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COMPUTER SIMULATOR FOR A MOBILE TELEPHONE SYSTEM

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Final Report



Donald L. Schilling
Professor of Electrical Engineering
Principal Investigator

Chaim Ziegler
Assoc. Prof. of Computer Science
Co-Principal Investigator

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COMMUNICATIONS SYSTEMS LABORATORY
DEPARTMENT OF ELECTRICAL ENGINEERING

The City College
New York, N.Y. 10031



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1. Introduction

This project is the result of a joint effort between the Department of Electrical Engineering at the City College, CUNY; and the Department of Computer & Information Science at the Brooklyn College, CUNY.

The goal of this project is to develop a software simulator to help NASA in the design of the LMSS. The simulator will be used to study the characteristics and implementation requirements of the LMSS's configuration with specifications as outlined by NASA.

This report represents progress made in implementing the simulator during the period 4/21/82 - April 19, 1983.

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2. The Present Simulator -----

The basic components of the present simulator were described previously in the first report (NASA Grant: NAG 3-119). However, previously, not all the components of the system were operational and only scenario 1 was implemented.

The current simulation now includes all the components, such as the interference sources, the S-band channels, the noise sources, the gateways, a revised master controller for the simulator, as well as other components which were recently completed.

The present simulator is now capable of executing all 5 scenarios, which are described below .

2.1 The Communication Scenarios -----

Through the use of the five scenarios, it is possible to study all the different possible combinations of types and modes of calls. The five scenarios are described below:

(1). Single Hop System:

For those calls which require the communication between two mobile units, without going through a gateway, we group them together and form scenario 1. In this scenario, a mobile will generate a call, for which the call will go up to the satellite, and be transponded down directly to the destination mobile. This can be seen in

figure 2.1.

(2). Double Hop, Single Gateway System:

For those calls which require communication between two mobile units by going through a gateway, we group the together and form scenario 2. In this scenario, a mobile will initiate a call, which will be transponded by the satellite to a gateway. After processing by the gateway, the call is once again transponded by the satellite to the destination mobile. This can be seen in figure 2.2.

(3). Double Hop, Double Gateway System:

For those calls which have to go through two gateways, we form scenario 3. In this scenario a mobile will generate a call, which is transponded to a gateway. The gateway forwards the call to the master control station. The master control station then routes the call to the destination gateway. Then the call is once again transponded by the satellite to the destination mobile. This can be seen in figure 2.3.

(4). Mobile-to-Wireline System

For any call that was initiated by a mobile and was desired to go through a fixed phone or to a mobile serviced by the cellular system, we have scenario 4. In this scenario, the call is initiated by the mobile and transponded by the satellite to a gateway. Then, the gateway forwards the call into the wireline network. This can be seen in figure 2.4.

(5). Wireline-to-Mobile System:

If a call is initiated by a fixed phone or mobile in a cellular system to a mobile in the LMSS, we resort to scenario 5. In this scenario a call is received from the wireline telephone network into a gateway. The call is then transponded by the satellite to the destination mobile. This can be seen in figure 2.5.

2.2 Output Facilities

Also new in the present simulator is the revised version of the Master Controller (see 4.1.2, first report). In the present simulator it is possible to go through a range of values for any one of the components in the scenario. It is possible to consider a range of values for up to 14 different components simultaneously. Previously, if a type 2 measurement was chosen, the simulator would display a two column table of the input vs output SNR values, for a given set of system parameters. With the present simulator it is possible in a type 2 measurement for the simulator to display up to 15 columns (15th column is output signal to noise ratio), one for each range of component values. In the present simulator, it is also possible to get plots of the input vs. output SNR values for any range of values of the other components (see section 5, "Sample Runs"). The looping or ranging feature mentioned above can also be used in a type 1 measurement, where the input signal, output signal (no disturbances present), and output signal (with all specified disturbances) are displayed in a table. It is now possible to consider a type 1 measurement over a range of values (up to 14 possible ranges of parameters). Once again, a plotting facility is available for every type 1 measurement table displayed (see section 5, "Sample Runs").

The revised master controller function has the following algorithm:

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/SIMULATION MASTER CONTROLLER FUNCTION/:

<initialize simulation master controller function>

- DO <range of Specular-to Multipath Power Ratio--UHF Uplink >
- <range of Specular-to-Multipath Power Ratio--S-Band Downlink>
- <range of Specular-to-Multipath Power Ratio--S-Band Uplink>
- <range of Specular-to-Multipath Power Ratio--UHF Downlink>
- <range of carr.-to-interf. power ratio--UHF Uplink Interference>
- <range of phase values--UHF Uplink Interference >
- <range of carr.-to-interf. power ratio--S-Band Downlink Interf>
- <range of phase values--S-Band Downlink Interference>
- <range of carr.-to-interf. power ratio--S-Band Uplink Interf.>
- <range of phase values--S-Band Uplink Interf.>
- <range,of carr.-to-interf. power ratio--UHF Downlink Interf>
- <range of phase values--UHF Downlink Interf.>
- <RANGE OF SNR >
- <calculate SNR>
- <calculate standard deviation for white noise>
- <perform simulation reset>
- <set flag for mobile transmitter>
- <PERFORM a simulation run>
- <perform master controller instrumentation package>

END <signal to noise ratio>

END /simulation master controller function/

2.3 System Structure

The present modular structure can be seen in the flowchart of figure 2.6, with its subroutines defined in table 2.7.

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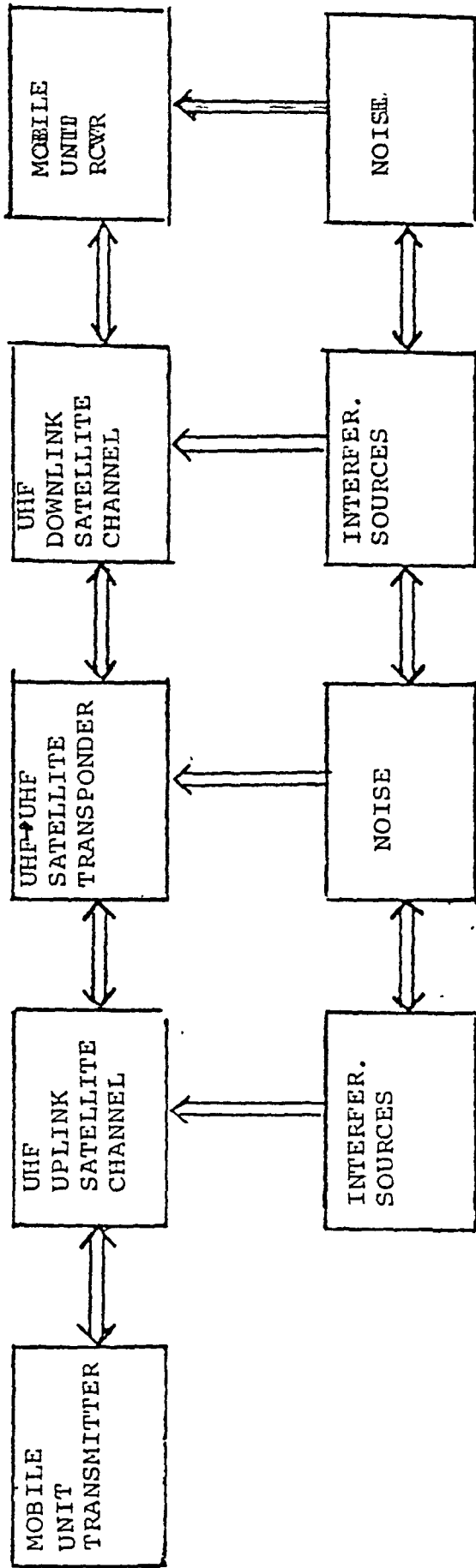
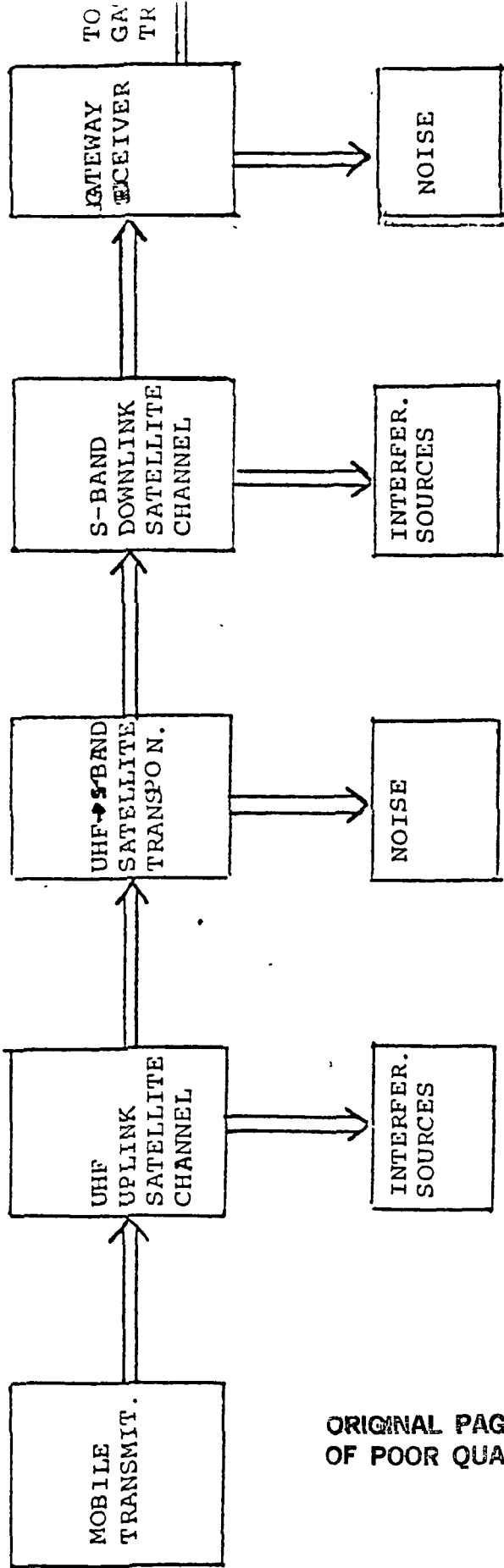


Figure 2.1 ; Single Hop Single Gateway System



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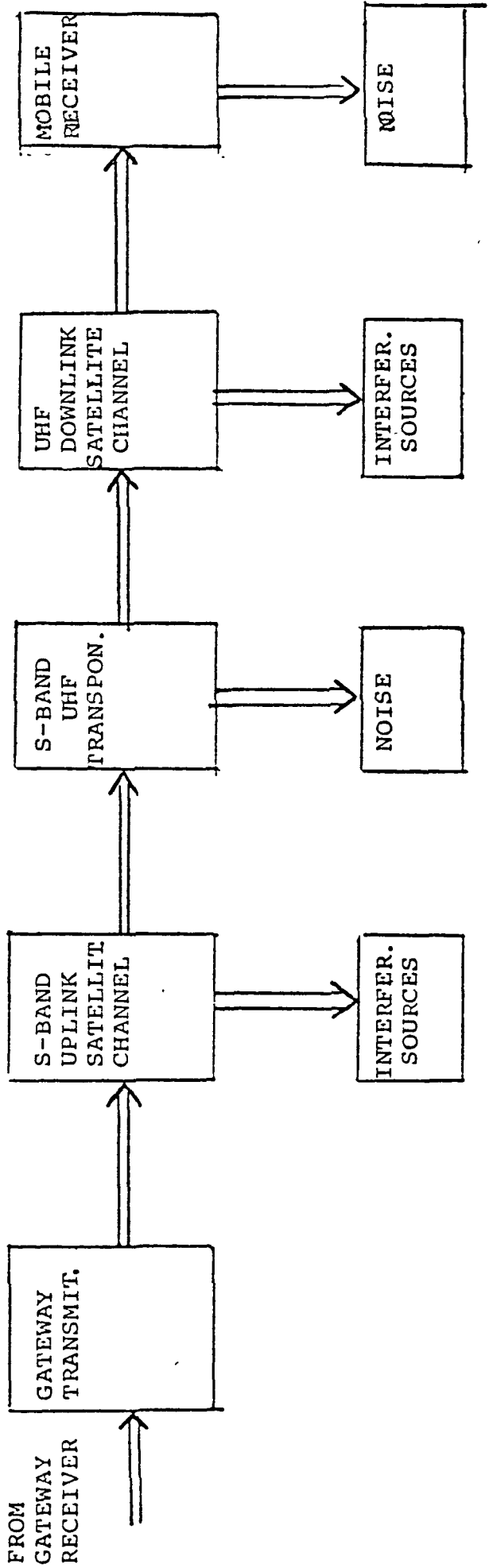


Figure 2.2: Double Hop Single Gateway

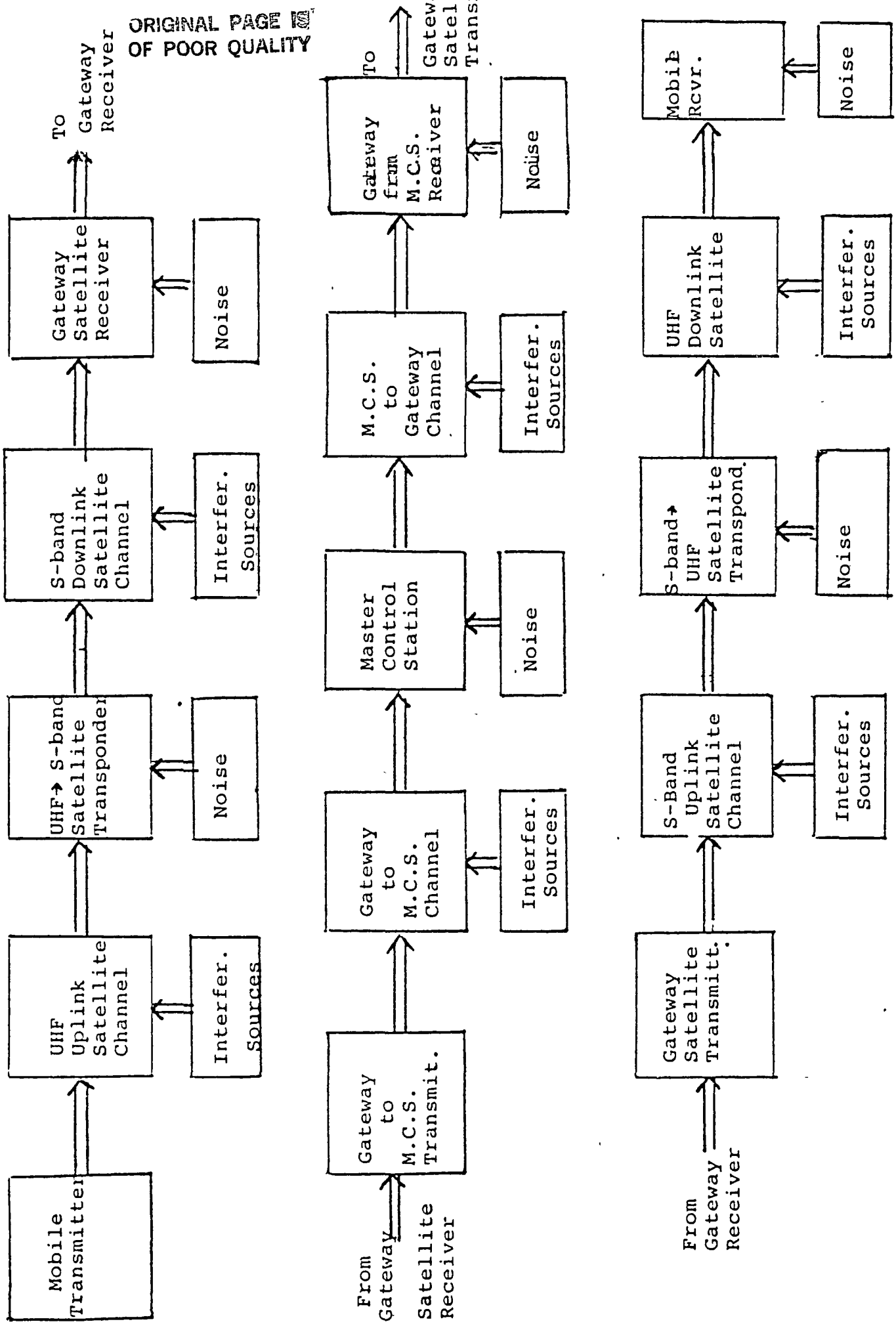
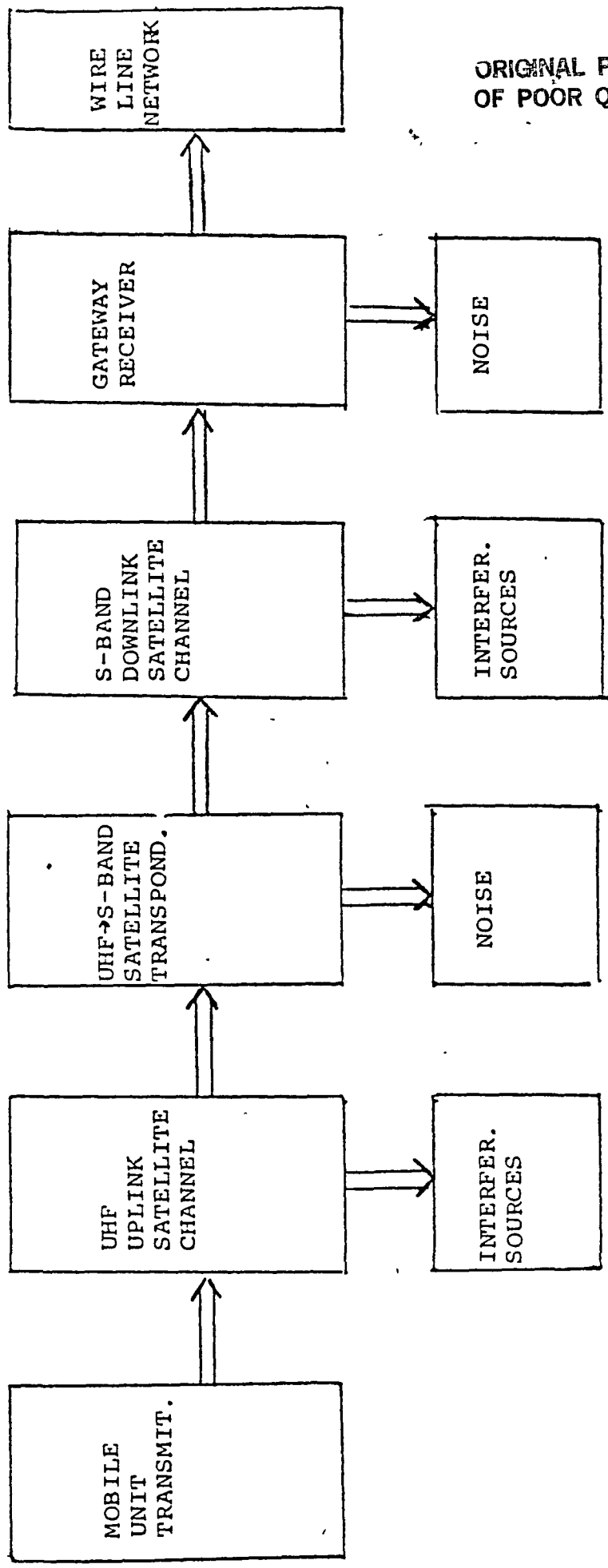
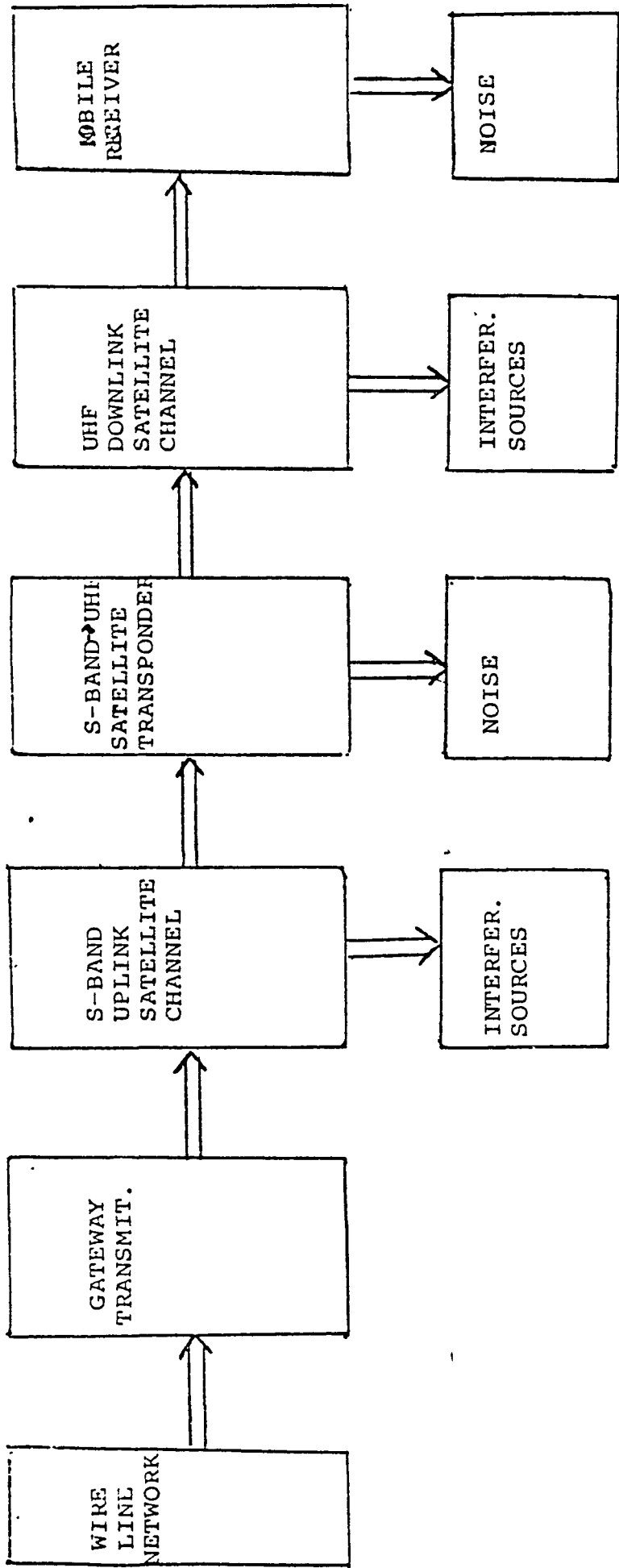


