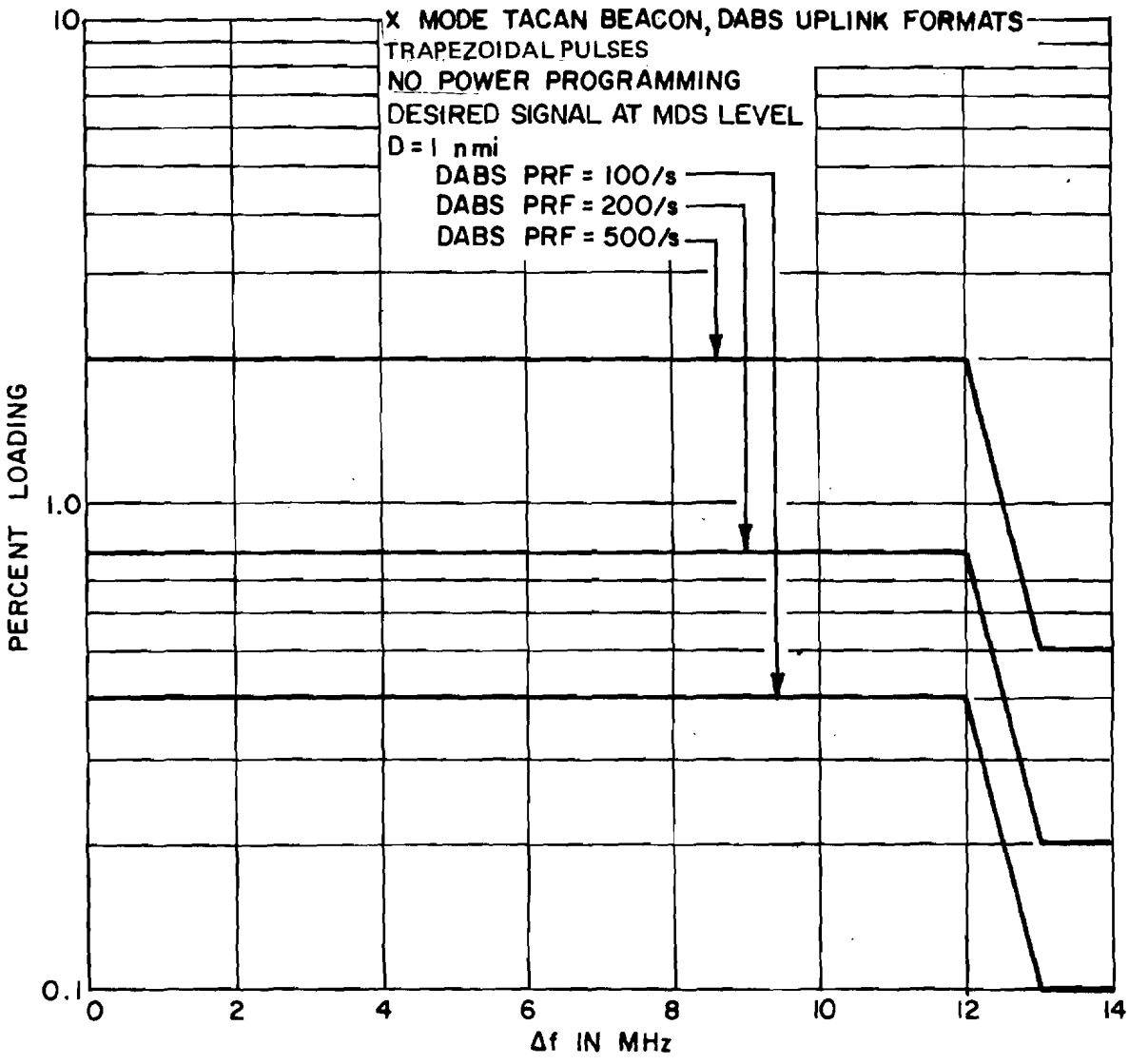

X MODE TACAN BEACON, DABS UPLINK FORMATS
TRAPEZOIDAL PULSES
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
D = 1 nmi
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
PERCENT LOADING
10
1.0
0.1
0
2
4
6
8
10
12
14
Δf IN MHz

Figure A-42.