Figure 2.3 : Double Hop Double Gateway



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Figure 2.4 : Mobile to Wireline System



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Figure 2.5 : Wireline to Mobile System

 SET-UP ROUTINES FOR EACH
 SCENARIO

(1)

SCENARIO 1

```

SETMSX----->SETSSG
SETIS1          SETMOD
SETUSC---->SETCFG    SETSPX--->SETCOM
SETNG1    SETFAD    SETNL      SETEMP
SETUUT          SETFLR    SETDEL
SETIS6          SETPDL
SETSUC---->SETCFG
SETNG6    SETFAD
SETMSR----->SETRSP
          SETFMD
          SETRCF
          SETSPR--->SETDPH
          SETEXP
  
```

SCENARIO 2

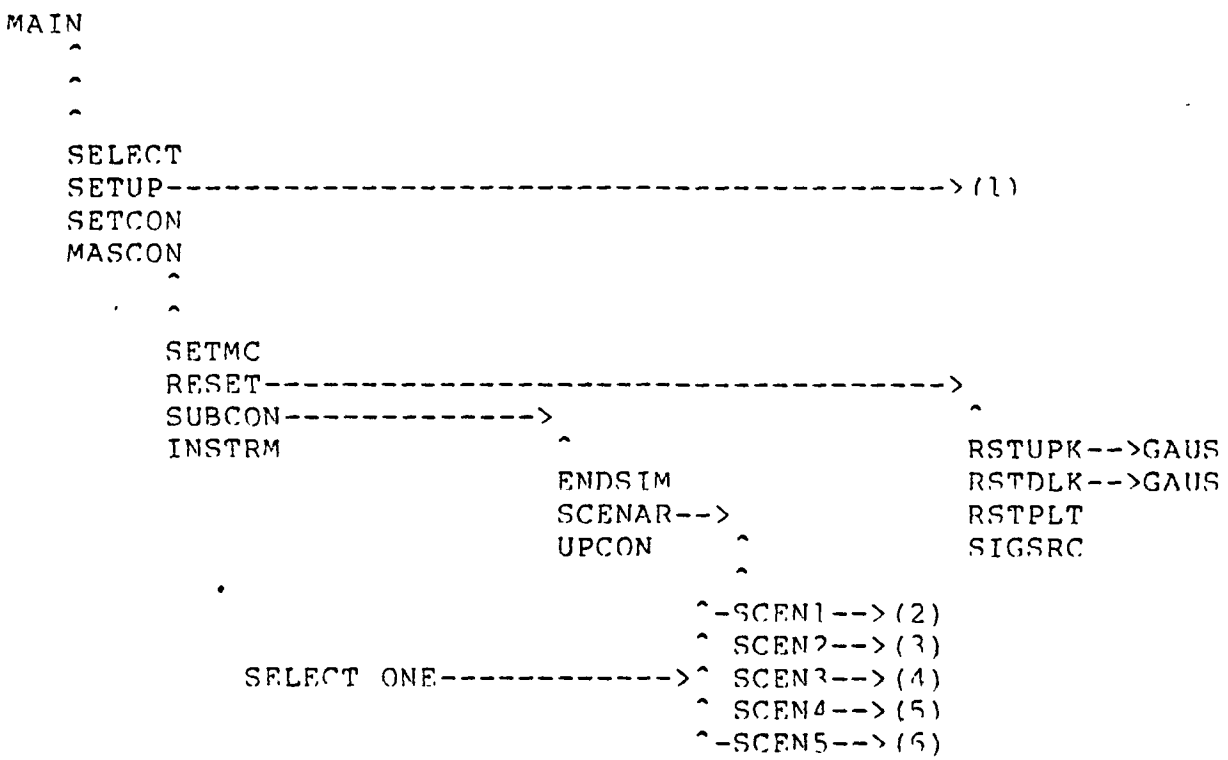
```

SETMSX----->SETSSG
SETIS1          SETMOD
SETUSC---->SETCFG    SETSPX--->SETCOM
SETNG1    SETFAD    SETNL      SETEMP
SETUBT          SETFLR    SETDEL
SETIS2          SETPDL
SETSBC
SETNG2
SETGSR
SETGAT
SETGSX
SETIS5
SETBSC
SETSUT
SETIS6
SETSUC---->SETCFG
SETNG6    SETFAD
  
```

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***** LMSS SIMULATOR *****

FLOW CHART OF LMSS SIMULATOR



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```

SETMSR----->SETRSP
                SETFMD
                SETRCF
                SETSPR---->SETDPH
                                SETEXP

```

SCENARIO 3

```

SETMSX----->SETSSG
SETIS1
SETUSC----->SETCFG
SETNG1      SETFAD
SETUBT
SETIS2
SETSBC
SETNG2
SETGSR
SETGAT
SETGCX
SETIS3
SETGCC
SETNG3
SETMCS
SETIS4
SETCGC
SETNG4
SETGCR
SETGSX
SETIS5
SETRSC
SETNG5
SETSUT
SETIS6
SETSUC----->SETCFG
SETNG6      SETFAD
SETMSR----->SETRSP
                SETFMD
                SETRCF
                SETSPR---->SETDPH
                                SETEXP

```

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SCENARIO 4

```

SETMSX----->SETSSG
SETIS1          SETMOD
SETUSC----->SETCFG  SETSPX---->SETCOM
SETNG1      SETFAD  SETNL      SETEMP
SETUBT          SETFLR      SETDEL
SETIS2          SETPDL
SETSRC
SETNG2
SETGSR
SETGAT
SETWNR

```

SCENARIO 5

```

SETWNX
SETGAT
SETGSX
SETIS5
SETBSC
SETNG5
SETSUT
SETIS6
SETSUC----->SETCFG
SETNG6      SETFAD
SETMSR----->SETRSP
              SETFMD
              SETRCF
              SETSPR----->SETPDH
                          SETEXP

```


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 * * * * *
 ** SCENARIO 1 **
 * * * * *

(2)

```

^
^
^
MSXMTR----->SIGSRC
INTFS1
UPMTSC----->FADE      SIPRXT----->COMPRS
NOISE1          MPCOEFF  MODS1G----->PHASE  PEMPHA
SATLT          ^        NONLIN      QUAD      DEVLIM
INTFS6          ^        FLTR          ,      PDEVLI
DNSTMC----->          GAUS
NOISE6----->          ^        DOPFLT
MSRCVR----->          ^        ^
INSTRS          ^        ^
          ^        ^        FADE---->MPCOEFF----->GAUS
          ^        ^        FADE---->          DOPFLT
          ^        ^
          ^        ^        MPCOEFF----->GAUS
          ^        ^        DOPFLT
          ^        ^
          ^        GAUSS
          ^        GAUSS
          ^
RSPDIV----->LPFLT1
FMDEMO----->FMDCRT      LPFLT1
SIPRRC---->DEMPH1      RCFLTR-->LPFLT
          EXPAND
  
```


*
** SCENARIO 2 **
*

(3)
^
^
^
^

```

MSXMTR----->SIGSRC
INTFS1          SIPRXT----->COMPRS
UPMTSC--->FADE  MODSIG--->  PEMPHA
NOISE1   MPCOEFF--->GAUS  NONLIN   ^   DEVLIM
SATLT           DOPFLT    FLPTR      ^   PDEVLI
INTFS2
DNSTGC
NOISE2
GSRCVR          PHASE
GATE            QUAD
GSXMTR
INTFS5
UPGTSG
NOISE5
SATLT
INTFS6
DNSTMC----->FADE----->
NOISE6----->GAUSS   FADE----->  ^
MSRCVR----->   GAUSS           ^   ^
INSTRS          ^   MPCOEFF      ^   ^
               ^           GAUS    ^   ^
               ^           DOPFLT  ^   ^
               ^           MPCOEFF ^   ^
               ^           GAUS    ^   ^
               ^           DOPFLT  ^   ^
               ^           MPCOEFF ^   ^
               ^           GAUS    ^   ^
               ^           DOPFLT  ^   ^

```

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RSPDIV-----> ^
FMDEMO-----> ^
SIPRRC-----> ^
^ ^ LPFLT1
^ ^ LPFLT1
^ ^ CHOICE
^ ^ FMDCRI
^ ^ RCFLTR
^ ^ LPFLT
DEMPHA--> ^
EXPAND ^
^ LPFLT2

* *
** SCENARIO 3 **
* *

(4)

^
^
^
^

MSXMTR----->SIGSRC
INTFS1
UPMTSC----->FADE
NOISE1 ^
SATLT MPCOEFF ^
INTFS2 ^
DNSTGC GAUS PHASE
NOISE2 DOPFLT QUAD
GSRCVR
GATE

```

SCXMTR
INTFS3
GTCC
NOISE3
MSTRCS
INTFS4
CTGC
NOISE4
GCRCVR
GATE
GSXMTR
INTFS5
UPGTSC
NOISE5
SATLT
INTFS6
DNSTMC----->FADE----->
NOISE6----->GAUSS          FADE-----> ^
MSRCVR----->          GAUSS          ^     MPCOEFF
               ^
               ^
               ^           MPCOEFF     GAUS
               ^           ^           DOPFLT
RSPDIV----->
FMDEMO----->
SIPRRC-->          ^           LPFLT1
               ^           LPFLT1
               ^           CHOICE
               ^
               ^           FMDCRI
               ^           RCFLTR---->LPFLT
               ^
DEMPHA--->LPFLT?
EXPAND
  
```


* * * * *
** SCENARIO 4 **
* * * * *

(5)

^
^
^
^

MSXMTR----->	SIGSRC
INTFS1	SIPRXT----->
UPMTSC----->FADE	MODSIG--> ^
NOISE1 ^	NONLIN ^ ^
SATLT MPCOEFF ^	FLPTR ^ ^
INTFS2	^ ^
DNSTGC GAUS	^ COMPRS
NOISE2 DOPFLT	^ PEMPFA
GSRCVR	^ DEVLTM
GATE	^ PDEVLT
WNCVR	^
INSTRS	^
	PHASE
	QUAD

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* * * * *
** SCENARIO 5 **
* * * * *

(6)

^
^
^
^

WNMXTR
GATE
GSXMTR
INTFSS
UPGTSC
NOISE5
SATLT
INTFS6

```

DNSTMC----->FADE---->
NOISE6----->GAUSS          FADE      ^
MSRCVR----->          GAUSS          ^      MPCOEFF
INSTRS      ^          ^          ^      ^
            ^          ^          ^      ^      GAUS
            ^          ^          ^      ^      DOPFLT
            ^          ^          ^
RSPDIV----->          ^          ^      MPCOFF
FMDEMO----->          ^          ^      ^
SIPRRC-->          ^          ^          ^      GAUS
            ^          ^          ^          ^      DOPFLT
            ^          ^          ^
            ^          ^          ^      LPFLT1
            ^          ^          ^      LPFLT1
            ^          ^          ^      CHOICE
            ^          ^          ^
            ^          ^          ^      FMDCRI
            ^          ^          ^      RCFLTR---->LPFLT
            ^
DEMPHA----->LPFLT?
EXPAND

```


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LMSS SIMULATOR

Subprocedures Dictionary:

- CHOICE space diversity receiver controller
- CTGC master control station to gateway channel
- DNSTGC S-band downlink satellite channel
- DNSTMC UHF downlink satellite channel
- ENDSIM test if it is end of simulation
- FLTR quadrature components filtered
- FMDCRI FM discriminator
- FMDEMO FM demodulator
- GATE gateway
- GAUSS gaussian generator
- GCRCVR gateway from master control station rcvr
- GCXMTR gateway to master control station xmtr
- GSRCVR gateway from satellite rcvr
- GSXMTR gateway to satellite xmtr
- GTCC gateway to master control station channel
- INSTRM update simulation master-control report
- INSTRS update simulation sub-control report
- INTFS1 interference sources 1
- INTFS2 interference sources 2
- INTFS3 interference sources 3
- INTFS4 interference sources 4
- INTFS5 interference sources 5
- INTFS6 interference sources 6
- MASCON simulation master control function
- MODSIG modulation of the input sample
- MSRCVR mobile from satellite rcvr
- MSTRCS master control station
- MSXMTR mobile to satellite xmtr
- NOISE1 noise generator 1
- NOISE2 noise generator 2
- NOISE3 noise generator 3
- NOISE4 noise generator 4
- NOISE5 noise generator 5
- NOISE6 noise generator 6
- NONLIN nonlinearity routine
- PHASE calculation of the phase angle
- QUAD claculation of the quadrature components
- RANDOM random number generator

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REPORT report generator
 RESET (re)initialization for a simulation run
 RSPDIV space diversity receiver
 SATLT the satellite
 SCENAR scenario execution selection
 SCEN1 scenario 1
 SCEN2 scenario 2
 SCEN3 scenario 3
 SCEN4 scenario 4
 SCEN5 scenario 5
 SELECT selection of call to be simulated
 SETBSC initialize S-band uplink satellite channel
 SETCGC initialize master control station to gateway channel
 SETFLR initialization of the filter
 SETCON initialize the simulation control function
 SETFMD initialization of FMDEMO routine
 SETGAT initialize gateway
 SETGCC initialize gateway to master control station channel
 SETGCR initialize gateway from master control station rcvr
 SETGCX initialize gateway to master control station xmtr
 SETGSR initialize gateway from satellite rcvr
 SETGSX initialize gateway to satellite xmtr
 SETIS1 initialize interference sources 1
 SETIS2 initialize interference sources 2
 SETIS3 initialize interference sources 3
 SETIS4 initialize interference sources 4
 SETIS5 initialize interference sources 5
 SETIS6 initialize interference sources 6
 SETMC initialize simulation master control function
 SETMCS initialize master control station
 SETMOD initialization of modulator
 SETMSR initialize mobile from satellite rcvr
 SETMSX initialize mobile to satellite xmtr
 SETNG1 initialize noise generator 1
 SETNG2 initialize noise generator 2
 SETNG3 initialize noise generator 3
 SETNG4 initialize noise generator 4
 SETNG5 initialize noise generator 5
 SETNG6 initialize noise generator 6
 SETNL initialization of nonlinearity
 SETRCF initialization of RCFLTR routine
 SETRSP initialization of RSPDIV routine
 SETSBC initialize S-band downlink satellite channel
 SETSSG initialization of the signal generator
 SETSUC initialize UHF downlink satellite channel
 SETSUT initialize S-band to UHF satellite transponder
 SETUBT initialize UHF to S-band satellite transponder

SETUP initialization of simulation run
SETUSC initialize UHF uplink satellite channel
SETUUT initialize UHF to UHF satellite transponder
SIGSRC sample generator
SETWNR initialize wireline network rcvr
SETWNX initialize wireline network xmtr
SUBCON simulation sub-control function
UPCON update the simulation control function
UPGTSC S-band uplink satellite channel
UPMTSC UHF uplink satellite channel
WNRRCVR wireline network rcvr
WNXMTR wireline network xmtr

3. Processing Voice Via The Simulation

One of the systems greatest present attributes is its ability to process voice. The present simulator can be utilized to listen to any of the following effects on voice (via each of the five scenarios):

- (a). Listen to the effects of noise.
- (b). Listen to the effects of interference.
- (c). Listen to the effects of modulation.
- (d). Listen to the effects of the fading channel.
- (e). Listen to the effects of filtering on the voice.
- (f). Listen to the effects of the space diversity receiver.
- (g). Listen to the effects of the satellite nonlinearity.
- (h). Listen to the effects of varying sampling rates.
- (i). All combinations of the above.

An analysis of a number of the above tests are included within the report (see section 6.2).

A basic model of how to use the simulation to process voice is shown in figure 3.1. In this model, an analog to digital converter samples voice at a rate of at least 8 kilohertz (minimum sampling rate for voice bandlimited to 4000 Hz.), producing 12 bit samples. In the second stage, these 12 bit samples are converted into 16 bit integer format (IBM format). These 16 bit integers are then read by the LMSS simulator. (see section users manual

for simulator voice setup). The output of the LMSS simulator is then converted from 32 bit floating point form (IBM format) back into a 12 bit integer format by the fourth stage. In the fifth stage, a digital to analog converter with the proper hardware connected, converts the samples into voice. In between each of the above stages, any type of storage device could have been used for intermediate storage.

The system outlined above is general, and actual implementation depends on the particular intermediate systems involved (stages 1,2,4,and 5).

In figure 3.2 we have a detailed block diagram of the specific algorithm we used in implementing what was shown in figure 3.1.

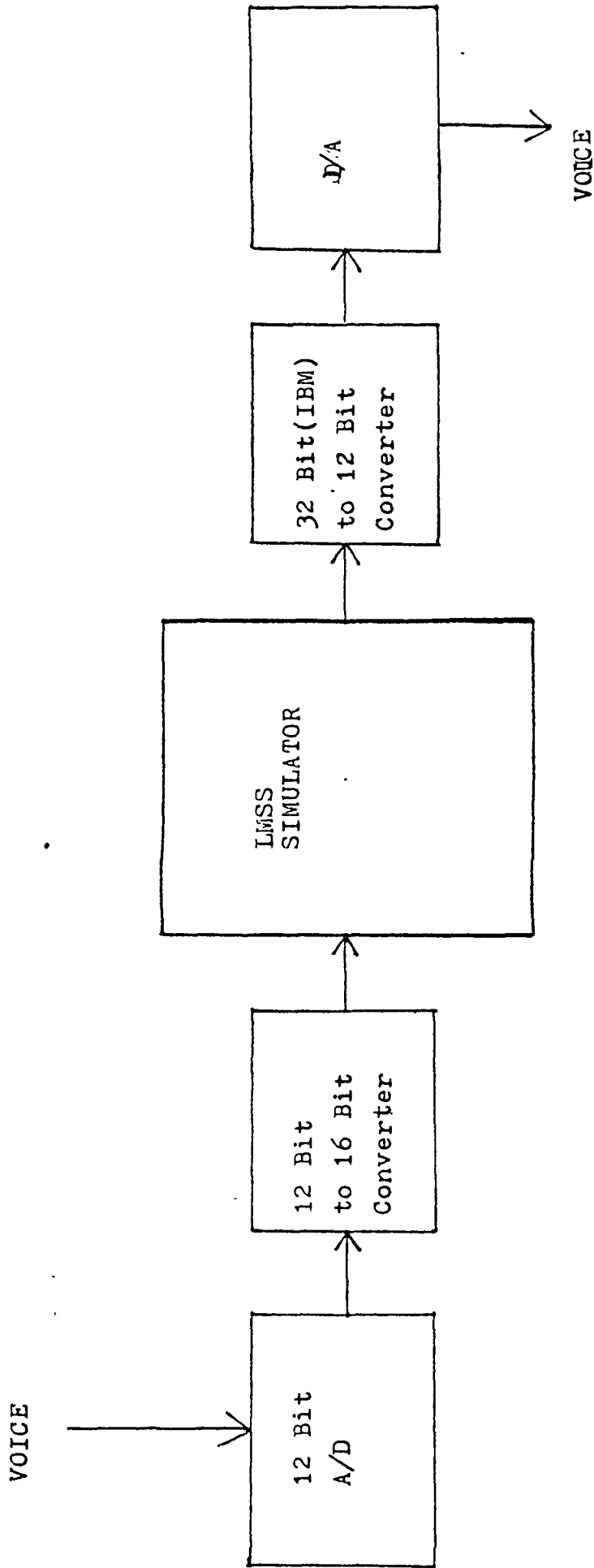
The first stage consisted of a 12 bit analog to digital converter interfaced into a Hewlett Packard 1000 (HP 1000) computer system. This system sampled the voice (bandlimited to 4000 Hz) with a sampling rate of 8 Khz, and stored it on tape with a "WRITT" format (This is an HP utility which stores data onto a tape in an ultra-condensed coded format, which can only be read by another HP system). We had to store it in this form because the system we used didn't have enough storage facility to do it any other way. In the next stage, we used another HP 1000, with much greater storage facility to convert the WRITT format tape into straight ASCII data. For error control and checking purposes, data was stored in the format of an integer (16 bit integer, represented by 4 characters) followed by a space.

This tape was now to be mounted on the IBM machine. We used the program shown in figure 3.3 to convert from ASCII into EBCDIC

(IBM) format. We stored the data on a disc. We then used the LMSS simulator to process the voice samples.

The LMSS simulator has the facility to read in integers (16-bit) in the format mentioned above. The simulator then interpolates between these samples if specified by the user, and then processes them. The output data set is a stream of 32-bit (IBM format) floating point numbers. Module 3.4 (see figure 3.4) is then used to convert this 32-bit data stream into a 16 bit interger data stream (format 16(1x,I4)), with sample values normalized to plus or minus 2047 (12-bit number). Module 3.5 (see figure 3.5) is then used to convert the data from EBCDIC to ASCII format, and stores it on tape. The tape is then read in by module 3.6 (see figure 3.6) using the HP-1000. This module converts data into the format needed by the digital to analog converter. Then finally the D/A converts the samples back to voice.

All the above steps were needed because of code conversions between machines as well as numerical format (the IBM is a 32-bit machine while the HP-1000 is a 16-bit machine). Ideally, one would use the setup of figure 3.1 if the proper equipment is attainable.



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3.1 Voice Processing Set Up

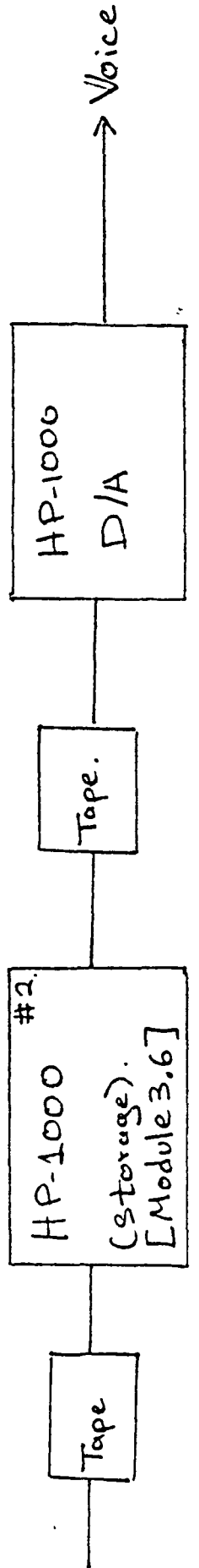
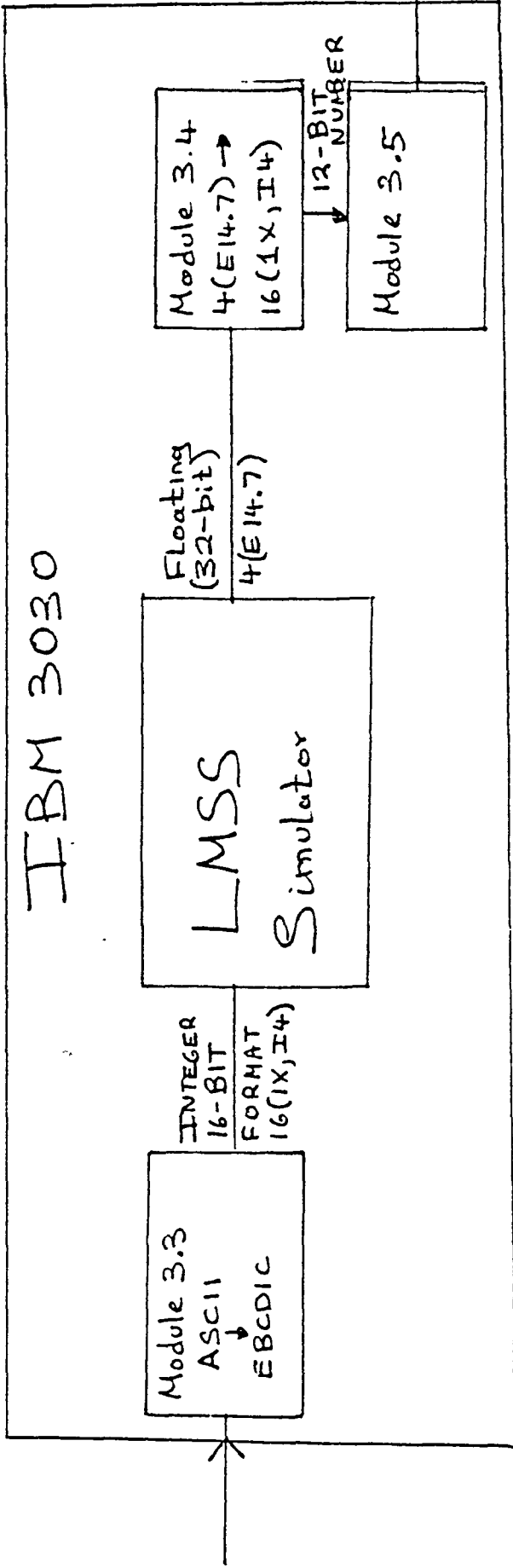
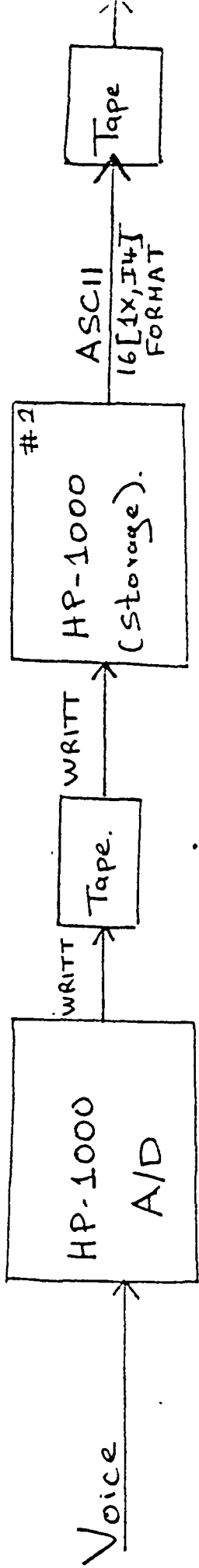


Figure 3.3

This program reads a tape in ASCII format, and converts it to a file in EBCDIC format. (file: TAPRD)