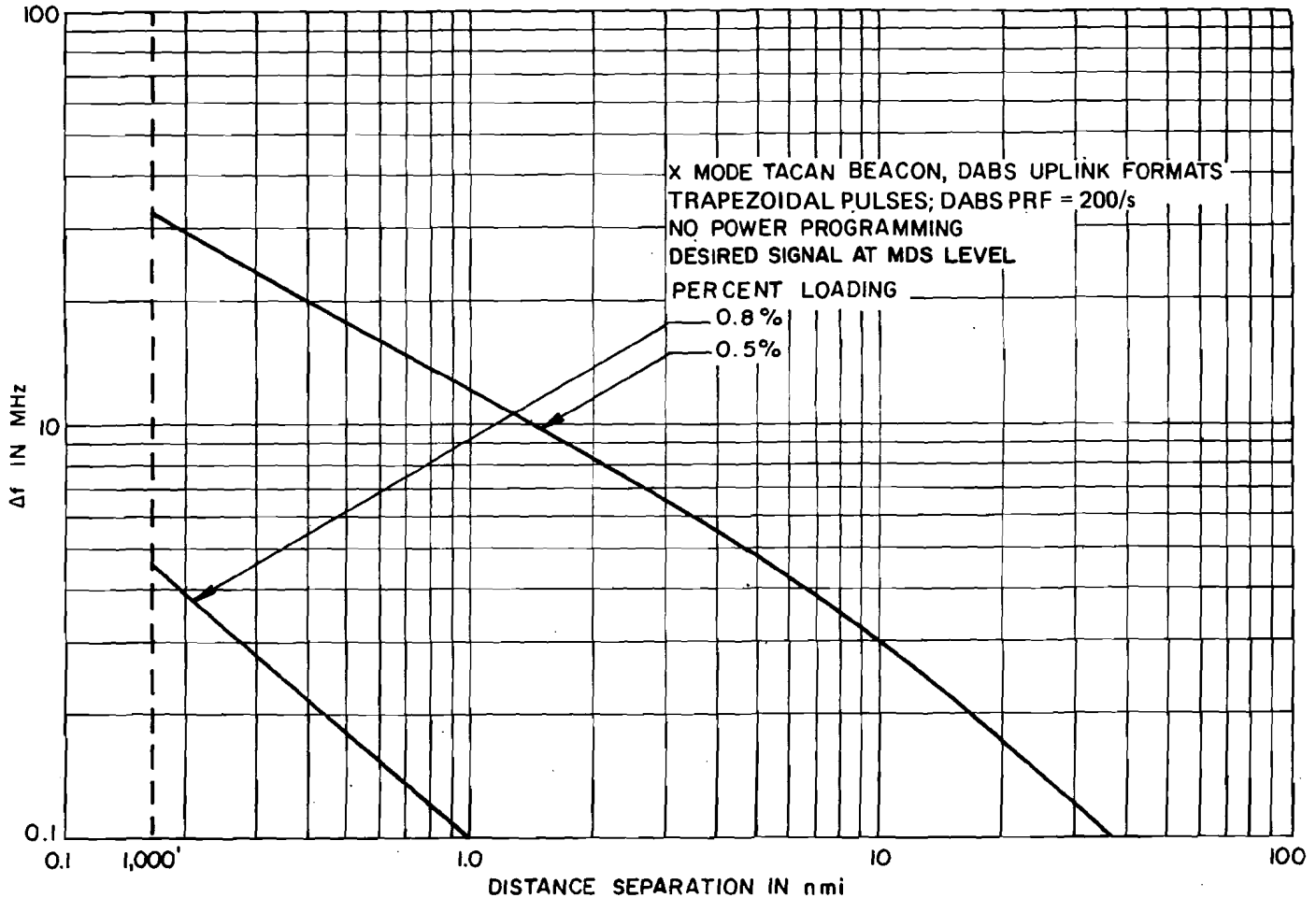

X MODE TACAN BEACON, DABS UPLINK FORMATS
TRAPEZOIDAL PULSES; DABS PRF = 200/s
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
PERCENT LOADING
0.8%
0.5%
100
10
0.1
Δf IN MHz
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi

Figure A-43.

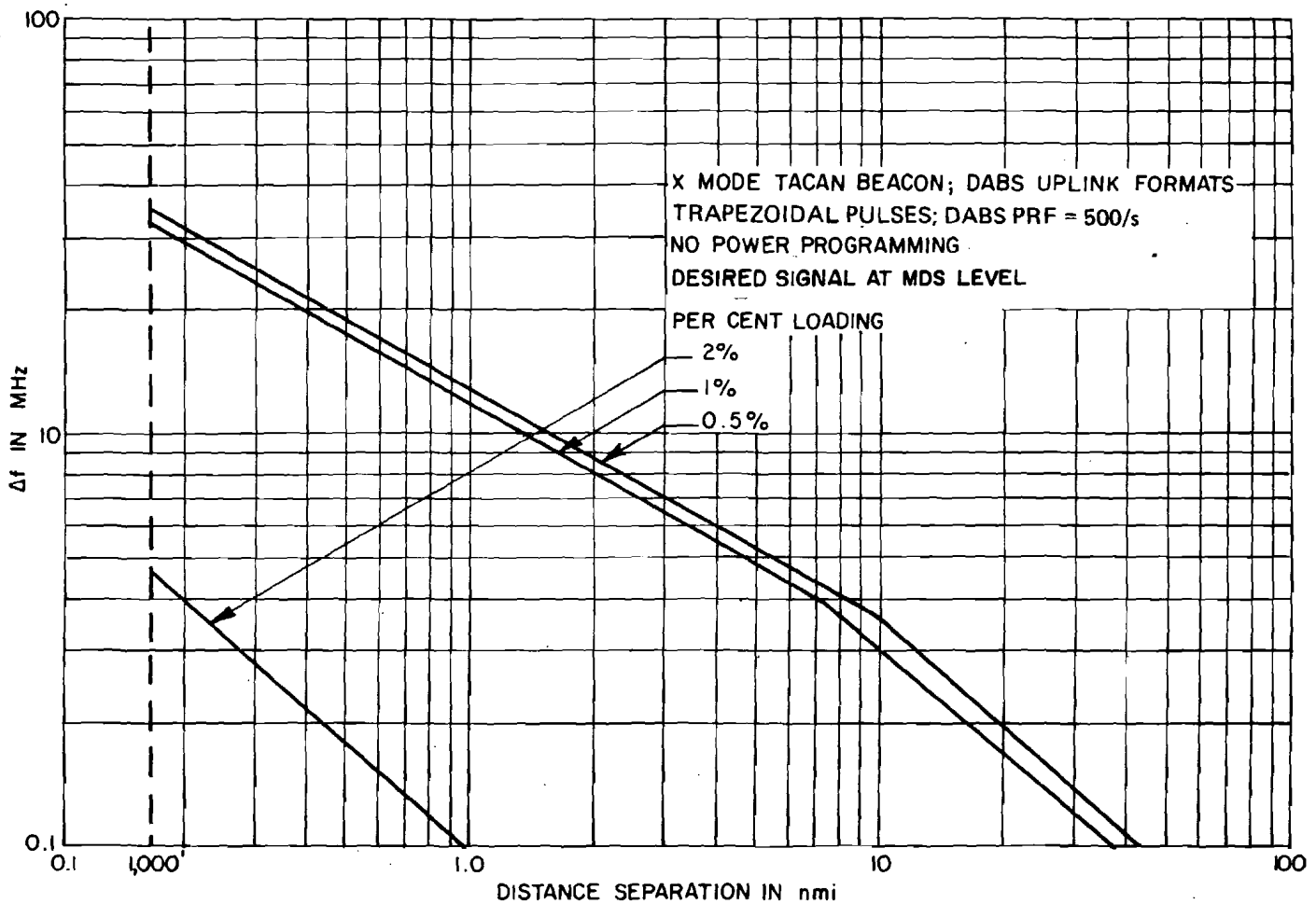

X MODE TACAN BEACON; DABS UPLINK FORMATS
TRAPEZOIDAL PULSES; DABS PRF = 500/s
NO POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
PER CENT LOADING
2%
1%
0.5%
100
10
0.1
Δf IN MHz
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi

Figure A-44.