```

//JOB
//STEP1 EXEC PGM=PRESS
//SYSPRINT DD SYSOUT=A
//SYSTN DD DUMMY
//SYSUT1- DD DSN=ONE-DISP=(OLD,PASS),LABEL=(1,NL),VOL=SER=CCT260,
// UNIT=TAPE,DCB=(1 RECF=80,BLKSIZE=80,RECFM=FB,DEN=3,OPTCD=0)
//SYSUT2 DD DSN=WYL.CC.BHC.TAPRD,UNIT=3330,DISP=(,CATLG),
// VOL=SER=SCROO2,DCB=(1 RECL=6233,BLKSIZE=6233,RECFM-U,DSORG=PS),
// SPACE=(TRK,(20,5),RLSE)
/*
//

```

```

1.  This program reads a file of 32 bit floating point numbers
2.  (format 4(F14.7)) per record, and converts them into a file of 12
3.  bit numbers (integers), for use in the D/A system.
4.
5.
6.
7.  // JOB TIME=4,REGION=400K
8.  // *MAIN LINES=50
9.  // EXEC FORTGCC
10. //FORF.SYSIN DD *
11.  C *****
12.  REAL MAX
13.  DIMENSION X(32768),IX(32768)
14.  MAX=0
15.  READ(1,100,END=200) (X(J),J=1,32768)
16. 100  FORMAT(4(F14.7))
17.  DO 55 J=1,32768
18.  IF (ABS(X(J)).GT.MAX) MAX=ABS(X(J))
19. 55  CONTINUE
20.  PRINT 70,MAX
21. 70  FORMAT(' ', 'MAX=',E14.7)
22.  DO 66 J=1,32768
23.  X(J)=X(J)/MAX
24.  X(J)=X(J)*2046.
25.  X(J)=X(J)+2047.
26.  X(J)=X(J)+.5
27.  )X(J)=X(J)
28. 66  CONTINUE
29.  WRITE(2,333) (IX(J),J=1,32768)
30. 333  FORMAT(1X,I4)
31. 200  CONTINUE
32.  STOP
33.  END
34. //GO.FT01F001 DD DSN=WYL.CC.BHC.RS1B,DISP=SHR
35. //GO.FT02F001 DD DSN=WYL.CC.PUB.XS1B,UNIT=3330,
36. // DISP=(NEW,CATLG,CATLG),SPACE=(TRK,(14,5),RLSE),
37. // VOL=SER=SCRO03,
38. // DCB=(DSORG=PS,RECFM=FB,LRECL=80,BLKSIZE=6160)
39. //GO.SYSIN DD *

```

Figure 3.5

```

1.          This program takes a file in EBCDIC Format (FILE11)
2.          and stores it on tape in ASCII format.
3.
4.
5.          // JOB TIME=5,REGION=BOOK
6.          //STEP1 EXEC PGM=JERGENER
7.          //SYSPRINT DD SYSOUT=A
8.          //SYSIN DD DUMMY
9.          //SYSUT1 DD DSN=WYL.CC.PUB.FILE11,DISP=SHR,
0.          //          UNIT=SYSDA
1.          //SYSUT2 DD DSN=ONE,UNIT=TAPE,DCB=(LRECL=80,BLKSIZE=80,RECFM=FB,
2.          // DEN=3,OPTCD=Q),VOL=SER=CCT004,LABEL=(1,NL),DISP=(NEW,KEEP)
3.          /*
4.          //STEP6 EXEC PGM=PRESS
5.          //SYSPRINT DD SYSOUT=A
6.          //SYSIN DD DUMMY
7.          //SYSUT1 DD DSN=ONE,DISP=(OLD,KEEP),LABEL=(1,NL),VOL=SER=CCT004,
8.          // UNIT=TAPE,DCB=(LRECL=80,BLKSIZE=80,RECFM=FB,DEN=3,OPTCD=Q)
9.          //SYSUT2 DD DSN=WYL.CC.PUB.NASA,UNIT=3330,DISP=(,CATLG),
0.          // VOL=SER=SC002,DCB=(LRECL=6233,BLKSIZE=6233,RECFM=U,DSORG=PS),
1.          // SPACE=(TRK,(400.5),RLSE)
2.          /*
3.          //

```

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Figure 3.6

```

PROGRAM GOATA
DEVELOPED BY: HARI P SINGH
              DECEMBER 1982

7 C THIS PROGRAM IS DESIGNED TO READ ASCII DATA OFF A TAPE, CONVERTS IT
8 C INTO HP FLOATING POINT FORMAT, AND THEN STORE IT IN A TYPE 1 FILE.
9 C IT IS ASSUMED THAT THE ORIGINAL DATA IS STORED ON THE TAPE IN 80
10 C COLUMN RECORDS 16(1X,2A2), AND THAT AFTER EVERY 2048 RECORDS A NEW
11 C FILE IS TO BE CREATED
12 C
13 C INTEGER I,
14 C + IBUFF(40),
15 C + IDC8(144),
16 C + IEPK,
17 C + INAK(3),
18 C + ISIZE(2),
19 C + ITYPE,
20 C + ITEMP,
21 C + J,
22 C + TABUFF(3)
23 C
24 C REAL RBUFF(64)
25 C
26 C DATA ISIZE /512,128/
27 C DATA ITYPE /1/
28 C
29 C
30 0010 WRITE(1,0025)
31 0025 FORMAT('WHAT DO YOU WANT TO NAME THIS FILE ')
32 READ '(3A2)',INAM
33 C
34 CALL CREAT(IDC8,IERR,INAM,ISIZE,ITYPE,ISC,32767)
35 IF(IERR.NE.0)THEN
36 WRITE(1,0030)IERR
37 0030 FORMAT('FMP ERROR NUMBER ',I4,' WHILE BUILDING DISC FILE ')
38 GO TO 9999
39 ENDIF
40 C
41 DO 1000 IREC=1,512
42 DO 0900 J=1,4
43 READ(8,0100)IBUFF
44 0100 FORMAT(4A2)
45 0200 FORMAT(1X,I4,3X,40A2)
46 C
47 C THIS LOOP IS USED TO DECODE THE ASCII DATA. IN EACH OF THE EIGHT
48 C ITERATIONS, TWO OF THE 16 INTEGERS ARE DECODED. THE DATA ON TAPE
49 C IS LAID OUT IN THE FORM 16(1X,2A2). FIRST THREE WORDS ARE BROUGHT
50 C INTO TBUFF. THESE WORDS CONTAIN 6 CHARACTERS:
51 C A LEADING BLANK, FOUR CHARACTERS REPRESENTING AN INTEGER, & ANOTHER BLANK
52 C THESE ARE THE INTEGERS IN POSITIONS (1,3,5,7,9,11,13,15)
53 C NEXT THE FOUR CHARACTERS REPRESENTING THE INTEGERS IN POSITIONS
54 C (2,4,6,8,10,12,14,16) ARE DECODED
55 C
56 DO 0800 I=1,8
57 I DECODE 2 INTEGERS AT A TIME

```

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```

57 TRBUFF(1)=IBUFF((I-1)*5)+1)
58 TRBUFF(2)=IBUFF((I-1)*5)+2)
59 TRBUFF(3)=IBUFF((I-1)*5)+3)
60 DECIDE(6,0500,TRBUFF)ITEMP
61 RBUFF((J-1)*16)*((I-1)*2)+1)=REAL(ITEMP)
62 TRBUFF(1)=IBUFF((I-1)*5)+4)
63 TRBUFF(2)=IBUFF((I-1)*5)+5)
64 DECIDE(4,0500,TRBUFF)ITEMP
65 RBUFF((J-1)*16)*((I-1)*2)+2)=REAL(ITEMP)
66 0500 FORMAT(16)
67 0800 CONTINUE
68 C
69 0900 CONTINUE
70 C
71 0905 WRITE(6,0905)RBUFF
72 0905 FORMAT(4(16(1X,F5 0)),)
73 CALL WRITE(IDC8,IERR,RBUFF) I WRITE A RECORD TO DISC
74 IF(IERR.LT.0)THEN I FMP ERROR
75 WRITE(1,0920)IERR I WRITE ERROR MESSAGE
76 0920 FORMAT('FMP ERROR NUMBER ',I4, ' WHILE WRITTING TO DISC ')
77 GO TO 9999 I EXIT PROGRAM
78 ENDIF
79 1000 CONTINUE
80 C
81 0930 WRITE(1,0930)
82 0930 FORMAT('DO YOU WISH TO BUILD ANOTHER FILE (Y/N) ')
83 READ '(A2)',IANSUR
84 IF(IANSUR.EQ.1HY)GO TO 0010
85 9999 CONTINUE
86 C
87 CALL CLOSE(IDC8,IERR) I CLOSE FILE
88 IF(IERR.LT.0)THEN I FMP ERROR
89 WRITE(1,9030)IERR I WRITE ERROR MESSAGE
90 9030 FORMAT('FMP ERROR NUMBER ',I4, ' WHILE CLOSING FILE')
91 ENDIF
92 C
93 END

```

FTN4X COMPILER: HP92834 .REV.2226 (820503)

** NO WARNINGS ** NO ERRORS ** PROGRAM: 745 COMMON: (NONE)

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4. User's Guide

This user's guide will provide the user with a step by step explanation of the questions that will be asked during a typical session with the simulator. References are given in each question so that the user can refer to the appropriate sections if an in depth discussion about the topic is desired (references made refer to the first report, "A Computer Simulator for a Mobile Telephone System", NASA Grant 3-119).

The following is a typical question-and-answer session with all the possible questions either being asked or presented in the explanation. The answers shown here are for a batch version version for a run. In an actual run, the answers shown would come out on the same line as the question. However we have seperated them here onto seperate lines for clarity. For an online session, merely the question will be prompted unto the user terminal, for which he would interactively enter his response.

The first question asked prompts the user as to whether the session is an online or batch session, and is displayed as follows:

```
Is this an online session? (Y/N) (1)
                                     N
```

The user should answer a 'Y' if it is an online session, or an 'N' if it is a batch session. In this case the response is "N" (no).

Next, the type of calls that are available in the communication system are displayed as follows:

communication system are displayed as follows:

TYPE OF CALL AVAILABLE: (2)

- 1: M1->M2, rural mobile to rural mobile in same UHF beam
- 2: M1->M3, rural mobile to rural mobile in different UHF beam, in same S-band
- 3: M1->M4, rural mobile to rural mobile in different UHF beam, in different S-band.
- 4: M1->FC1, rural mobile to fixed in same S-band beam
- 5: M1->FC2, rural mobile to fixed in different S-band beam
- 6: FC1->M1, fixed to rural mobile in same S-band beam
- 7: FC2->M1, fixed to rural mobile in different S-band beam

INPUT TYPE OF CALL TO BE SIMULATED:

1

Here the type of calls that are available in the communication system are displayed, each one being designated by a number from 1 through 7. Right after the list, the user is prompted to input the type of call he wishes to be simulated by inputting a number from 1 through 7. In this case, the first call ("1") was chosen. For an explanation of each of these calls, see section 2.2.

After the user has inputted the type of call to be simulated, the modes of call available within the type of call selected will be displayed (refer to section 2.3). In this case, the user chose to simulate type 1, which is rural mobile calling rural mobile in the same UHF-beam and S-beam. Correspondingly, the following choice of modes was displayed:

MODE OF CALL AVAILABLE: (3)

- 1: M1->M2, hard wired transponder
- 2: M1->M2, direct switched transponder
- 3: M1->M2, indirect switched transponder
- 4: M1->G1->M2, double hop system

INPUT MODE OF CALL TO BE SIMULATED:

1

Note that the type of modes that will be displayed depends on the type of call that is chosen (in this case type 1 was chosen). A full list of the range of possible modes corresponding to the

type of call chosen is found in section 2.3. (table 2.3.1).

One notes that following the list of modes available, the user is prompted to input the mode of the call by entering its corresponding number. In this case the user chose "1", from a choice of 1 to 4.

Based on the type of call and mode of call selected, the program will determine which scenario to be simulated (refer to section 3.3). The questions asked from this point on will vary depending on the features to be simulated within the scenario. Even though each of the five scenarios are different, the questions to be answered for each of them are more or less of the same nature. Therefore the rest of our discussion will focus only on those questions that are asked when the single hop system is to be simulated (which is the case of this particular simulation run).

In the next question, the user is asked to choose from the types of signal sources available. Choice 1, corresponds to a program generated sinusoid which can be used for making analytical tests. If choice "1" is chosen, no further questions about the signal source are asked and question (4) is then displayed. Choice "2" corresponds to sampled voice. If type 2 is chosen, then see section 3.2 for an explanation of procedures to be used.

TYPES OF SIGNAL SOURCES AVAILABLE:

- 1: Program generated single tone sinusoid.
- 2: Sampled voice from tape source.

Choose type of signal to be used (11):

1

In the next question,

FREQUENCY OF THE BASEBAND SIGNAL (LESS THAN 3000 HZ.) (4)
(IN HERTZ, F7.2):

1000.00 HZ

the user is asked to input the frequency of the baseband signal in hertz using the format "F7.2". The baseband signal has an upper limit of 3000 Hz (refer to section 5).

The next question displayed is as follows:

NOTE: POWER OF THE BASEBAND SIGNAL HAS TO BE LESS OR EQUAL (5)
THAN .5 WATTS;
SO THAT THE MAXIMUM INSTANTANEOUS FREQUENCY DEVIATION IS
LESS OR EQUAL THAN 12000 HZ
POWER OF THE BASEBAND SIGNAL (IN WATTS, F7.2): (6)
0.50 WATTS

Here the user inputs the power of the baseband signal in watts using the format F7.2. The power of the baseband signal has to be less than or equal to .5 watts, so that the maximum instantaneous frequency deviation is less than or equal to 12000 Hz (refer to section 5).

In the next question that appears

THE CARRIER POWER (IN WATTS, F7.2): (7)
1.00 WATTS

the user is asked to input the carrier signal power in watts using the format F7.2.

The next question appearing,

THE FREQUENCY DEVIATION (IN HERTZ, F8.2): 12000 HZ. (8)
(FIXED FOR NOW)

asks the user to input the frequency deviation in Hertz using the format F8.2. Under the current version, the frequency deviation is fixed at 12,000 Hz in order for the simulator to meet AMPS specifications (refer to section 5).

The next question is displayed as follows:

How many times the nyquist rate do you want the sampling (9)
frequency to be? (2 - 4, I1):

Here the user is asked to input the sampling frequency in terms of a multiple of the Nyquist rate. Acceptable values are from twice the Nyquist rate to four times the Nyquist rate. Twice the Nyquist rate is the minimum in order for the simulator to integrate and differentiate correctly. Four times the Nyquist rate is the maximum since any increase of the sampling frequency beyond this point will not improve any significant approximation, but will prolong run time substantially (refer to section 3.2).

In the next question,

THE CARRIER FREQUENCY (IN HERTZ, F7.2):(NOT USED FOR NOW) (10)

the user is asked to input the carrier frequency in Hertz using the format F7.2. Under the current version of the simulator, the carrier frequency is not used in the simulation.

The next question is displayed as follows:

DO YOU WANT THE COMPRESSOR/EXPANDER IN? Y-YES , N-NO : (11)
Y

Here the user is asked whether the compressor/expander (AMPS specs) are used in the transmitter and receiver (refer to section 5). This question is answered either with a "Y" (yes) or an "N" (no).

The next question appears as follows:

DO YOU WANT THE PRE-EMPHASIS - DE-EMPHASIS FILTERS IN ? (12)
Y-YES , N-NO :
Y

Here the user is asked whether pre-emphasis and de-emphasis filters (AMPS specs) are used in the transmitter and receiver (see section 5).

The user is then prompted as to whether or not interference is

present in the UHF uplink satellite channel. This question is displayed as follows:

DO YOU WANT A CO-CHANNEL INTERFERER IN THE UPLINK? (13)
Y-YES,N-NO: Y

Are multiple values of the carrier to interference power ratio to be tested? (Y/N): (14)

Y
Input the range of values to be tested (in DB):
Input the initial value (-99 -- +99,I3): (15)

10 DB
Input the increment value (01 -- 99,I3): (16)

10 DB
Input the final value (01 -- 99,I3): (17)

70 DB
Are multiple values of the interference phase values to be tested? (Y/N): (18)

Y
Input the range of values to be tested (in degrees):
Input the initial value (F6.2) : (19)

10.00 DEGREES
Input the increment value (F6.2) : (20)

5.00 DEGREES
Input the final value (F6.2) : (21)
25.00 DEGREES

Note the answer to the first of these questions was "Y" (yes). If the response was "N" (no interference), then the next eight questions would not have appeared. However, since in this case the response is yes, they did appear. In the first of these questions (14), the user is asked if he wishes to input a range of values for the carrier to interference power ratio. If the answer is "Y" (yes), as in this case, then questions 15-17 will follow. Here, the user inputs the initial value, increment value, and final value respectively (in dB, using the format I3) of the carrier to interference power ratio. If the answer to question (14) was "N" (no), then the user would have just been asked to input one value of the carrier to interference power ratio in the same format as above. After question 17, the user is asked whether he wants to

input a range of phase values for the interference source (question 18). If the response to this is "Y" (yes), then questions 19-21 will appear, asking the user to input the initial, incremental, and final value of the phase, respectively (using format F6.2 , in degrees). If the response to question 18 was "N" (no), then a question would have appeared asking only one value for the phase.

In the next question,

IS FADING PRESENT IN THE UPLINK CHANNEL? Y-YES,N-NO: (22)
Y

one responds as to whether or not the uplink satellite channel is a fading channel or not. One responds to the question by either typing a "Y" for yes or a "N" for no. If the response is no, the next five questions (questions 23-28) will not appear. However, as in this case, if the response is yes, then questions 24 through 28 will definitely appear. If interference is present, as is the case in the current simulation run, then question 23 will also appear. If interference were not present in the uplink, then question 23 would have not been asked. Questions 23-28 are displayed as follows:

IS THE INTERFERENCE FADED? Y-YES,N-NO: (23)
Y

THE UPLINK FADING CHANNEL IS PRESENT
TYPES OF FADING CHANNELS AVAILABLE: (24)
1: NO SPECULAR COMPONENT (RALEIGH FADING)
2: SPECULAR COMPONENT, SHORTEST PATH
3: SPECULAR COMPONENT, MEAN PATH
INPUT TYPE OF CHANNEL:

2
ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): (25)
500.00 MICROSECONDS

ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): (26)
1.00 HZ

Are multiple values of the specular to multipath power ratio to be tested? (Y/N) : (27)

N
ENTER THE SPECULAR-TO-MULTIPATH POWER RATIO (IN DB, I3): (28)
100 DB

In the first of these questions, the user responds as to whether or not the interference is effected by the fading channel. If it is, it is done so independently of the signal and is added at the end. If it is not, then the interference is just added to the faded signal.

In the second of these questions, the user decides which type of fading is present, by entering a 1 digit number from 1 to 3 corresponding to the type of fading that is present. If (1) is chosen, then the fading channel will be a Rayleigh distributed one with no specular component. If (3) is chosen, then the channel will have Rician statistics, with the specular component in the middle. In other words, the mean path is taken. In the last case, (2), the channel has Rician statistics with the shortest path being taken (refer to section 6).

In the third of these questions (25), the user is asked to input the total multipath spread time of the fading channel in microseconds using the format F9.2. In this case, "500.00" was entered as data.

In question (26), the user is asked to input the doppler spread bandwidth of the fading channel in Hertz using the format F7.2. In this case the number "1.00" was entered as data.

Question (27) will only be asked if the response to question (24) is either 2 or 3. If the response is 1, then Rayleigh fading is being used which exhibits no specular component. Question (27)

once again asks whether or not the user wishes to input a range of values for the specular to multipath power ratios (in dB). In this case the answer is "N" (no), and thus question (28) appears, which asks the user to input only one value of the specular to multipath power ratio (in dB) using the format I3 (in this case 100 was entered as data). If the response to question (27) was yes, then three questions asking for the initial, incremental, and final values respectively (using the same input format as question (28)) would have been displayed as they have in the questions asked previously.

The next question,

DO YOU WANT A CO-CHANNEL INTERFERER IN THE DOWNLINK? (29)
 Y-YES,N-NO:

Y

Are multiple values of the carrier to interference power ratio to be tested? (Y/N) : (30)

N

INPUT CARRIER TO INTERFERENCE POWER RATIO IN DB(I3): (31)
 30 DB

Are multiple values of the interference phase values to be tested? (Y/N): (32)

N

INPUT PHASE OF INTERFERENCE IN DEGREES (F7.2): (32.1)
 30.80 DEGREES

is the dual of the uplink interference case. The data entry is exactly the same as it were for the uplink case. Note however, in this case that the responses to the questions asking if the user wants to input a range of values are both negative. In this case the user is only inputting single values (030 dB for the power ratio, and 30.80 Degrees for the phase).

The next question,

IS FADING PRESENT IN THE DOWNLINK CHANNEL? Y-YES,N-NO: (33)
 Y

is basically the dual of the uplink case, the only exception however is the facility for a space diversity receiver. Once again, if the response to the above question is "N" (no), then questions 34 through 45 will not be asked. If the response is "Y" (yes), the next question that will be displayed is:

IS A SPACE DIVERSITY RECEIVER BEING USED? Y-YES,N-NO: (34)
Y

If a space diversity receiver is being used (response "Y"), as is the case for this example, then parameters for 2 fading channels will have to be set; questions 36 through 40 for the first channel and questions 41 through 45 for the second channel. If a space diversity receiver is not being used (response "N"), then the user will only be prompted to enter parameters for one channel.

If co-channel interference is present in the downlink channel (response to (29) is "Y"), then the following question will be displayed:

IS THE INTERFERENCE FADED? Y-YES,N-NO: (35)
Y

Here one enters whether or not the interference should be faded. If yes (as in this case), the user enters a "Y", and if not, the user enters an "N".

Questions 36 through 40 or questions 36 through 45 if a space diversity receiver is present, are entered in an analogous way as were the questions for the uplink satellite channel.

THE DOWNLINK FADING CHANNEL IS PRESENT
SET PARAMETERS FOR FIRST FADING CHANNEL: (36)
TYPES OF FADING CHANNELS AVAILABLE:
1: NO SPECULAR COMPONENT (RALEIGH FADING)
2: SPECULAR COMPONENT, SHORTEST PATH
3: SPECULAR COMPONENT, MEAN PATH

INPUT TYPE OF CHANNEL:
 2
 ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): (37)
 500.00 MICROSECONDS
 ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): (38)
 1.00 HZ
 Are multiple values of the specular to multipath power
 ratio to be tested? (Y/N): (39)
 N
 ENTER THE SPECULAR-TO-MULTIPATH POWER RATIO (IN DB, I3): (40)
 100 DB
 SET PARAMETERS FOR THE SECOND FADING CHANNEL: (41)
 TYPES OF FADING CHANNELS AVAILABLE:
 1: NO SPECULAR COMPONENT (RALEIGH FADING)
 2: SPECULAR COMPONENT, SHORTEST PATH
 3: SPECULAR COMPONENT, MEAN PATH
 INPUT TYPE OF CHANNEL:
 2
 ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): (42)
 500.00 MICROSECONDS
 ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): (43)
 1.00 HZ
 Are multiple values of the specular to multipath power
 ratio to be tested? (Y/N): (44)
 N
 ENTER THE SPECULAR-TO-MULTIPATH POWER RATIO (IN DB, I3): (45)
 100 DB

In the next question,

Are multiple SNR values to be tested? Y=yes,N=no: (46)
 Y

the user is asked whether multiple SNR values are to be tested. If the response is "Y" (yes), then questions 47.1 through 47.3 will appear asking the user to input the range of SNR's (in this case, the carrier to noise ratio) for the Gaussian noise in the mobile receiver. If multiple SNR values are not to be tested (response "N"), then the user will be asked to input only one SNR value.

Questions 47.1/47.3 would appear as follows:

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Input the range of SNR values to be tested (in Db): (47)
Input the initial value of SNR (-99 -- +99, I3): (47.1)
36 DB
Input the increment value (01 -- 99, I2): (47.2)
4 DB
Input the ending value of SNR (-99 -- +99, I3): (47.3)
40 DB

In the next question,

IS A SPACE DIVERSITY RECEIVER REQUIRED? (Y/N) (48)
Y

the user is asked whether or not a space diversity receiver is to be used. If it is present (response "Y"), then the user will be asked (next question) to input the duration of the decision period which is the duration of the lapse time before a decision is made to determine which receiver is receiving a stronger signal. If it is not present (response "N"), then the next question (49) will not displayed.

INPUT DURATION BETWEEN DECISION TIMES FOR THE S.D. RECEIVER
(F7.5, IN SECONDS) (49)
0.00020SEC.

The next question is displayed as follows:

Input the approximate duration of simulation in seconds (50)
(0.01 - 9.99, F4.2):
0.01 SEC.

Here the user inputs the approximate duration of the input signal to be tested in seconds using the format F7.5. For now, the boundary imposed is from 0.01 seconds to 9.99 seconds (refer to section 4.1).

In the next question displayed,

Type of performance measurement available: (51)
1. Compare recovered output signal to original input signal
2. Measure output signal to noise ratio
Input type:

1

the user is asked to input the type of performance to be measured. Under the current version, the user has the choice of choosing either to compare the recovered output signal to the original input signal (choice "1"), or (choice "2") to measure the output signal to noise ratio vs input signal to noise ratio (refer to section 4.2). If choice 2 is chosen, the user will be asked if he wishes that a plot be displayed of the input vs output SNR values. However, if choice 1 is chosen, as is the case in this example, than the following will be the last question displayed:

```
DO YOU WANT OUTPUT TO BE PLOTTED?                (52)
                                                Y
```

Here the user has the option of having the output vs input signals plotted. If the response to this question is "Y" (yes), then following the printing of the input vs output signal values (for each respective SNR value), a graph will be plotted corresponding to these values. The maximum possible length of the graph is 2000 lines (per SNR value). If the response is "N" (no), then just the values without a graph will be printed.

A few lines of the resulting output are printed as follows:

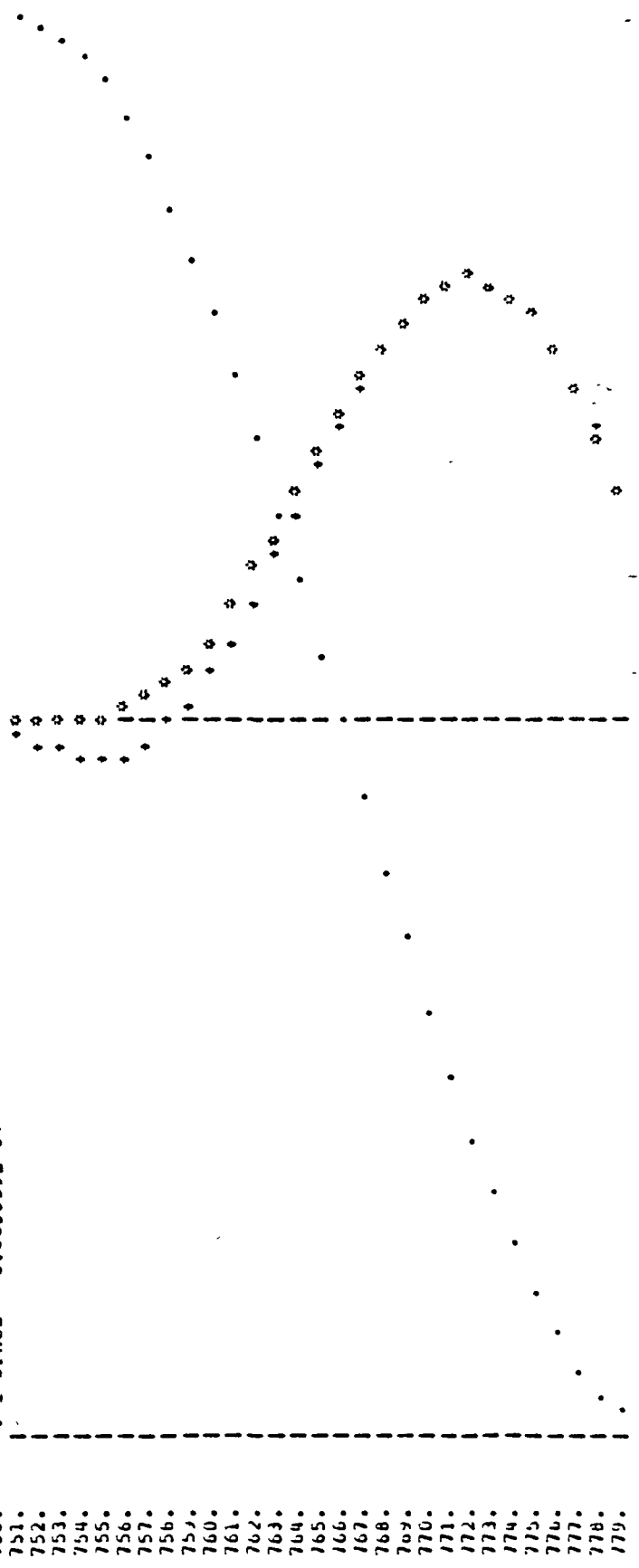
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Input signal	Output signal (No Noise)	Output signal (With Noise)
The SNR is 36.00 DB		
0.1000000E 01	-0.3008653E 02	0.6992087E 02
0.9972572E 00	-0.9639141E 03	0.2256493E 04
0.9890135E 00	-0.7375438E 04	0.1755339E 05
0.9752213E 00	-0.2662992E 05	0.6575075E 05
0.9557958E 00	-0.6205368E 05	0.1653216E 06
0.9306050E 00	-0.1081285E 06	0.3328434E 06
0.8994539E 00	-0.1487061E 06	0.5898719E 06
0.8620588E 00	-0.1609989E 06	0.9725955E 06
0.8180044E 00	-0.1277967E 06	0.1540994E 07
0.7666720E 00	-0.5651906E 05	0.2387130E 07
0.7071075E 00	-0.7818813E 03	0.3643070E 07
0.6377603E 00	0.7991531E 05	0.5487024E 07
0.5558942E 00	0.4918778E 06	0.8145275E 07
0.4559756E 00	0.1515125E 07	0.1188825E 08
0.3233112E 00	0.3496630E 07	0.1701875E 08
0.1490450E-02	0.6825587E 07	0.2384659E 08
-0.3233029E 00	0.1189424E 08	0.3265666E 08
-0.4559686E 00	0.1904904E 08	0.4366894E 08
-0.5558881E 00	0.2853454E 08	0.5699677E 08
-0.6377543E 00	0.4043526E 08	0.7258918E 08
-0.7071018E 00	0.5462040E 08	0.9018307E 08
	:	
	:	
	:	

```

720. -0.8134990E 00 -0.3250146E 05 -0.3252382E 05
721. -0.7462617E 00 -0.3871931E 05 -0.3873486E 05
722. -0.6746396E 00 -0.4453807E 05 -0.4455445E 05
723. -0.5440157E 00 -0.4990534E 05 -0.4991791E 05
724. -0.5066984E 00 -0.5476577E 05 -0.5477025E 05
725. -0.4138190E 00 -0.5906239E 05 -0.5905626E 05
726. -0.3164213E 00 -0.6273980E 05 -0.6271593E 05
727. -0.215436E 00 -0.6574794E 05 -0.6570694E 05
728. -0.1123206E 00 -0.6804550E 05 -0.6800881E 05
729. -0.7652316E-02 -0.6960200E 05 -0.6958081E 05
730. 0.9668678E-01 -0.7039825E 05 -0.7038119E 05
731. 0.2001823E 00 -0.7042663E 05 -0.7040781E 05
732. 0.3014705E 00 -0.6968919E 05 -0.6967275E 05
733. 0.1994715E 00 -0.6819650E 05 -0.6818431E 05
734. 0.4930038E 00 -0.6596506E 05 -0.6595363E 05
735. 0.5813091E 00 -0.6301504E 05 -0.6299994E 05
736. 0.6631559E 00 -0.5936834E 05 -0.5935133E 05
737. 0.737512E 00 -0.5504795E 05 -0.5503618E 05
738. 0.8042567E 00 -0.5008057E 05 -0.5008200E 05
739. 0.8619632E 00 -0.4450350E 05 -0.4452383E 05
740. 0.9102221E 00 -0.3837407E 05 -0.3841241E 05
741. 0.9485188E 00 -0.3177484E 05 -0.3181984E 05
742. 0.9764227E 00 -0.2480832E 05 -0.2484891E 05
743. 0.9936365E 00 -0.1758397E 05 -0.1761883E 05
744. 0.9999666E 00 -0.1020682E 05 -0.1023401E 05
745. -----
=====
* = INPUT SIGNAL, + = OUTPUT-NO NOISE, * = FADED OUTPUT
* : 1-SPACE= 0.181818E-01
* : 1-SPACE= 0.128063E 04
* : 1-SPACE= 0.128119E 04

```



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5. Sample Runs

One of the biggest advantages of the present simulator is its ability to span over a range of inputs for the different devices, as opposed to only entering one value at a time as was the case in the previous simulation. This facility is illustrated in figure 1. In this particular example, 4 parameters are variables: the specular to multipath power ratio of the UHF downlink channel, the carrier to interference power ratio of the UHF downlink co-channel interferer, the phase values for the UHF downlink co-channel interferer, and the input signal to noise ratio of the Gaussian noise source. One can see from figure 1 that every possible permutation of the above values is exhibited. In this simulation run, a type one measurement is chosen with the plotting facility on. Thus the output is a list of the input vs. output values of the system, followed by its corresponding plot. One notes that a type one output exists for each of the possible permutations as mentioned above.

Figure 2 illustrates the above mentioned "looping" feature for a type 2 measurement. In this output, a type 2 measurement of the input vs. output SNR values and its corresponding plots are exhibited for every possible permutation of the 7- input parameters (columns) shown.

In figure 3, the output SNR values are being plotted as a function of the input SNR values for different values of the carrier to interference power ratio of the UHF uplink interference source. Again, the looping facility is exhibited here. One notes

from the output curves, that as the carrier to interference power ratio gets smaller, the output curves flatten out. At large values, the curves remain linear above threshold as expected.

Figure 4 illustrates the execution of a double hop system (scenario 2 in this case). One notes here that both an S-band and an UHF band uplink channel are set, as well as an S-band and an UHF band downlink channel.

6. Results

The results of the present simulator are divided into two sections; The analytical results (section 6.1), and the processed voice results (section 6.2). In both cases, tests are made using a single hop system (scenario 1).

6.1 Analytical Results

The system discussed can be seen to have the responses shown on various plots obtained for several different Rician channels over a single hop system (scenario 1).

We first analyzed a single hop system over a channel without fading or interference present as a function of the input SNR values. A pure sinusoid was used as input. The results can be seen in figure 6.1 (referenced from first report). Note that the results are analyzed for various combinations of signal processing stages. These results represent a pure FM system with white noise present.

We next simulated a single hop system over a Rician channel with no interference present, and analyzed the output vs input SNR values for various values of the specular-to-multipath component power ratios of the fading channel. The results are summarized in the plot of figure 6.2. First, we note that when the specular-to-multipath power ratio of the channel is 100 db, no

real effects of fading can be seen and the output vs input SNR curve remains a linear one as expected. An analysis of the various plots, however, does show that as the specular-to-multipath power ratio is decreased, a flattening out of the linear curve does occur and the effects of fading become increasingly destructive.

We next analyzed a single hop system over a Rician channel with no interference present, with and without a space diversity receiver present. The results are summarized in figure 6.3. One observes from this plot that there is a significant improvement with the space diversity receiver on.

We next plotted the output signal-to-noise ratio as a function of the specular-to-multipath power ratio of the fading channel, with no other disturbances present. We started with a specular-to-multipath power ratio of -35 dB (practically Raleigh fading), and went all the way up to a specular-to-multipath power ratio of 100 dB. The results are summarized in figure 6.4. Here we noticed a threshold effect beginning at a specular-to-multipath power ratio of about +05 dB. The curve moves up very quickly in a linear fashion from 5 dB to 50 dB, and then flattens out to its maximum value.

Figure 6.5 considers the effects of interference on the output signal to noise ratio. One can observe from the plot that an interference source with a carrier to interference power ratio ranging from 100 dB all the way down to 20 dB has no major effect on the output performance. However, as one gets below 20 dB, a flattening out of the input vs. output SNR curve does occur above

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threshold. As the carrier to interference power ratio is taken below 8 dB, the flattening out effects become very predominant and output performance starts getting poor. At 0 dB, the curve flattens out completely to about .5 dB (Threshold effect).

Figure 6.6 considers results obtained using scenario 2. In this plot we analyze the input vs. output SNR values of a double hop system assuming all four channels are Rician fading channels. The UHF uplink channel, the S-band downlink channel, the S-band uplink channel, and the UHF downlink channel are the channels which are considered. As one can see from the plot, various permutations of the 4 channels (specular to multipath power ratio of the fading channel is varied) are considered.

These are just a few of the vast number of results obtainable with this simulation. Section 5 contains various sample runs illustrating some of the various possible results obtainable.

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6.2. Results: Voice

In addition to the analytical results, we were also able to use the simulation to process sampled voice and actually listen to it. In particular, the following tests were made on the voice:

First, we put the sampled voice through the simulation with no fading, interference, or thermal noise present, or in other words, "pure FM". The output voice sounded exactly the same as the input. We listened to the voice (still pure FM) with the pre-emphasis de-emphasis filters both off and on, and could here a slight improvement with the latter case. With the expander - compander on or off, difference in voice quality was to slight to be heard .