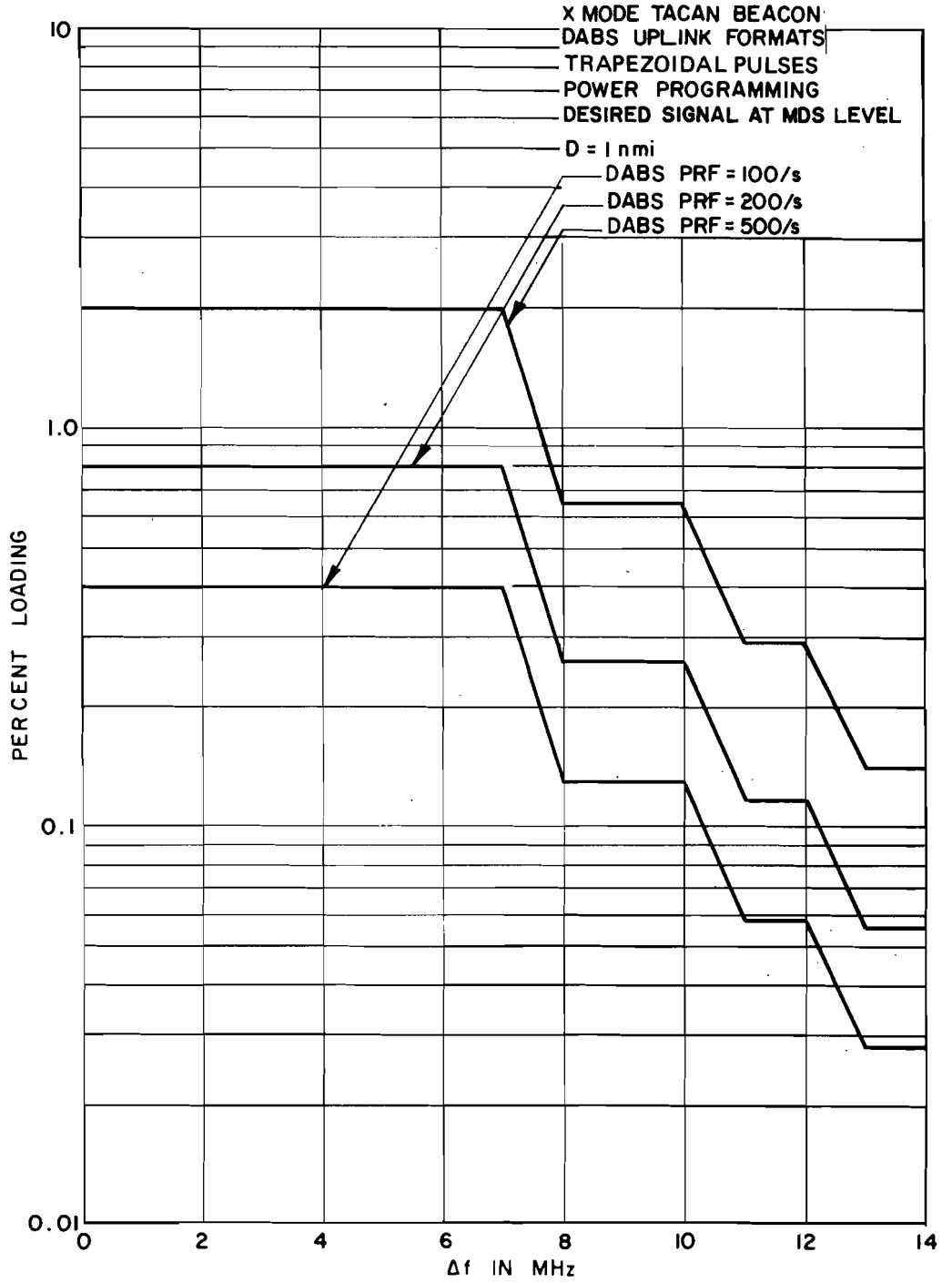

X MODE TACAN BEACON
DABS UPLINK FORMATS
TRAPEZOIDAL PULSES
POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
D = 1 nmi
DABS PRF = 100/s
DABS PRF = 200/s
DABS PRF = 500/s
10
1.0
0.1
0.01
PERCENT LOADING
0
2
4
6
8
10
12
14
Δf IN MHz

Figure A-45.

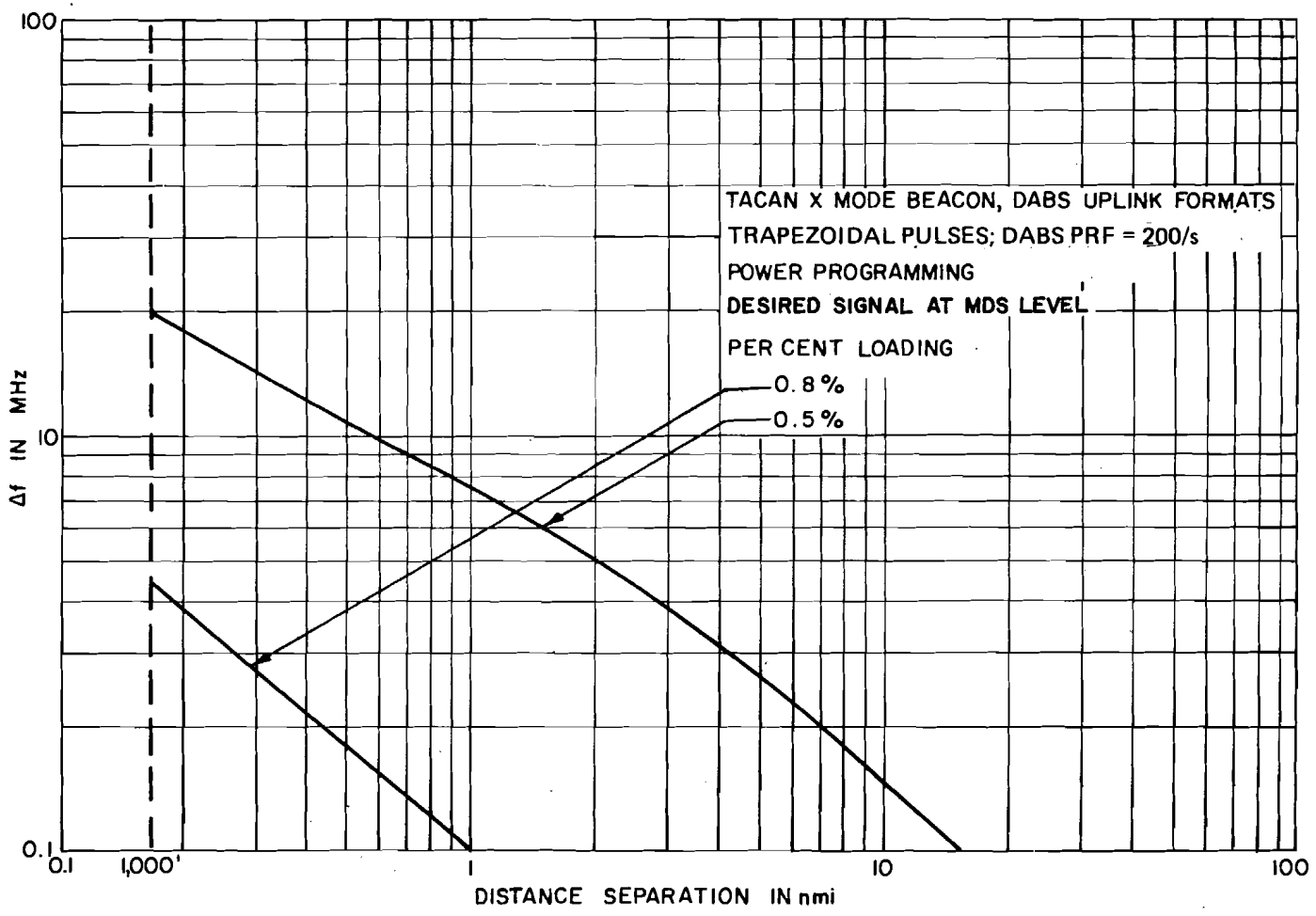

TACAN X MODE BEACON, DABS UPLINK FORMATS
TRAPEZOIDAL PULSES; DABS PRF = 200/s
POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
PER CENT LOADING
0.8 %
0.5 %
100
10
0.1
Δf IN MHz
0.1
1,000'
1
10
100
DISTANCE SEPARATION IN nmi

Figure A-46.