Next, with no other disturbances present, we listened to the voice as a function of the thermal noise power. Results could be summarized as follows:

Carrier-to-Noise Power Ratio (dB)	Speech Quality
-----	-----
+40	Excellent
+35	Excellent
+30	Excellent
+25	Excellent
+20	Excellent
+16	Very good
+14	Good
+12	Good (very light static)
+10	Fair (light crackling)
+08	Fair-Poor (crackling louder)
+06	Poor (crackling loud)
+03	Very Poor (Basically only crackling)
-02	No sign of voice (only loud crackling)

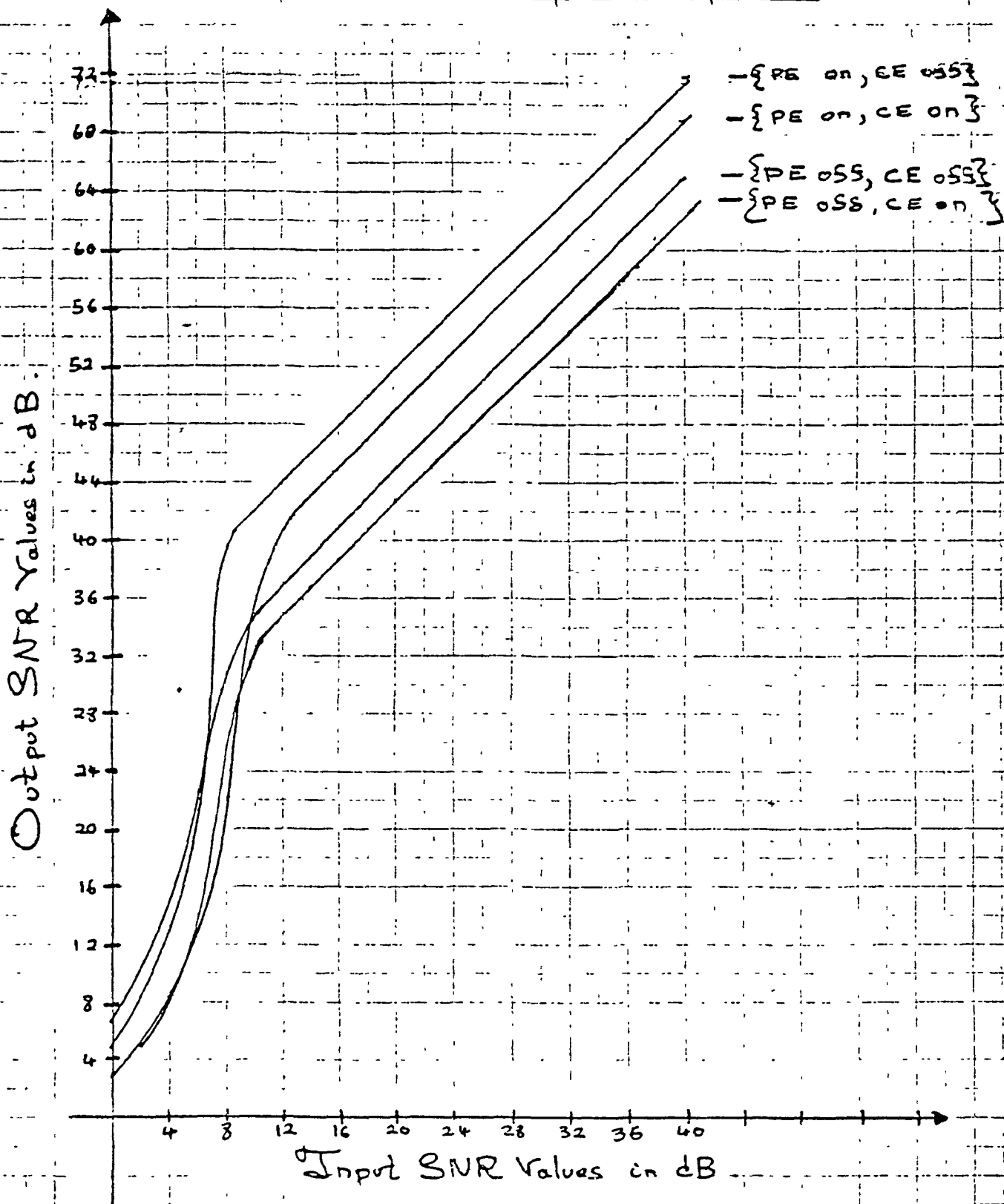
As the above indicates, the quality of voice went from excellent just above threshold, to poor just below threshold, consistent with our analytical results as well as theoretical results.

We then listened to the voice as a function of the specular-to-multipath power ratio (dB) of the fading channel (see sample run 5.1 for channel parameters), with no other disturbances present (input carrier-to-noise power ratio at +40dB). Within the range of specular-to-multipath power ratios from +6 dB and better, output voice quality was excellent. Within the range from -10 dB through +6 dB, voice quality was good (tonal characteristics of the voice were altered somewhat). Below -12 dB, voice quality was fair (tonal characteristics altered), with some crackling present.

The above examples are a few of the many possible tests on voice. Any of the 5 scenarios can be tested on the voice, with all possible parameter variations. (note that the above tests correspond to scenario 1).

FIGURE
8.1

Input vs. Output SNR Curves with and without Pre-emphasis/
De-emphasis and/or Compressor/Expander

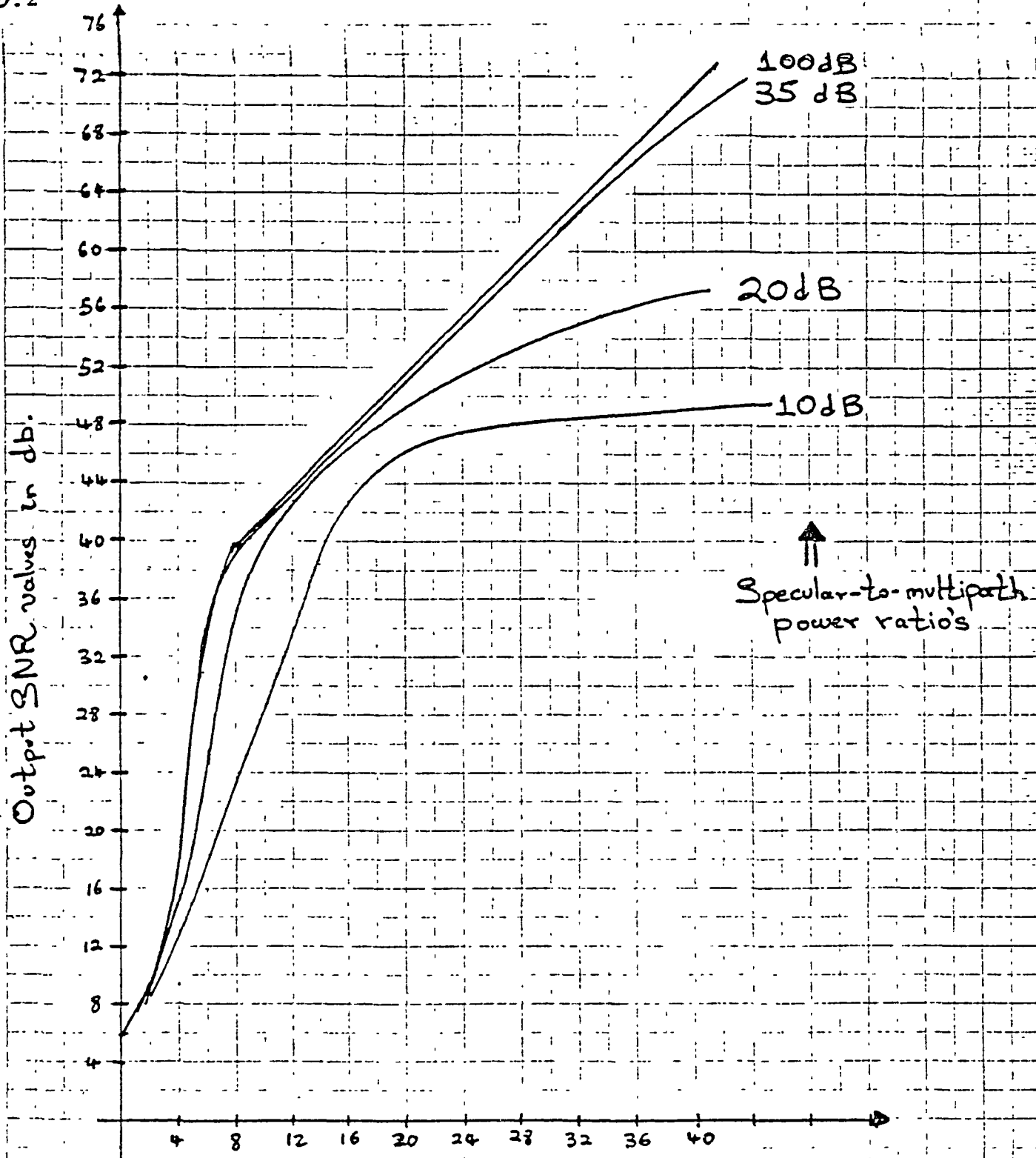


PE - Pre-emphasis-De-emphasis
CE - Compressor-Expander.

FIGURE

Input vs. Output SNR values for Rician Fading

6.2



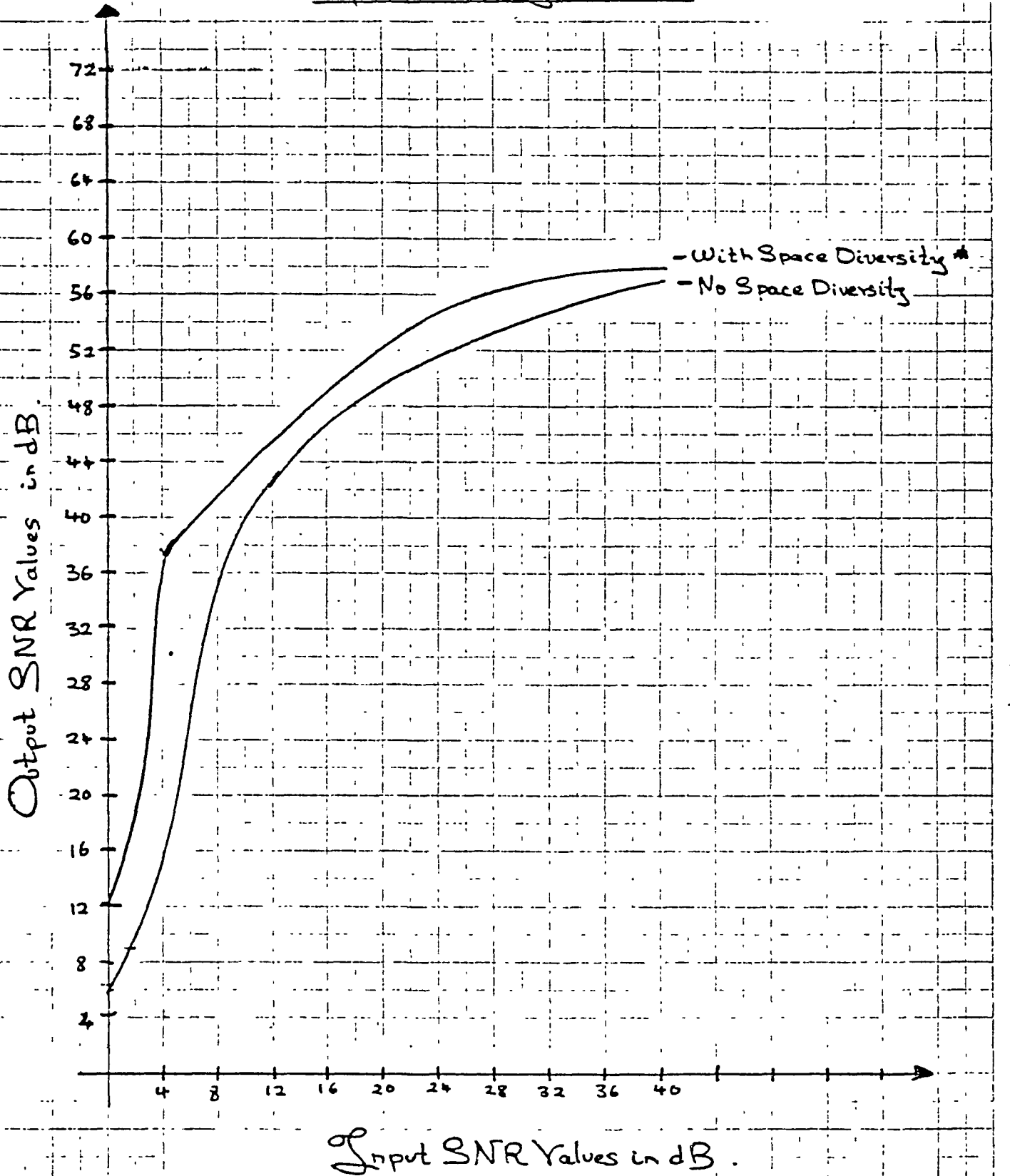
↑
Specular-to-multipath
power ratios

Input SNR Values in db.

Note: Pre-emphasis }
De-emphasis }
Compressor/ }
Expander. }

FIGURE
6.3

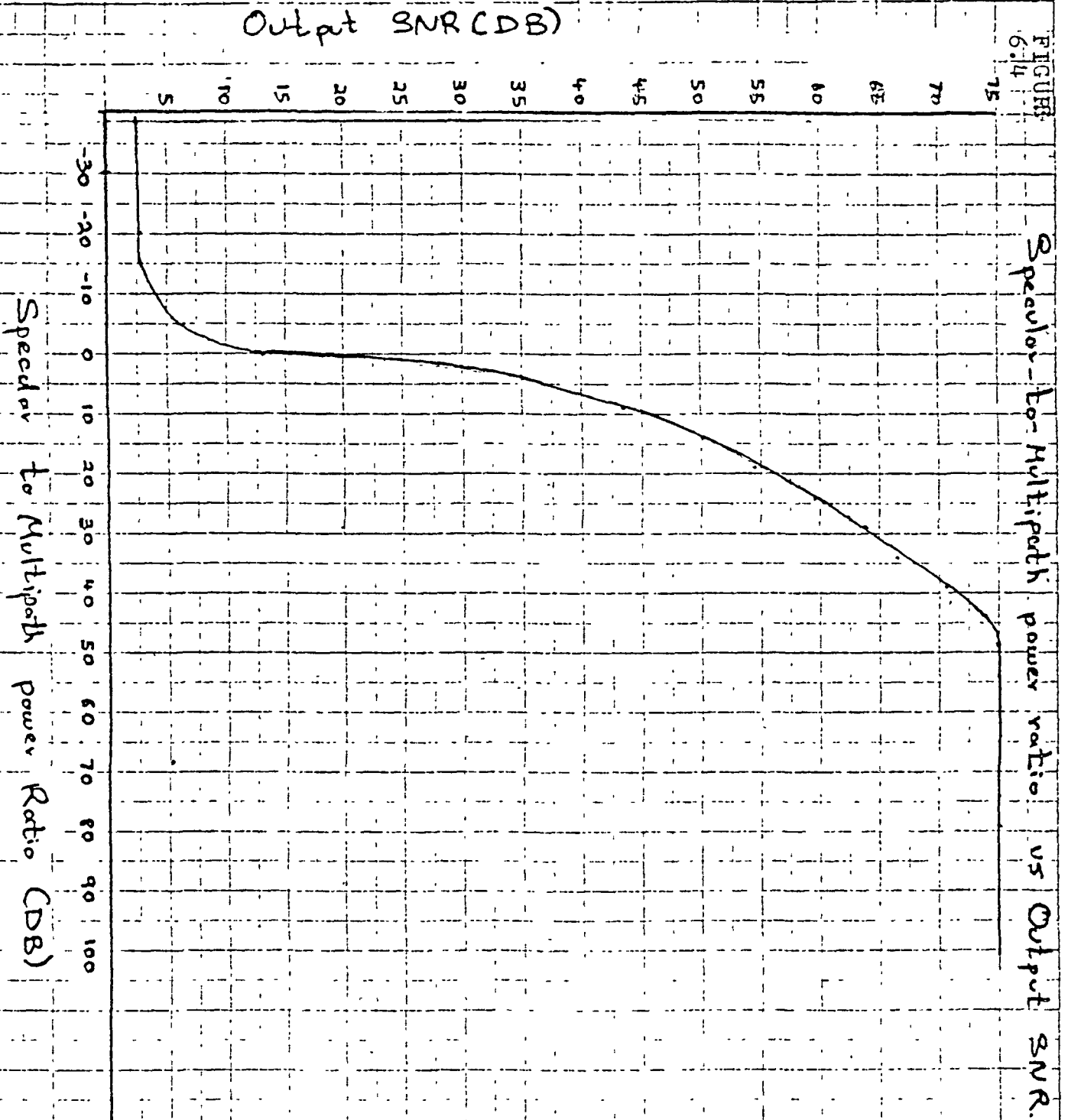
Output vs Input SNR Values with and without Space Diversity Receiver



Specular-to-multipath
power ratio = 20 dB,
for both cases.

* Decision time = 0.00016 sec

FIGURE 6.14

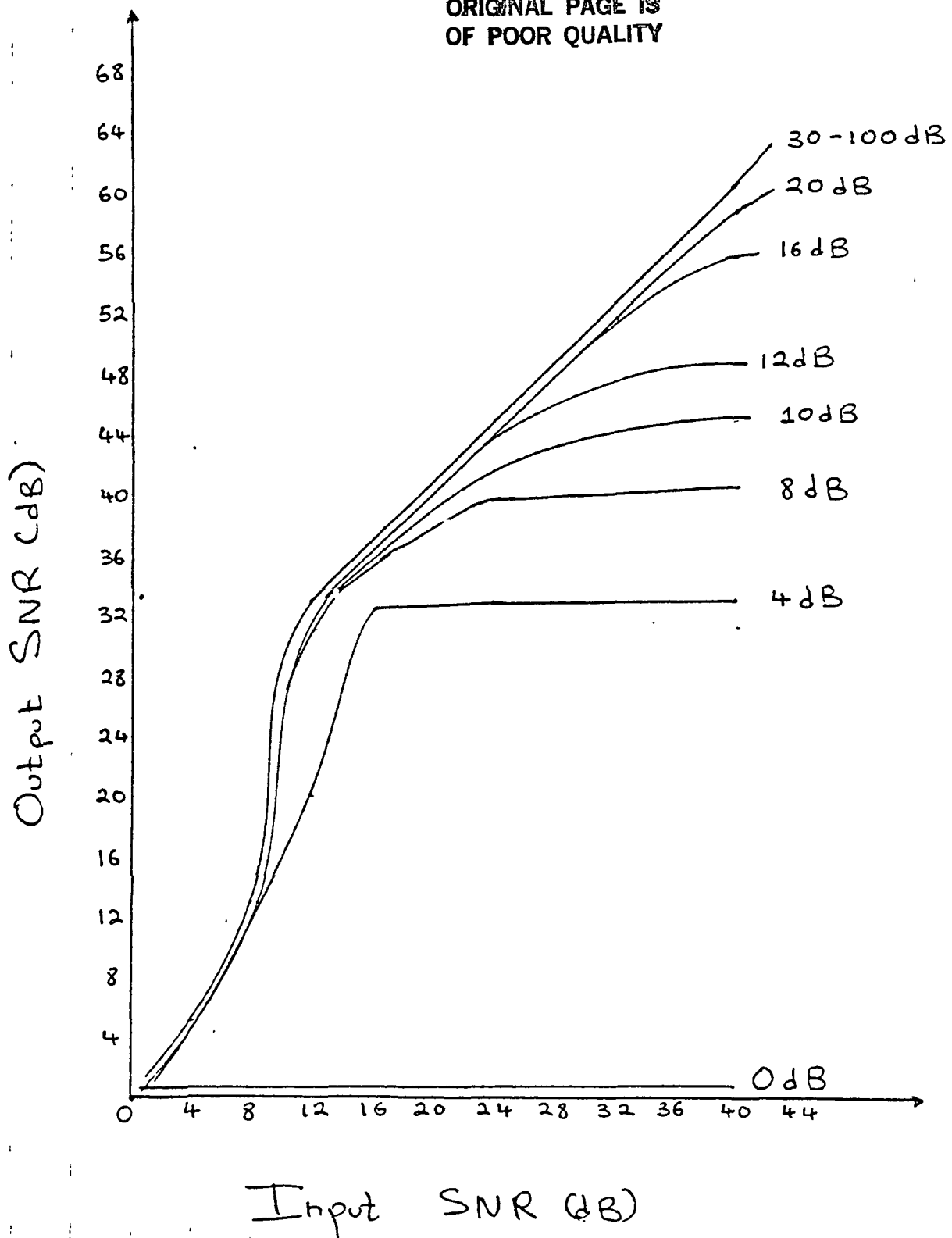


Specular to Multipath power ratio vs Output SNR.

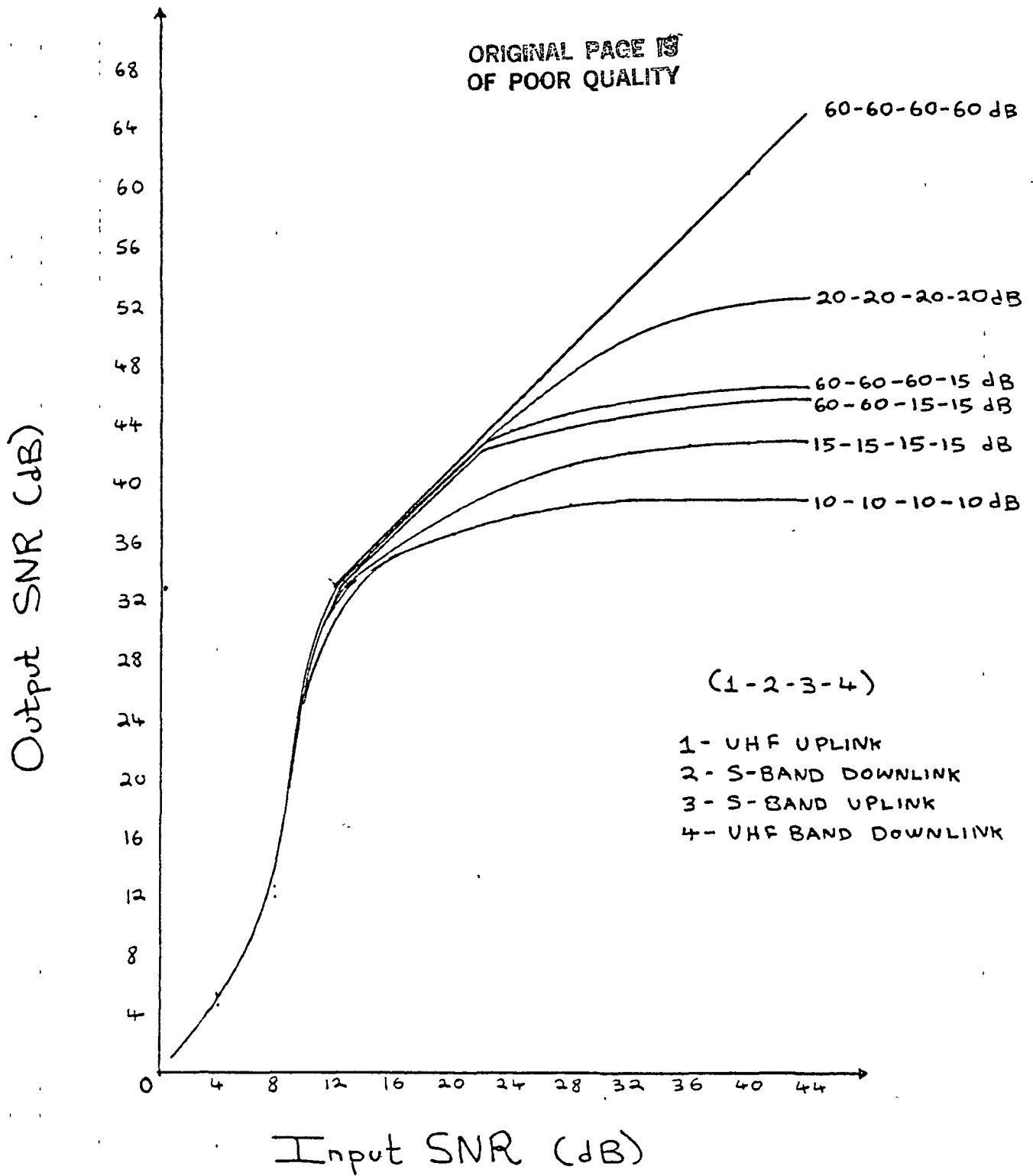
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6.5 Output vs Input SNR as a function of
the Carrier-to-Interference Power Ratio

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6.6 Multi-channel Performance of a Double Hop System (Scenario 2)



7. Proposed Research for the Forthcoming Year

Because of the present system's very modular structure, simulation of other modulation techniques over any one of the five scenarios can be done with relative ease. Since the simulation is designed in such a way that the inphase and quadrature phase components of the input signal are being passed through the components of the system in a parallel fashion, any type of modulation scheme which can be broken up into these components can be easily implemented. For example, the present simulator could be used to test the performance characteristics of duo-binary FM or tamed FM, both which use less bandwidth than standard FM.

At the same time, one could use the simulation to process voice using various modulation techniques to see which types produce the best subjective voice quality. In the report, we propose to construct a system to allow for simple testing of actual voice input. This system will allow for simple interfacing of voice input to the IBM system on which the actual simulation took place. We plan to build this device using a personal computer as the controller.

Also because of the systems modular structure, it would be possible to test other types of components or noise sources.

- 1. Is this an online session? (Y/N) N
- 2. TYPE OF CALL AVAILABLE:
- 3. 1: M1->M2, rural mobile to rural mobile in same UHF beam
- 4. 2: M1->M3, rural mobile to rural mobile in different UHF beam, in same S-band
- 5. 3: M1->M4, rural mobile to rural mobile in different UHF beam, in different S-band
- 6. 4: M1->FC1, rural mobile to fixed in same S-band beam
- 7. 5: M1->FC2, rural mobile to fixed in different S-band beam
- 8. 6: FC1->M1, fixed to rural mobile in same S-band beam
- 9. 7: FC2->M1, fixed to rural mobile in different S-band beam
- 10. INPUT TYPE OF CALL TO BE SIMULATED: 1
- 11. MODF OF CALL AVAILABLE:
- 12. 1: M1->M2, hard wired transponder
- 13. 2: M1->M2, direct switched transponder
- 14. 3: M1->M2, indirect switched transponder
- 15. 4: M1->M1->M2, double hop system
- 16. INPUT MODE OF CALL TO BE SIMULATED: 1
- 17. FREQUENCY OF THE BASEBAND SIGNAL (LESS THAN 3000 HZ.) (IN HERTZ, F7.2): 1000.00 HZ
- 18. NOTE : POWER OF THE BASEBAND SIGNAL HAS TO BE LESS OR EQUAL THAN .5 WATTS:
- 19. SO THAT THE MAXIMUM INSTANTANEOUS FREQUENCY DEVIATION IS
- 20. LESS OR EQUAL THAN 12000 HZ
- 21. POWER OF THE BASEBAND SIGNAL(IN WATTS, F7.2): 0.50 WATTS
- 22. THE CARRIER POWER (IN WATTS, F7.2): 1.00 WATTS
- 23. THE FREQUENCY DEVIATION (IN HERTZ, F8.2): 12000 HZ. (FIXED FOR NOW)
- 24. How many times the nyquist rate do you want the sampling frequency to be? (2 - 4, 11): 2
- 25. THE CARRIER FREQUENCY (IN HERTZ, F7.2):(NOT USED FOR NOW)
- 26. DO YOU WANT THE COMPRESSOR/EXPANDER IN? Y-YES , N-NO : N
- 27. DO YOU WANT THE PRE-EMPHASIS - DE-EMPHASIS FILTERS IN ? Y-YES , N-NO : N
- 28. DO YOU WANT A CO-CHANNEL INTERFERER IN THE UPLINK? Y-YES,N-NO: N
- 29. IS FADING PRESENT IN THE UPLINK CHANNEL? Y-YES,N-NO: N
- 30. DO YOU WANT A CO-CHANNEL INTERFERER IN THE DOWNLINK? Y-YES,N-NO: Y
- 31. Are multiple values of the carrier to interference power
- 32. ratio to be tested? (Y/N): Y
- 33. Input the range of values to be tested (in DB):
- 34. Input the initial value (-99 -- +99,13) : 60DB
- 35. Input the increment value (01 -- 99,13) : 10DB
- 36. Input the final value (01 -- 99,13) : 60DB
- 37. Are multiple values of the interference phase values
- 38. to be tested? (Y/N): Y
- 39. Input the range of values to be tested (in degrees):
- 40. Input the initial value (F6.2) : 10.00DEGREES
- 41.
- 42.
- 43.
- 44.
- 45.
- 46.
- 47.
- 48.
- 49.
- 50.
- 51.
- 52.
- 53.
- 54.
- 55.
- 56.
- 57.
- 58.
- 59.

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60. Input the increment value (F6.2) : 5.00DEGREES
61.
62. Input the final value (F6.2) : 10.00DEGREES
63.
64. IS FADING PRESENT IN THE DOWNLINK CHANNEL? Y-YES,N-NO: Y
65.
66. IS A SPACE DIVERSITY RECEIVER BEING USED? Y-YES,N-NO: Y
67.
68. IS THE INTERFERENCE FADED? Y-YES,N-NO: Y
69.
70. THE DOWNLINK FADING CHANNEL IS PRESENT
71. SET PARAMETERS FOR FIRST FADING CHANNEL:
72. TYPES OF FADING CHANNELS AVAILABLE:
73. 1: NO SPECULAR COMPONENT (RALEIGH FADING)
74. 2: SPECULAR COMPONENT, SHORTEST PATH
75. 3: SPECULAR COMPONENT, MEAN PATH
76. INPUT TYPE OF CHANNEL: 2
77.
78. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
79.
80. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
81.
82. Are multiple values of the specular to multipath power
83. ratio to be tested? (Y/N): Y
84.
85. Input the range of values to be tested (in DB):
86. Input the initial value (-99 -- +99,I3): 55DB
87.
88. Input the increment value (-99 -- +99,I2):
89. 10DB
90.
91. Input the final value (01 -- 99,I2): 55DB
92.
93. SET PARAMETERS FOR THE SECOND FADING CHANNEL:
94. TYPES OF FADING CHANNELS AVAILABLE:
95. 1: NO SPECULAR COMPONENT (RALEIGH FADING)
96. 2: SPECULAR COMPONENT, SHORTEST PATH
97. 3: SPECULAR COMPONENT, MEAN PATH
98. INPUT TYPE OF CHANNEL: 2
99.
100. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2):
101. 500.00 MICROSECONDS
102. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
103.
104. Are multiple values of the specular to multipath power
105. ratio to be tested? (Y/N): Y
106.
107. Input the range of values to be tested (in DB):
108. Input the initial value (-99 -- +99,I3): 55DB
109.
110. Input the increment value (-99 -- +99,I2):
111. 10DB
112.
113. Input the final value (01 -- 99,I2): 55DB
114.
115. Are multiple SNR values to be tested? Y-yes,N-no: Y
116. Input the range of SNR values to be tested (in DB):
117. Input the initial value of SNR (-99 -- +99, I3): 36 DB
118.
119. Input the increment value (01 -- 99, I2): 4 DB

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Input the ending value of SNR (-99 -- +99, I3): 40 DB
 IS A SPACE DIVERSITY RECEIVER REQUIRED? (Y/N) Y
 INPUT DURATION BETWEEN DECISION TIMES FOR THE S.O. RECEIVER (F7.5, IN SECONDS) 0.00020SEC.
 Input the approximate duration of simulation in seconds (0.01 - 9.99, F4.2): 0.01 SEC.

Type of performance measurement available:
 1. Compare recovered output signal to original input signal
 2. Measure output signal to noise ratio

Input type: 1

DO YOU WANT OUTPUT TO BE PLOTTED? Y

1-Specular to multipath power ratio- Downlink Channel
 2-Carrier to interference power ratios- UHF Downlink Channel
 3-Phase values of interference- UHF Downlink Channel
 4-Input SNR Value

Input signal	Output signal (No Noise)	Output signal (With Noise)
55.00	60.00	10.00
36.00000000		
0.1000000E 01	-0.3546265E 03	0.9127492E 02
0.9945219E 00	-0.1308870E 04	0.3438616E 03
0.9781477E 00	-0.2297429E 04	0.6371396E 03
0.9510567E 00	-0.2868278E 04	0.9103672E 03
0.9135456E 00	-0.2998826E 04	0.1268146E 04
0.8660256E 00	-0.2613447E 04	0.1859902E 04
0.8090173E 00	-0.1618970E 04	0.2839659E 04
0.7431453E 00	0.4053467E 02	0.4315348E 04
0.6691312E 00	0.2359897E 04	0.6330977E 04
0.5877859E 00	0.5289641E 04	0.8883230E 04
0.5000010E 00	0.8754652E 04	0.1193763E 05
0.4067382E 00	0.1265577E 05	0.1541877E 05
0.3090183E 00	0.1686925E 05	0.1921204E 05
0.2079136E 00	0.2125362E 05	0.2310747E 05
0.1045300E 00	0.2565789E 05	0.2720433E 05
0.2221441E-05	0.2992696E 05	0.3111771E 05
-0.1045247E 00	0.3390678E 05	0.3478890E 05
-0.2079074E 00	0.3745015E 05	0.3807883E 05
-0.3090113E 00	0.4042305E 05	0.4084572E 05
-0.4067307E 00	0.4270941E 05	0.4295670E 05
-0.4499930E 00	0.4421439E 05	0.4431964E 05
-0.587774E 00	0.4486550E 05	0.4486210E 05
-0.6691231E 00	0.4461211E 05	0.4453346E 05
-0.7431371E 00	0.4342422E 05	0.4329643E 05
-0.8090098E 00	0.4129246E 05	0.4113549E 05
-0.8660184E 00	0.3823110E 05	0.3805855E 05
-0.9510516E 00	0.3428400E 05	0.3410566E 05
-0.9135392E 00	0.2952932E 05	0.2935406E 05
-0.9781440E 00	0.2407629E 05	0.2391016E 05
-0.9945199E 00	0.1805300E 05	0.1709995E 05
-0.1000000E 01	0.1159213E 05	0.1145747E 05
-0.9945242E 00	0.4822430E 04	0.4713137E 04
-0.9781522E 00	-0.2134279E 04	-0.2213715E 04
-0.9510636E 00	-0.9164684E 04	-0.9219867E 04
-0.9135556E 00	-0.1616573E 05	-0.1621178E 05
-0.8660381E 00	-0.2304510E 05	-0.2309281E 05

180.	-0.8090329E 00	-0.2972033E 05	-0.2976236E 05
181.	-0.7431634E 00	-0.3611538E 05	-0.3613345E 05
182.	-0.6691524E 00	-0.4215837E 05	-0.4215495E 05
183.	-0.5076101E 00	-0.4777842E 05	-0.4777386E 05
184.	-0.5000271E 00	-0.5290458E 05	-0.5290686E 05
185.	-0.4067667E 00	-0.5746700E 05	-0.5748503E 05
186.	-0.3090497E 00	-0.6139990E 05	-0.6144706E 05
187.	-0.2079459E 00	-0.6464539E 05	-0.6471502E 05
189.	-0.1045648E 00	-0.6715650E 05	-0.6722169E 05
189.	-0.3710153E-04	-0.6809931E 05	-0.6893930E 05
190.	0.1044899E 00	-0.6985300E 05	-0.6986744E 05
191.	0.2078722E 00	-0.7000956E 05	-0.7000250E 05
192.	0.3089781E 00	-0.6937213E 05	-0.6934825E 05
193.	0.4066978E 00	-0.6795288E 05	-0.6792225E 05
194.	0.4999627E 00	-0.6577056E 05	-0.6574175E 05
195.	0.5677492E 00	-0.6284800E 05	-0.6282023E 05
196.	0.6690964E 00	-0.5920971E 05	-0.5918269E 05
197.	0.7431136E 00	-0.5488154E 05	-0.5486558E 05
198.	0.8089866E 00	-0.4989328E 05	-0.4989481E 05
199.	0.8660005E 00	-0.4429588E 05	-0.4429971E 05
200.	0.9135250E 00	-0.3812075E 05	-0.3813838E 05
201.	0.9510405E 00	-0.3148445E 05	-0.3150355E 05
202.	0.9781367E 00	-0.2448261E 05	-0.2451255E 05
203.	0.9945163E 00	-0.1722654E 05	-0.1727591E 05
204.	0.1000000E 01	-0.9822348E 04	-0.9886230E 04
205.	0.4945278E 00	-0.2367284E 04	-0.2432360E 04
206.	0.3791597E 00	0.5050090E 04	0.4999566E 04
207.	0.9510749E 00	0.1235017E 05	0.1232246E 05
208.	0.9135698E 00	0.1945291E 05	0.1946250E 05
209.	0.8660561E 00	0.2632707E 05	0.2635513E 05
210.	0.8000535E 00	0.3288803E 05	0.3292590E 05
211.	0.7431874E 00	0.3909482E 05	0.3913027E 05
212.	0.6691790E 00	0.4489691E 05	0.4493780E 05
213.	0.5878384E 00	0.5024172E 05	0.5028242E 05
214.	0.5000582E 00	0.5507376E 05	0.5509581E 05
215.	0.4067986E 00	0.5933614E 05	0.5933974E 05
216.	0.3090830E 00	0.6297383E 05	0.6297384E 05
217.	0.2079611E 00	0.6593744E 05	0.6593544E 05
218.	0.1045996E 00	0.6819663E 05	0.6817588E 05
219.	0.7309525E-04	0.6969169E 05	0.6968163E 05
220.	-0.1044542E 00	0.7043463E 05	0.7043706E 05
221.	-0.2078381E 00	0.7040856E 05	0.7041133E 05
222.	-0.3099439E 00	0.6961644E 05	0.6960206E 05
223.	-0.4066659E 00	0.6806944E 05	0.6804369E 05
224.	-0.4999316E 00	0.6578450E 05	0.6576169E 05
225.	-0.5877201E 00	0.6278211E 05	0.6276499E 05
226.	-0.6690704E 00	0.5908429E 05	0.5906898E 05
227.	-0.7130896E 00	0.5471427E 05	0.5470021E 05
228.	-0.8089681E 00	0.4969926E 05	0.4968748E 05
229.	-0.8659830E 00	0.4407779E 05	0.4406672E 05
230.	-0.9135104E 00	0.3790904E 05	0.3789540E 05
231.	-0.9510297E 00	0.3127739E 05	0.3126080E 05
232.	-0.9781253E 00	0.2428645E 05	0.2427244E 05
233.	-0.9945125E 00	0.1704566E 05	0.1704160E 05
234.	-0.1000000E 01	0.9659547E 04	0.9667125E 04
235.	-0.9945316E 00	0.2224056E 04	0.2236339E 04
236.	-0.9781669E 00	-0.5173293E 04	-0.5167508E 04
237.	-0.9510657E 00	-0.1245371E 05	-0.1246022E 05
238.	-0.9135844E 00	-0.1954774E 05	-0.1956504E 05
239.	-0.8660736E 00	-0.2639459E 05	-0.2641453E 05

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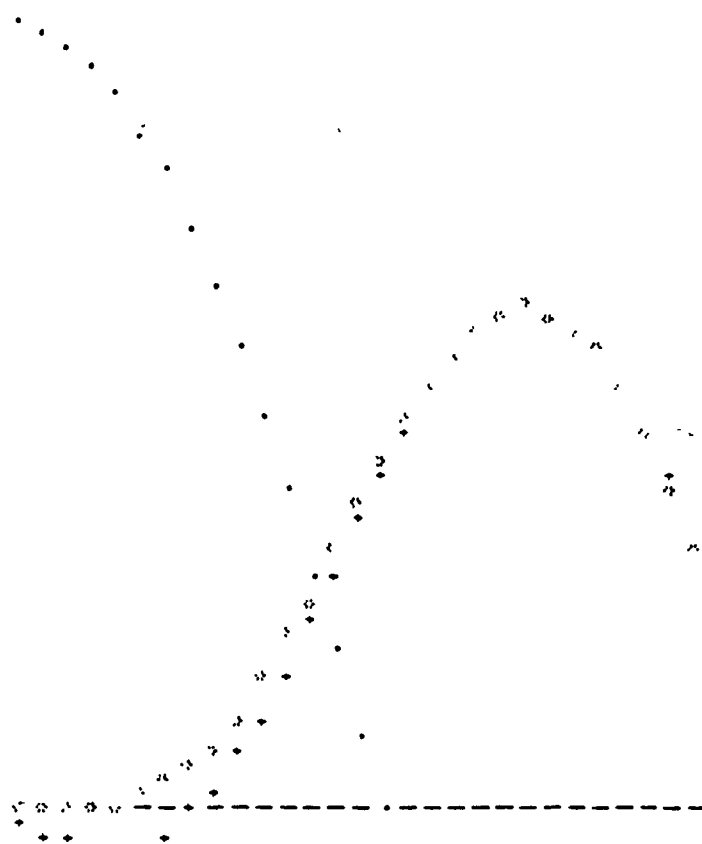
-0.3252382E 05
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 -0.1020682E 05

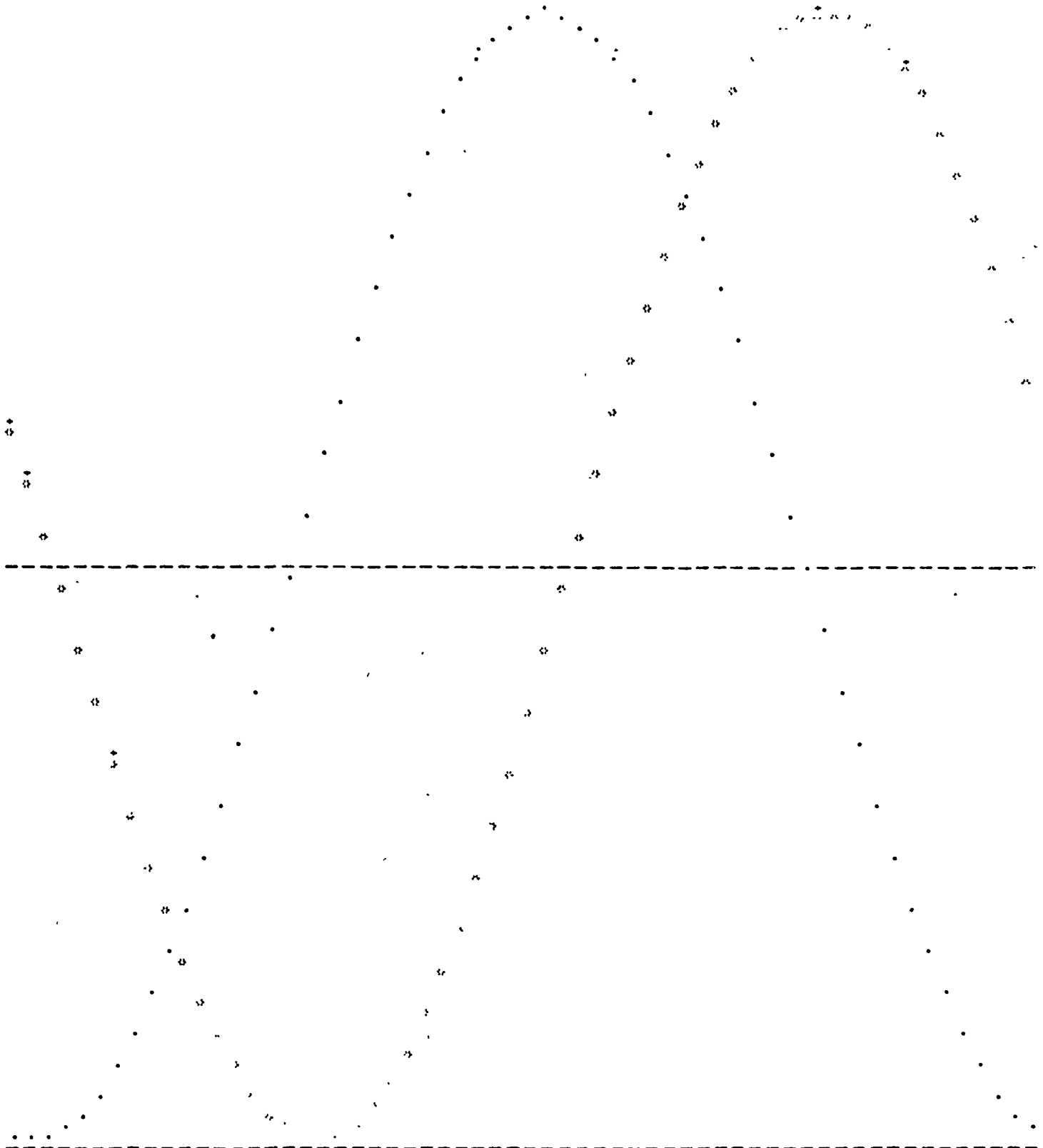
-0.8134990E 00
 -0.7452617E 00
 -0.6744396E 00
 -0.5940157E 00
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 -0.4138190E 00
 -0.3164213E 00
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 0.5813091E 00
 0.683159E 00
 0.7377512E 00
 0.8042567E 00
 0.8619632E 00
 0.9102221E 00
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 0.999966E 00