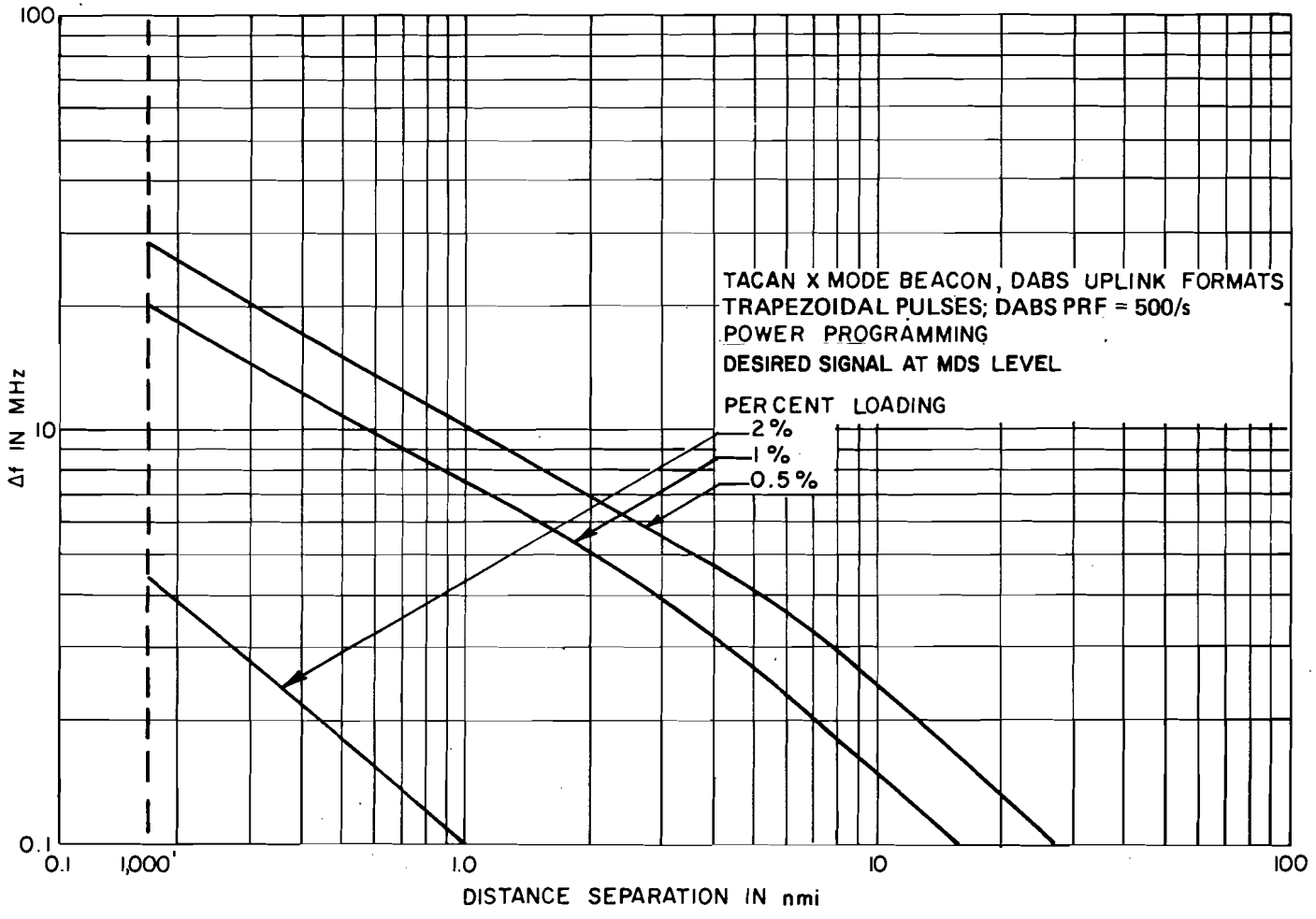

TACAN X MODE BEACON, DABS UPLINK FORMATS
TRAPEZOIDAL PULSES; DABS PRF = 500/s
POWER PROGRAMMING
DESIRED SIGNAL AT MDS LEVEL
PERCENT LOADING
2 %
1 %
0.5 %
100
10
0.1
Δf IN MHz
0.1
1,000'
1.0
10
100
DISTANCE SEPARATION IN nmi

Figure A-47.