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 .: INPUT SIGNAL, +=OUTPUT-NO NOISE, *=FADED OUTPUT
 .: 1-SPACE= 0.181818E-01
 .: 1-SPACE= 0.128003E 04
 .: 1-SPACE= 0.128119E 04
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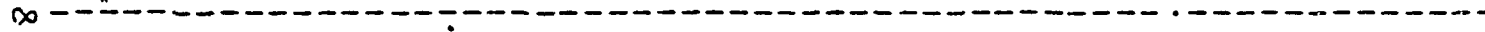


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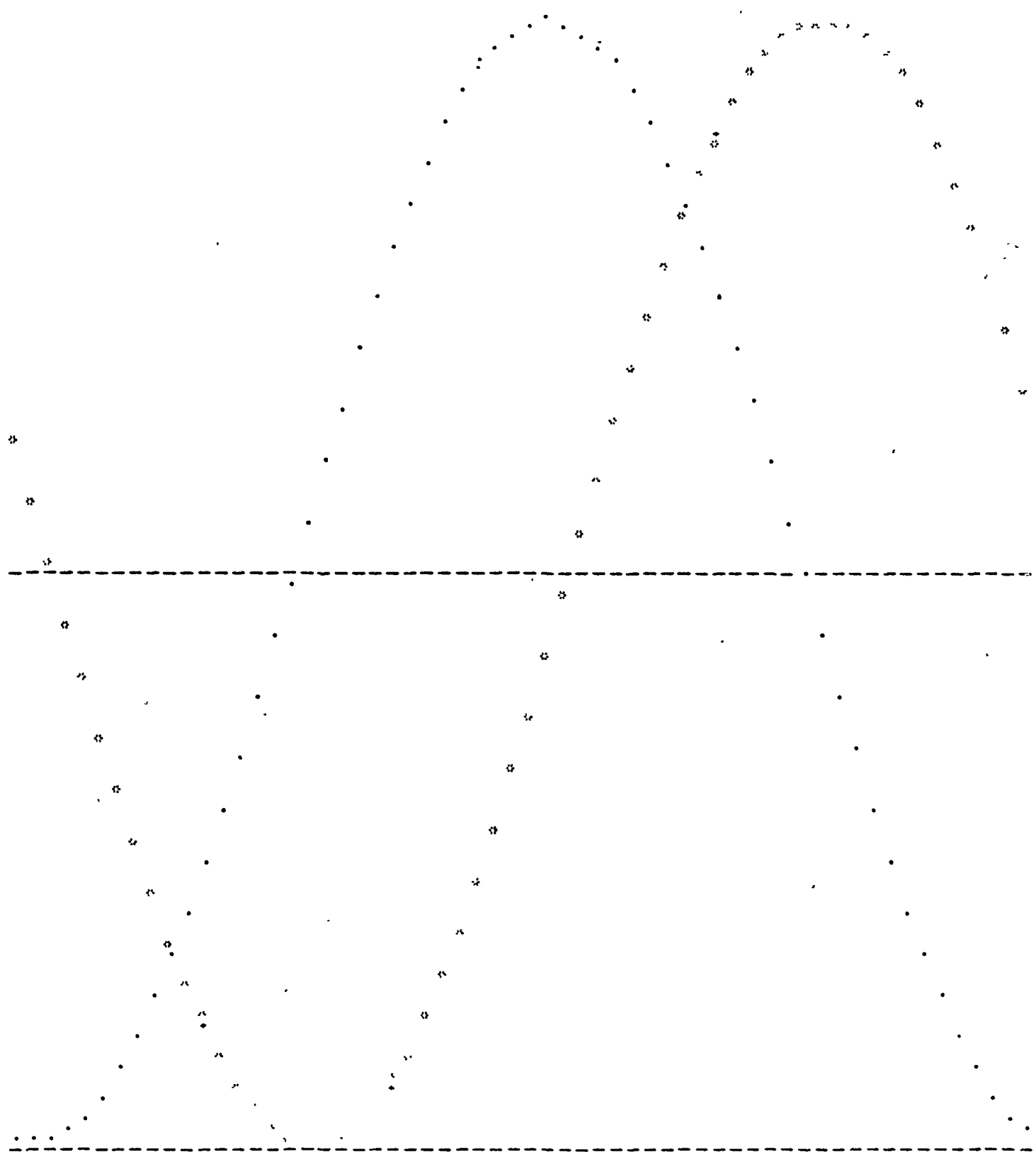
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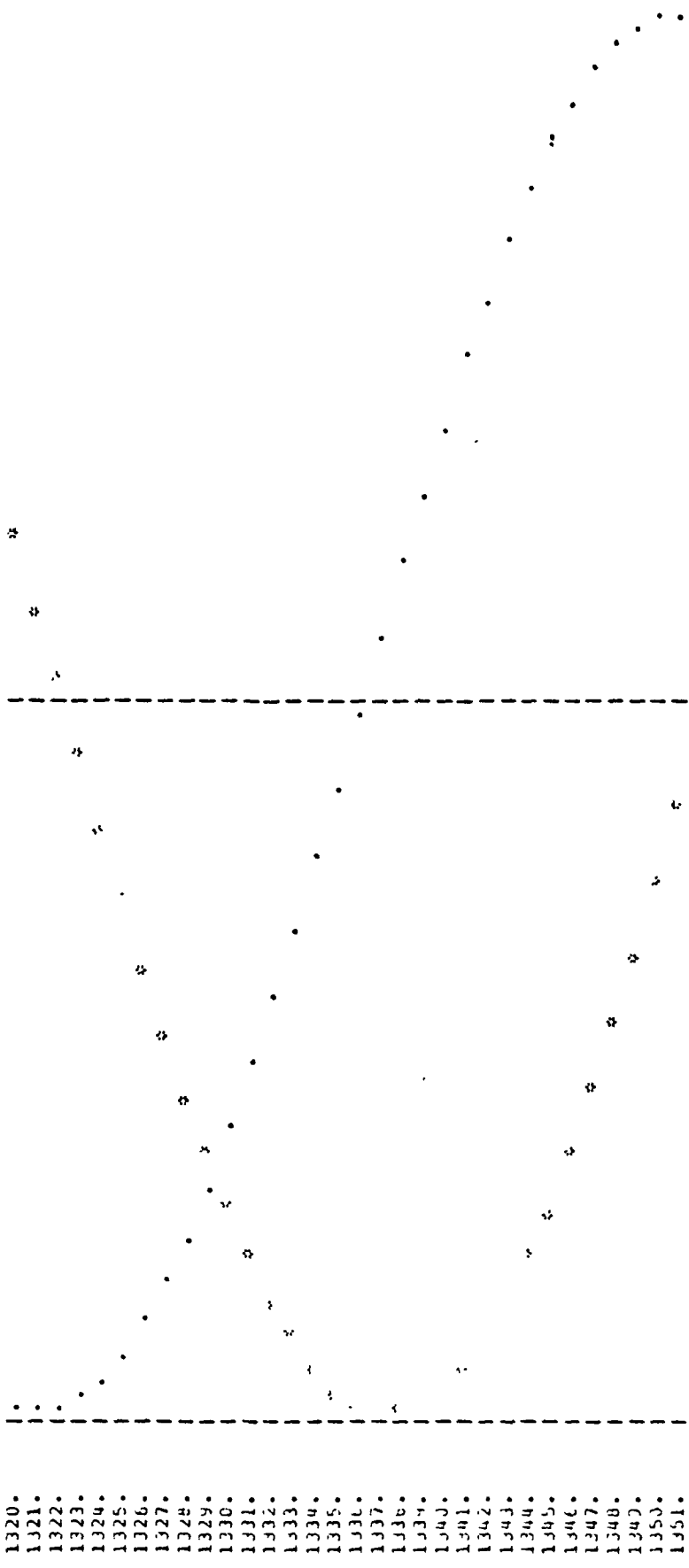
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1320.	0.1000000E 01	0.277237E 04	0.2795974E 04	0.4803941E 04	Output signal (With Noise)
1321.	0.5945219E 00	0.4938637E 04	0.4803941E 04	0.4803941E 04	0.4803941E 04
1322.	0.9711477E 00	0.1286013E 05	0.1282080E 05	0.1282080E 05	0.1282080E 05
1323.	0.9510567E 00	0.2100996E 05	0.2098013E 05	0.2098013E 05	0.2098013E 05
1324.	0.9135456E 00	0.2073141E 05	0.2873204E 05	0.2873204E 05	0.2873204E 05
1325.	0.8660456E 00	0.3586253E 05	0.3586194E 05	0.3586194E 05	0.3586194E 05
1326.	0.8090173E 00	0.4242026E 05	0.4245413E 05	0.4245413E 05	0.4245413E 05
1327.	0.7431453E 00	0.4839245E 05	0.4841986E 05	0.4841986E 05	0.4841986E 05
1328.	0.6691312E 00	0.5374292E 05	0.5376315E 05	0.5376315E 05	0.5376315E 05
1329.	0.5877859E 00	0.5849212E 05	0.5849972E 05	0.5849972E 05	0.5849972E 05
1330.	0.5000010E 00	0.6259657E 05	0.6260185E 05	0.6260185E 05	0.6260185E 05
1331.	0.4057562E 00	0.6605913E 05	0.6607675E 05	0.6607675E 05	0.6607675E 05
1332.	0.3090103E 00	0.6888213E 05	0.6889513E 05	0.6889513E 05	0.6889513E 05
1333.	0.2079136E 00	0.7101725E 05	0.7103463E 05	0.7103463E 05	0.7103463E 05
1334.	0.1045300E 00	0.7245975E 05	0.7248288E 05	0.7248288E 05	0.7248288E 05
1335.	0.2221441E -05	0.7320056E 05	0.7322319E 05	0.7322319E 05	0.7322319E 05
1336.	-0.1045247E 00	0.7323656E 05	0.7324936E 05	0.7324936E 05	0.7324936E 05
1337.	-0.2079074E 00	0.7257094E 05	0.7257475E 05	0.7257475E 05	0.7257475E 05
1338.	-0.3090113E 00	0.7121225E 05	0.7121025E 05	0.7121025E 05	0.7121025E 05
1339.	-0.4067307E 00	0.6917375E 05	0.6916423E 05	0.6916423E 05	0.6916423E 05
1340.	-0.499930E 00	0.6647131E 05	0.6645313E 05	0.6645313E 05	0.6645313E 05
1341.	-0.5817774E 00	0.6312226E 05	0.6309744E 05	0.6309744E 05	0.6309744E 05

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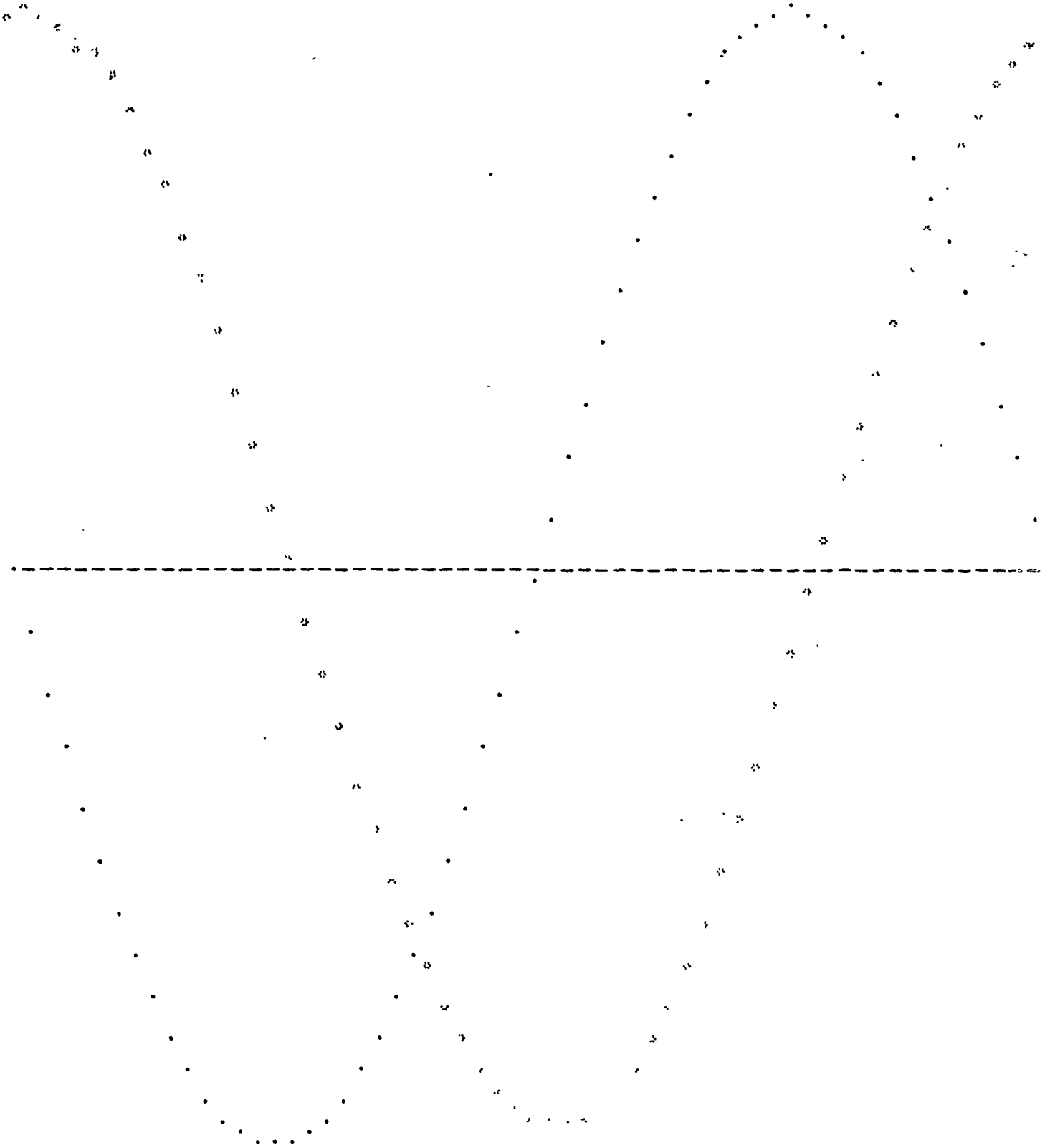
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1921.	-0.7391990E 00	0.5501893E 05	0.5501455E 05
1922.	-0.6046411E 00	0.5004760E 05	0.5003273E 05
1923.	-0.8622911E 00	0.4446686E 05	0.4444214E 05
1924.	-0.9104099E 00	0.3833419E 05	0.3830366E 05
1925.	-0.5437236E 00	0.3173232E 05	0.3170295E 05
1926.	-0.9755623E 00	0.2476386E 05	0.2474148E 05
1927.	-0.4937092E 00	0.1753824E 05	0.1752593E 05
1928.	-0.9999716E 00	0.1016046E 05	0.1015360E 05
1929.	-0.9952626E 00	0.2727003E 04	0.2720426E 04
1930.	-0.3796954E 00	-0.4674066E 04	-0.4675146E 04
1931.	-0.9533756E 00	-0.1196336E 05	-0.1194940E 05
1932.	-0.4156194E 00	-0.1907083E 05	-0.1904743E 05
1933.	-0.4536184E 00	-0.2593510E 05	-0.2591674E 05
1934.	-0.6134990E 00	-0.3250172E 05	-0.3248980E 05
1935.	-0.7452617E 00	-0.3871952E 05	-0.3870435E 05
1936.	-0.6748396E 00	-0.4453823E 05	-0.4451641E 05
1937.	-0.5940157E 00	-0.4993544E 05	-0.4980629E 05
1938.	-0.5069844E 00	-0.5476582E 05	-0.5475410E 05
1939.	-0.4138190E 00	-0.5906240E 05	-0.5905006E 05
1940.	-0.3164213E 00	-0.6273977E 05	-0.6272255E 05
1941.	-0.2155438E 00	-0.6574788E 05	-0.6573019E 05
1942.	-0.1123201E 00	-0.6804544E 05	-0.6803163E 05
1943.	-0.7052316E-02	-0.6960189E 05	-0.6959406E 05
1944.	0.9669678E-01	-0.7039819E 05	-0.7039825E 05
1945.	0.2001623E 00	-0.7042656E 05	-0.7043138E 05
1946.	0.3014705E 00	-0.6968913E 05	-0.6969200E 05
1947.	0.3994715E 00	-0.6819644E 05	-0.6819775E 05
1948.	0.430638E 00	-0.6596494E 05	-0.6597188E 05
1949.	0.5413091E 00	-0.6301495E 05	-0.6302990E 05
1950.	0.6631559E 00	-0.5935823E 05	-0.5938573E 05
1951.	0.7377512E 00	-0.5504783E 05	-0.5506212E 05
1952.	0.8042567E 00	-0.5008044E 05	-0.5008456E 05
1953.	0.9619132E 00	-0.4450318E 05	-0.4450699E 05
1954.	0.9102221E 00	-0.3837396E 05	-0.3837339E 05
1955.	0.9425186E 00	-0.3177475E 05	-0.3177151E 05
1956.	0.9764227E 00	-0.2490826E 05	-0.2480193E 05
1957.	0.9936365E 00	-0.1758392E 05	-0.1757286E 05
1958.	0.9999666E 00	-0.1020677E 05	-0.1019132E 05
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=IN,UI SIGNAL,=OUTPUT-NO NOISE, =FADED OUTPUT
=: I-SPACE= 0.181818E-01
=: I-SPACE= 0.133157E 04
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SIGTP=1

Is this an online session? (Y/N)

N

TYPE OF CALL AVAILABLE:

- 1: M1->M2, rural mobile to rural mobile in same UHF beam
- 2: M1->M3, rural mobile to rural mobile in different UHF beam, in same S-band
- 3: M1->M4, rural mobile to rural mobile in different UHF beam, in different S-band
- 4: M1->FC1, rural mobile to fixed in same S-band beam
- 5: M1->FC2, rural mobile to fixed in different S-band beam
- 6: FC1->M1, fixed to rural mobile in same S-band beam
- 7: FC2->M1, fixed to rural mobile in different S-band beam

INPUT TYPE OF CALL TO BE SIMULATED:

1

MODE OF CALL AVAILABLE:

- 1: M1->M2, hard wired transponder
- 2: M1->M2, direct switched transponder
- 3: M1->M2, indirect switched transponder
- 4: M1->G1->M2, double hop system

INPUT MODE OF CALL TO BE SIMULATED:

1

FREQUENCY OF THE BASEBAND SIGNAL (LESS THAN 3000 HZ.) (IN HERTZ, F7.2): 1000.00 HZ

NOTE : POWER OF THE BASEBAND SIGNAL HAS TO BE LESS OR EQUAL THAN .5 WATTS:
SO THAT THE MAXIMUM INSTANTANEOUS FREQUENCY DEVIATION IS
LESS OR EQUAL THAN 12000 HZ

POWER OF THE BASEBAND SIGNAL(IN WATTS, F7.2): 0.50 WATTS

THE CARRIER POWER (IN WATTS, F7.2): 1.00 WATTS

THE FREQUENCY DEVIATION (IN HERTZ, F8.2): 12000 HZ. (FIXED FOR NOW)

How many times the nyquist rate do you want the sampling frequency to be? (2 - 4, I1): 2

THE CARRIER FREQUENCY (IN HERTZ, F7.2): (NOT USED FOR NOW)

DO YOU WANT THE COMPRESSOR/EXPANDER IN? Y-YES, N-NO : Y

DO YOU WANT THE PRE-EMPHASIS - DE-EMPHASIS FILTERS IN ? Y-YES, N-NO : Y

DO YOU WANT A CO-CHANNEL INTERFERER IN THE UPLINK? Y-YES, N-NO: Y

Are multiple values of the carrier to interference power ratio to be tested? (Y/N): Y

Input the range of values to be tested (in DB):

Input the initial value (-99 -- +99.13) : 30DB

Input the increment value (01 -- 99.13) : 10DB

Input the final value (01 -- 99.13) : 40DB

Are multiple values of the interference phase values to be tested? (Y/N): Y

Input the range of values to be tested (in degrees):

Input the initial value (F6.2) : 5.00 DEGREES

Input the increment value (F6.2) : 1.00 DEGREES

Input the final value (F6.2) :

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60. IS FADING PRESENT IN THE UPLINK CHANNEL? Y-YES,N-NO: Y

61. IS THE INTERFERENCE FADED? Y-YES,N-NO: Y

62. THE UPLINK FADING CHANNEL IS PRESENT

63. TYPES OF FADING CHANNELS AVAILABLE:

64. 1: NO SPECULAR COMPONENT (RALEIGH FADING)

65. 2: SPECULAR COMPONENT, SHORTEST PATH

66. 3: SPECULAR COMPONENT, MEAN PATH

67. INPUT TYPE OF CHANNEL: 2

68. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS

69. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ

70. Are multiple values of the specular to multipath power ratio to be tested? (Y/N): Y

71. Input the range of values to be tested (in DB):

72. Input the initial value (-99 -- +99,I3): 50DB

73. Input the increment value (-99 -- +99,I2): 10DB

74. Input the final value (01 -- 99,I2): 60DB

75. DO YOU WANT A CO-CHANNEL INTERFERER IN THE DOWNLINK? Y-YES,N-NO: Y

76. Are multiple values of the carrier to interference power ratio to be tested? (Y/N): Y

77. Input the range of values to be tested (in DB):

78. Input the initial value (-99 -- +99,I3): 10DB

79. Input the increment value (01 -- 99,I3): 10DB

80. Input the final value (01 -- 99,I3): 20DB

81. Are multiple values of the interference phase values to be tested? (Y/N): Y

82. Input the range of values to be tested (in dearees):

83. Input the initial value (F6.2): 10.00DEGREES

84. Input the increment value (F6.2): 5.00DEGREES

85. Input the final value (F6.2): 15.00DEGREES

86. IS FADING PRESENT IN THE DOWNLINK CHANNEL? Y-YES,N-NO: Y

87. IS A SPACE DIVERSITY RECEIVER BEING USED? Y-YES,N-NO: Y

88. IS THE INTERFERENCE FADED? Y-YES,N-NO: Y

89. THE DOWNLINK FADING CHANNEL IS PRESENT

90. SET PARAMETERS FOR FIRST FADING CHANNEL:

91. TYPES OF FADING CHANNELS AVAILABLE:

92. 1: NO SPECULAR COMPONENT (RALEIGH FADING)