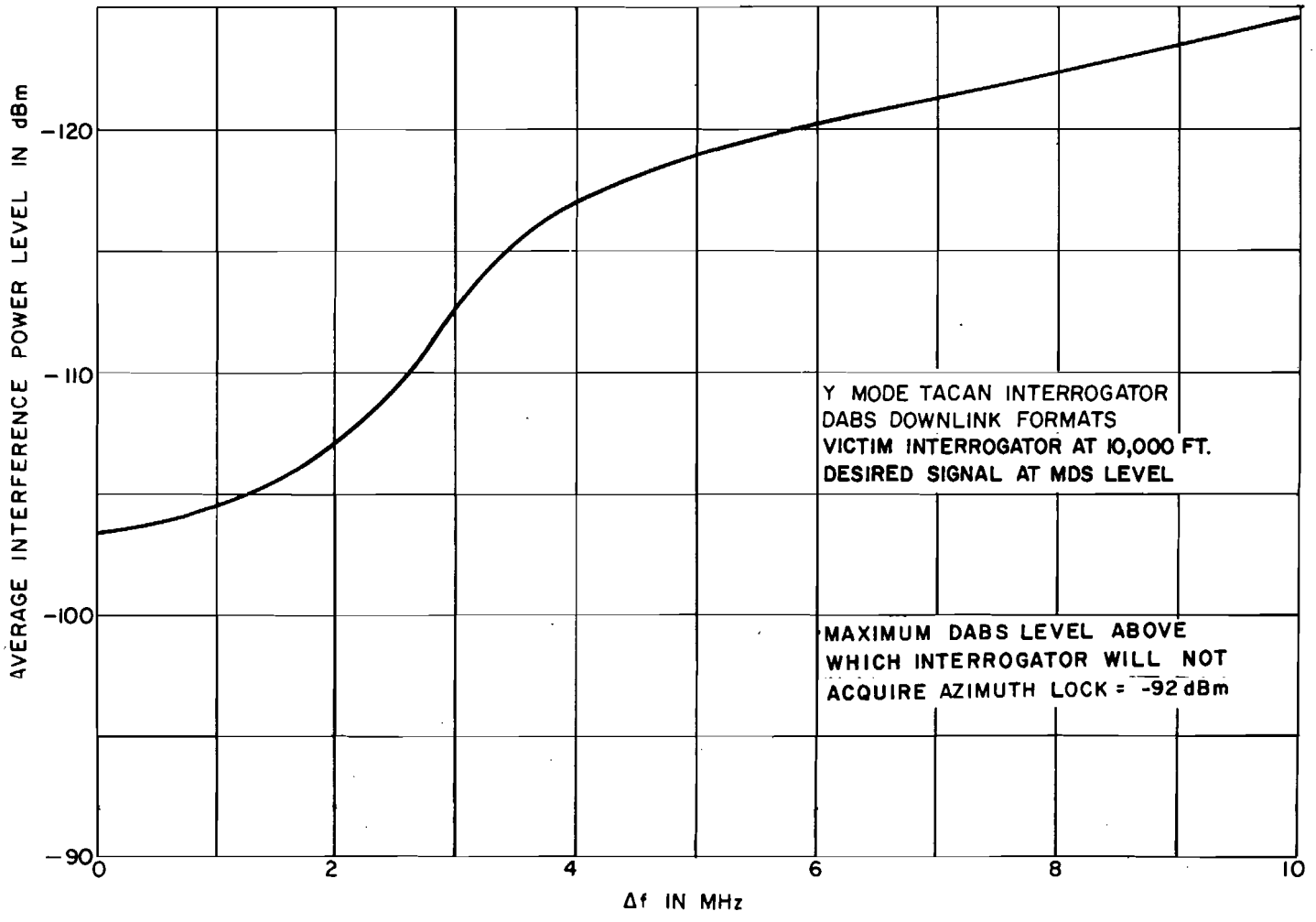

AVERAGE INTERFERENCE POWER LEVEL IN dBm
-120
-110
-100
-90
0
2
4
6
8
10
Δf IN MHz
Y MODE TACAN INTERROGATOR
DABS DOWNLINK FORMATS
VICTIM INTERROGATOR AT 10,000 FT.
DESIRED SIGNAL AT MDS LEVEL
MAXIMUM DABS LEVEL ABOVE
WHICH INTERROGATOR WILL NOT
ACQUIRE AZIMUTH LOCK = -92 dBm

Figure A-48.

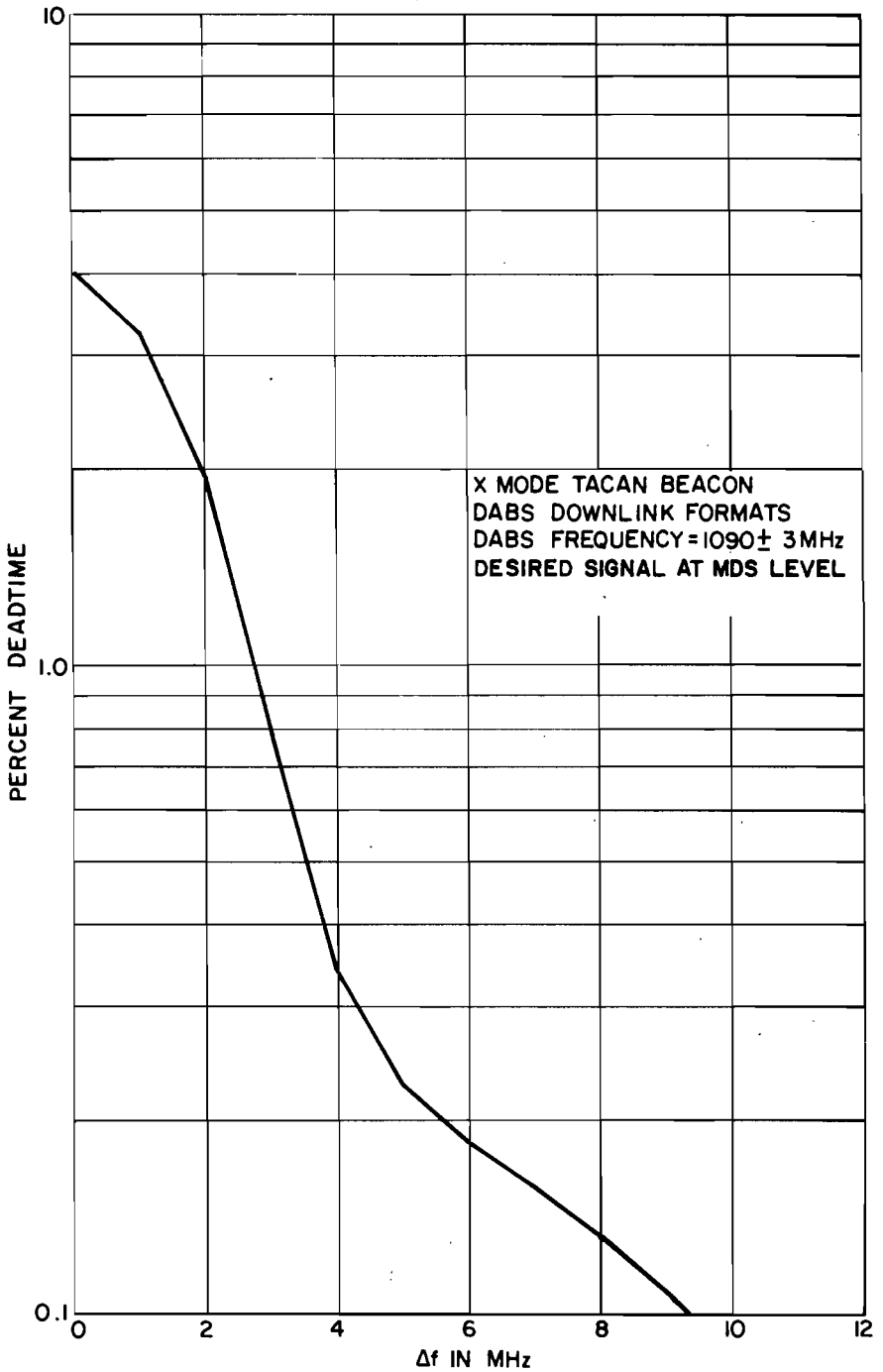

10
1.0
0.1
PERCENT DEADTIME
0
2
4
6
8
10
12
Δf IN MHz
X MODE TACAN BEACON
DABS DOWNLINK FORMATS
DABS FREQUENCY = 1090 ± 3 MHz
DESIRED SIGNAL AT MDS LEVEL

Figure A-49.

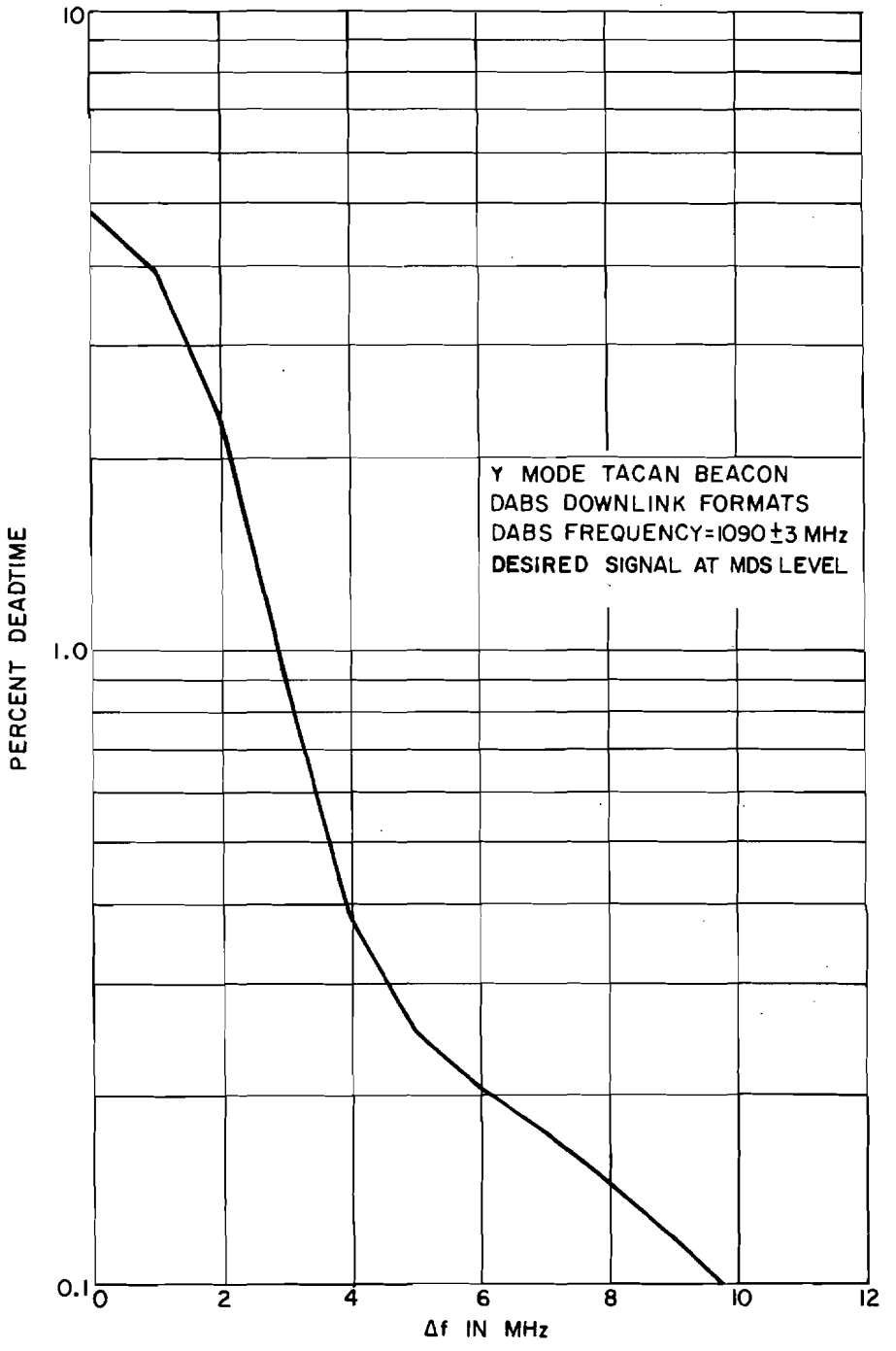

10
1.0
0.1
PERCENT DEADTIME
0
2
4
6
8
10
12
Δf IN MHz
Y MODE TACAN BEACON
DABS DOWNLINK FORMATS
DABS FREQUENCY=1090±3 MHz
DESIRED SIGNAL AT MDS LEVEL

Figure A-50.

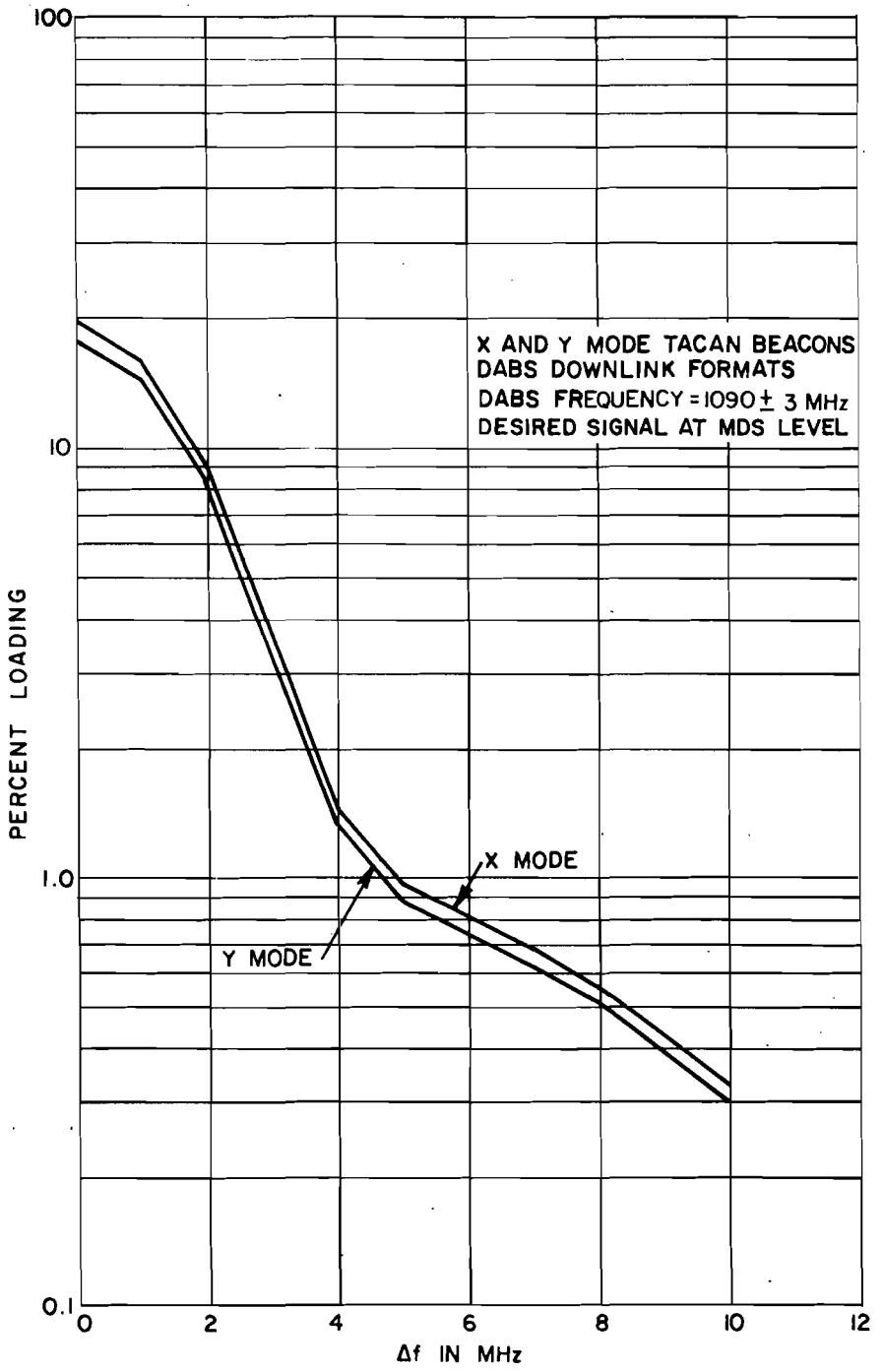

100
10
1.0
0.1
PERCENT LOADING
0
2
4
6
8
10
12
Δf IN MHz
X AND Y MODE TACAN BEACONS
DABS DOWNLINK FORMATS
DABS FREQUENCY = 1090 ± 3 MHz
DESIRED SIGNAL AT MDS LEVEL
X MODE
Y MODE

Figure A-51.