93. 2: SPECULAR COMPONENT, SHORTEST PATH

94. 3: SPECULAR COMPONENT, MEAN PATH

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120. INPUT TYPE OF CHANNEL: 2
 121. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
 122. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
 123. Are multiple values of the specular to multipath power ratio to be tested? (Y/N): Y
 124. Input the range of values to be tested (in DB):
 125. Input the initial value (-99 -- +99,I3): 11DB
 126. Input the increment value (-99 -- +99,I2): 10DB
 127. Input the final value (01 -- 99,I3): 23DB
 128. SET PARAMETERS FOR THE SECOND FADING CHANNEL:
 129. TYPES OF FADING CHANNELS AVAILABLE:
 130. 1: NO SPECULAR COMPONENT (RALEIGH FADING)
 131. 2: SPECULAR COMPONENT, SHORTEST PATH
 132. 3: SPECULAR COMPONENT, MEAN PATH
 133. INPUT TYPE OF CHANNEL: 2
 134. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
 135. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
 136. Are multiple values of the specular to multipath power ratio to be tested? (Y/N): Y
 137. Input the range of values to be tested (in DB):
 138. Input the initial value (-99 -- +99,I3): 11DB
 139. Input the increment value (-99 -- +99,I2): 10DB
 140. Input the final value (01 -- 99,I3): 23DB
 141. Are multiple SNR values to be tested? Y-yes,N-no: Y
 142. Input the range of SNR values to be tested (in Db):
 143. Input the initial value of SNR (-99 -- +99, I3): 10 DB
 144. Input the increment value (01 -- 99, I2): 4 DB
 145. Input the ending value of SNR (-99 -- +99, I3): 40 DB
 146. IS A SPACE DIVERSITY RECEIVER REQUIRED? (Y/N) Y
 147. INPUT DURATION BETWEEN DECISION TIMES FOR THE S.D. RECEIVER (F7.5, IN SECONDS) 0.00020SEC.
 148. Input the approximate duration of simulation in seconds (0.01 - 9.99, F4.2): 0.01 SEC.
 149. Type of performance measurement available:
 150. 1. Compare recovered output signal to original input signal
 151. 2. Measure output signal to noise ratio
 152. Input type: 2
 153. 1-Specular to multipath power ratio- Uplink Channel.
 154. 2-Specular to multipath power ratio- Downlink Channel
 155. 3-Carrier to interference power ratios- UHF Uplink Channel

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180.	50.00	11.00	30.00	5.00	10.00	10.00	10.00000000	30.3934021
181.	50.00	11.00	30.00	5.00	10.00	10.00	14.00000000	47.3245239
182.	50.00	11.00	30.00	5.00	10.00	10.00	18.00000000	50.2981110
183.	50.00	11.00	30.00	5.00	10.00	10.00	22.00000000	51.2792206
184.	50.00	11.00	30.00	5.00	10.00	10.00	26.00000000	54.7541809
185.	50.00	11.00	30.00	5.00	10.00	10.00	30.00000000	52.6393585
186.	50.00	11.00	30.00	5.00	10.00	10.00	34.00000000	56.1096954
187.	50.00	11.00	30.00	5.00	10.00	10.00	38.00000000	56.5043640
188.	50.00	11.00	30.00	5.00	10.00	15.00	10.00000000	44.7787476
189.	50.00	11.00	30.00	5.00	10.00	15.00	14.00000000	48.3026123
190.	50.00	11.00	30.00	5.00	10.00	15.00	18.00000000	49.7561340
191.	50.00	11.00	30.00	5.00	10.00	15.00	22.00000000	50.7476758
192.	50.00	11.00	30.00	5.00	10.00	15.00	26.00000000	56.9706879
193.	50.00	11.00	30.00	5.00	10.00	15.00	30.00000000	56.2624512
194.	50.00	11.00	30.00	5.00	10.00	15.00	34.00000000	56.3648682
195.	50.00	11.00	30.00	5.00	10.00	15.00	38.00000000	53.2024231
196.	50.00	11.00	30.00	5.00	10.00	15.00	10.00000000	43.4536896
197.	50.00	11.00	30.00	5.00	20.00	10.00	10.00000000	45.6832581
198.	50.00	11.00	30.00	5.00	20.00	10.00	14.00000000	49.5198517
199.	50.00	11.00	30.00	5.00	20.00	10.00	18.00000000	51.9888763
200.	50.00	11.00	30.00	5.00	20.00	10.00	22.00000000	52.6079559
201.	50.00	11.00	30.00	5.00	20.00	10.00	26.00000000	54.6950989
202.	50.00	11.00	30.00	5.00	20.00	10.00	30.00000000	53.6224518
203.	50.00	11.00	30.00	5.00	20.00	10.00	34.00000000	56.5738373
204.	50.00	11.00	30.00	5.00	20.00	10.00	38.00000000	44.2585754
205.	50.00	11.00	30.00	5.00	20.00	15.00	10.00000000	47.7853851
206.	50.00	11.00	30.00	5.00	20.00	15.00	14.00000000	50.1994781
207.	50.00	11.00	30.00	5.00	20.00	15.00	18.00000000	51.7635803
208.	50.00	11.00	30.00	5.00	20.00	15.00	22.00000000	56.5586243
209.	50.00	11.00	30.00	5.00	20.00	15.00	26.00000000	53.9149475
210.	50.00	11.00	30.00	5.00	20.00	15.00	30.00000000	57.5394592
211.	50.00	11.00	30.00	5.00	20.00	15.00	34.00000000	54.8444366
212.	50.00	11.00	30.00	5.00	20.00	10.00	10.00000000	45.7154999
213.	50.00	11.00	30.00	5.00	20.00	10.00	14.00000000	47.1175690
214.	50.00	11.00	30.00	5.00	20.00	10.00	18.00000000	50.5426788
215.	50.00	11.00	30.00	5.00	20.00	10.00	22.00000000	51.5821686
216.	50.00	11.00	30.00	5.00	20.00	10.00	26.00000000	55.7178497
217.	50.00	11.00	30.00	5.00	20.00	10.00	30.00000000	51.3821564
218.	50.00	11.00	30.00	5.00	20.00	10.00	34.00000000	53.1560211
219.	50.00	11.00	30.00	5.00	20.00	10.00	38.00000000	53.6389618
220.	50.00	11.00	30.00	5.00	20.00	10.00	10.00000000	45.3472900
221.	50.00	11.00	30.00	5.00	20.00	15.00	14.00000000	48.1585999
222.	50.00	11.00	30.00	5.00	20.00	15.00	18.00000000	49.5726776
223.	50.00	11.00	30.00	5.00	20.00	15.00	22.00000000	52.5801348
224.	50.00	11.00	30.00	5.00	20.00	15.00	26.00000000	52.2198944
225.	50.00	11.00	30.00	5.00	20.00	15.00	30.00000000	54.8355865
226.	50.00	11.00	30.00	5.00	20.00	15.00	34.00000000	58.1746674
227.	50.00	11.00	30.00	5.00	20.00	15.00	38.00000000	55.4336243
228.	50.00	11.00	30.00	5.00	20.00	10.00	10.00000000	43.6742096
229.	50.00	11.00	30.00	5.00	20.00	10.00	14.00000000	46.3095856
230.	50.00	11.00	30.00	5.00	20.00	10.00	18.00000000	48.9533997
231.	50.00	11.00	30.00	5.00	20.00	10.00	22.00000000	49.1971588
232.	50.00	11.00	30.00	5.00	20.00	10.00	26.00000000	54.4777325
233.	50.00	11.00	30.00	5.00	20.00	10.00	30.00000000	
234.	50.00	11.00	30.00	5.00	20.00	10.00	34.00000000	
235.	50.00	11.00	30.00	5.00	20.00	10.00	38.00000000	
236.	50.00	11.00	30.00	5.00	20.00	10.00	10.00000000	
237.	50.00	11.00	30.00	5.00	20.00	10.00	14.00000000	
238.	50.00	11.00	30.00	5.00	20.00	10.00	18.00000000	
239.	50.00	11.00	30.00	5.00	20.00	10.00	22.00000000	
240.	50.00	11.00	30.00	5.00	20.00	10.00	26.00000000	

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240.	50.00	11.00	30.00	6.00	20.00	10.00	30.00000000	51.7566528
241.	50.00	11.00	30.00	6.00	20.00	10.00	38.00000000	56.4712982
242.	50.00	11.00	30.00	6.00	20.00	10.00	36.00000000	58.0856659
243.	50.00	11.00	30.00	6.00	20.00	15.00	10.00000000	43.9559326
244.	50.00	11.00	30.00	6.00	20.00	15.00	14.00000000	46.8102417
245.	50.00	11.00	30.00	6.00	20.00	15.00	18.00000000	50.4700731
246.	50.00	11.00	30.00	6.00	20.00	15.00	22.00000000	52.0825348
247.	50.00	11.00	30.00	6.00	20.00	15.00	26.00000000	48.2390594
248.	50.00	11.00	30.00	6.00	20.00	15.00	30.00000000	49.6101379
249.	50.00	11.00	30.00	6.00	20.00	15.00	34.00000000	58.3103790
250.	50.00	11.00	30.00	6.00	20.00	15.00	30.00000000	56.8903198
251.	50.00	11.00	40.00	5.00	10.00	10.00	10.00000000	44.8637543
252.	50.00	11.00	40.00	5.00	10.00	10.00	14.00000000	47.4381714
253.	50.00	11.00	40.00	5.00	10.00	10.00	18.00000000	49.4681702
254.	50.00	11.00	40.00	5.00	10.00	10.00	22.00000000	51.1010895
255.	50.00	11.00	40.00	5.00	10.00	10.00	26.00000000	52.2202301
256.	50.00	11.00	40.00	5.00	10.00	10.00	30.00000000	53.9355164
257.	50.00	11.00	40.00	5.00	10.00	10.00	34.00000000	52.8522644
258.	50.00	11.00	40.00	5.00	10.00	10.00	38.00000000	55.8222351
259.	50.00	11.00	40.00	5.00	10.00	15.00	10.00000000	44.6431580
260.	50.00	11.00	40.00	5.00	10.00	15.00	14.00000000	47.5508575
261.	50.00	11.00	40.00	5.00	10.00	15.00	18.00000000	50.2478333
262.	50.00	11.00	40.00	5.00	10.00	15.00	22.00000000	52.2345428
263.	50.00	11.00	40.00	5.00	10.00	15.00	26.00000000	55.0059662
264.	50.00	11.00	40.00	5.00	10.00	15.00	30.00000000	56.0988922
265.	50.00	11.00	40.00	5.00	10.00	15.00	34.00000000	56.1244202
266.	50.00	11.00	40.00	5.00	10.00	15.00	38.00000000	53.4188232
267.	50.00	11.00	40.00	5.00	20.00	10.00	10.00000000	44.6074371
268.	50.00	11.00	40.00	5.00	20.00	10.00	14.00000000	49.0097961
269.	50.00	11.00	40.00	5.00	20.00	10.00	18.00000000	47.6365051
270.	50.00	11.00	40.00	5.00	20.00	10.00	22.00000000	52.2730255
271.	50.00	11.00	40.00	5.00	20.00	10.00	26.00000000	53.8841705
272.	50.00	11.00	40.00	5.00	20.00	10.00	30.00000000	53.2715454
273.	50.00	11.00	40.00	5.00	20.00	10.00	34.00000000	57.8299561
274.	50.00	11.00	40.00	5.00	20.00	10.00	38.00000000	54.3217926
275.	50.00	11.00	40.00	5.00	20.00	15.00	10.00000000	44.5611572
276.	50.00	11.00	40.00	5.00	20.00	15.00	14.00000000	47.4875946
277.	50.00	11.00	40.00	5.00	20.00	15.00	18.00000000	52.7612762
278.	50.00	11.00	40.00	5.00	20.00	15.00	22.00000000	52.9886627
279.	50.00	11.00	40.00	5.00	20.00	15.00	26.00000000	54.1265869
280.	50.00	11.00	40.00	5.00	20.00	15.00	30.00000000	55.7081604
281.								

CITY UNIVERSITY / UNIVERSITY COMPUTER CENTER

1: Is this an online session? (Y/N) N

TYPE OF CALL AVAILABLE:

- 1: M1->M2, rural mobile to rural mobile in same UHF beam
- 2: M1->M3, rural mobile to rural mobile in different UHF beam, in same S-band
- 3: M1->M4, rural mobile to rural mobile in different UHF beam, in different S-band
- 4: M1->FC1, rural mobile to fixed in same S-band beam
- 5: M1->FC2, rural mobile to fixed in different S-band beam
- 6: FC1->M1, fixed to rural mobile in same S-band beam
- 7: FC2->M1, fixed to rural mobile in different S-band beam

INPUT TYPE OF CALL TO BE SIMULATED: 1

MODE OF CALL AVAILABLE:

- 1: M1->M2, hard wired transponder
- 2: M1->M2, direct switched transponder
- 3: M1->M2, indirect switched transponder
- 4: M1->G1->M2, double hop system

INPUT MODE OF CALL TO BE SIMULATED: 2

TYPE OF SIGNAL SOURCES AVAILABLE:

- 1: Program generated single tone sinusoid.
- 2: Sampled voice from tape source.

Choose type of signal to be used (I1) : 1

FREQUENCY OF THE BASEBAND SIGNAL (LESS THAN 3000 HZ.) (IN HERTZ, F7.2): 1000.00 HZ

NOTE : POWER OF THE BASEBAND SIGNAL HAS TO BE LESS OR EQUAL THAN .5 WATTS;
SO THAT THE MAXIMUM INSTANTANEOUS FREQUENCY DEVIATION IS
LESS OR EQUAL THAN 12000 HZ

POWER OF THE BASEBAND SIGNAL(IN WATTS, F7.2): 0.50 WATTS

THE CARRIER POWER (IN WATTS, F7.2): 1.00 WATTS

THE FREQUENCY DEVIATION (IN HERTZ, F8.2): 12000 HZ. (FIXED FOR NOW)

How many times the nyquist rate do you want the sampling frequency to be? (2 - 4, I1): 2

THE CARRIER FREQUENCY (IN HERTZ, F7.2):(NOT USED FOR NOW)

DO YOU WANT THE COMPRESSOR/EXPANDER IN? Y-YES , N-NO : Y

DO YOU WANT THE PRE-EMPHASIS - DE-EMPHASIS FILTERS IN ? Y-YES , N-NO : N

DO YOU WANT A CO-CHANNEL INTERFERER IN THE UPLINK? Y-YES,N-NO: Y

Are multiple values of the carrier to interference power ratio to be tested? (Y/N): Y

Input the range of values to be tested (in DB):

Input the initial value (-99 -- +99,I3) : 0DB

Input the increment value (01 -- 99,I3) : 4DB

Input the final value (01 -- 99,I3) : 20DB

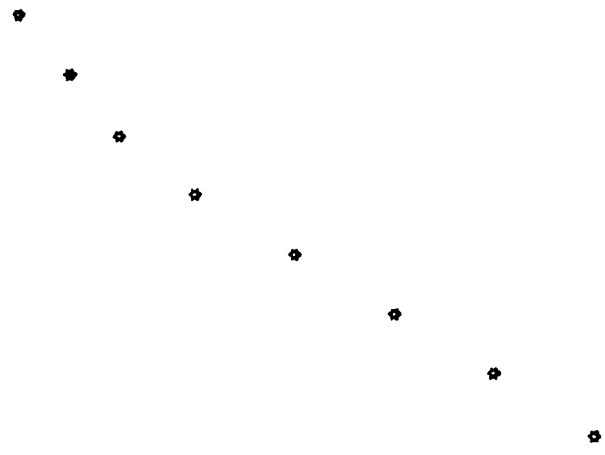
Are multiple values of the interference phase values to be tested? (Y/N) : N

INPUT PHASE OF INTERFERENCE IN DEGREES (F7.2):

IS FADING PRESENT IN THE UHF - UPLINK CHANNEL? Y-YES,N-NO: 0.0 DEGREES

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TYPE OF CALL AVAILABLE:
1: M1->M2, rural mobile to rural mobile in same UHF beam
2: M1->M3, rural mobile to rural mobile in different UHF beam, in same S-band
3: M1->M4, rural mobile to rural mobile in different UHF beam, in different S-band
4: M1->FC1, rural mobile to fixed in same S-band beam
5: M1->FC2, rural mobile to fixed in different S-band beam
6: FC1->M1, fixed to rural mobile in same S-band beam
7: FC2->M1, fixed to rural mobile in different S-band beam
INPUT TYPE OF CALL TO BE SIMULATED: 1

MODE OF CALL AVAILABLE:
1: M1->M2, hard wired transponder
2: M1->M2, direct switched transponder
3: M1->M2, indirect switched transponder
4: M1->G1->M2, double hop system
INPUT MODE OF CALL TO BE SIMULATED: 4

TYPE OF SIGNAL SOURCES AVAILABLE:
1: Program generated single tone sinusoid.
2: Sampled voice from tape source.
Choose type of signal to be used (I1) : 1

FREQUENCY OF THE BASEBAND SIGNAL (LESS THAN 3000 HZ.) (IN HERTZ, F7.2): 1000.00 HZ
NOTE : POWER OF THE BASEBAND SIGNAL HAS TO BE LESS OR EQUAL THAN .5 WATTS;
SO THAT THE MAXIMUM INSTANTANEOUS FREQUENCY DEVIATION IS
LESS OR EQUAL THAN 12000 HZ

POWER OF THE BASEBAND SIGNAL(IN WATTS, F7.2): 0.50 WATTS
THE CARRIER POWER (IN WATTS, F7.2): 1.00 WATTS
THE FREQUENCY DEVIATION (IN HERTZ, F8.2): 12000 HZ. (FIXED FOR NOW)
How many times the nyquist rate do you want the sampling frequency to be? (2 - 4, I1): 2

THE CARRIER FREQUENCY (IN HERTZ, F7.2):(NOT USED FOR NOW)
DO YOU WANT THE COMPRESSOR/EXPANDER IN? Y-YES, N-NO : Y
DO YOU WANT THE PRE-EMPHASIS - DE-EMPHASIS FILTERS IN ? Y-YES, N-NO : N
DO YOU WANT A CO-CHANNEL INTERFERER IN THE UPLINK? Y-YES, N-NO: N

IS FADING PRESENT IN THE UHF - UPLINK CHANNEL? Y-YES, N-NO: Y
IS THE INTERFERENCE FADED? Y-YES, N-NO: N
THE UPLINK FADING CHANNEL IS PRESENT
TYPES OF FADING CHANNELS AVAILABLE:
1: NO SPECULAR COMPONENT (RALEIGH FADING)
2: SPECULAR COMPONENT, SHORTEST PATH
3: SPECULAR COMPONENT, MEAN PATH
INPUT TYPE OF CHANNEL: 2

ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
Are multiple values of the specular to multipath power

- 60. ratio to be tested? (Y/N): Y
- 61. Input the range of values to be tested (In DB):
- 62. Input the initial value (-99 -- +99,I3): 10DB
- 64. Input the increment value (-99 -- +99,I2): 25DB
- 66. Input the final value (01 -- 99,I2): 90DB
- 68. DO YOU WANT A CO-CHANNEL INTERFERER IN THE S-BAND DOWNLINK? Y-YES,N-NO: N
- 70. IS FADING PRESENT IN THE S-BAND DOWNLINK CHANNEL? Y-YES,N-NO: Y
- 72. IS A SPACE DIVERSITY RECEIVER BEING USED? Y-YES,N-NO: N
- 74. THE DOWNLINK FADING CHANNEL IS PRESENT
- 75. SET PARAMETERS FOR FADING CHANNEL.
- 76. TYPES OF FADING CHANNELS AVAILABLE:
- 77. 1: NO SPECULAR COMPONENT (RALEIGH FADING)
- 78. 2: SPECULAR COMPONENT, SHORTEST PATH
- 79. 3: SPECULAR COMPONENT, MEAN PATH
- 80. INPUT TYPE OF CHANNEL: 2
- 82. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
- 84. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
- 86. Are multiple values of the specular to multipath power ratio to be tested? (Y/N): Y
- 88. Input the range of values to be tested (In DB):
- 90. Input the initial value (-99 -- +99,I3): 11DB
- 92. Input the increment value (-99 -- +99,I2): 25DB
- 94. Input the final value (01 -- 99,I2): 90DB
- 96. DO YOU WANT A CO-CHANNEL INTERFERER IN THE S-BAND UPLINK? Y-YES,N-NO: N
- 98. IS FADING PRESENT IN THE S-BAND UPLINK CHANNEL? Y-YES,N-NO: Y
- 100. IS THE INTERFERENCE FADED? Y-YES,N-NO: N
- 102. THE UPLINK FADING CHANNEL IS PRESENT
- 103. TYPES OF FADING CHANNELS AVAILABLE:
- 104. 1: NO SPECULAR COMPONENT (RALEIGH FADING)
- 105. 2: SPECULAR COMPONENT, SHORTEST PATH
- 106. 3: SPECULAR COMPONENT, MEAN PATH
- 107. INPUT TYPE OF CHANNEL: 2
- 109. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
- 111. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
- 113. Are multiple values of the specular to multipath power ratio to be tested? (Y/N): Y
- 115. Input the range of values to be tested (In DB):
- 117. Input the initial value (-99 -- +99,I3): 12DB
- 119.

120. Input the increment value (-99 -- +99, I2): 25DB
121. Input the final value (01 -- 99, I2): 90DB
122. DO YOU WANT A CO-CHANNEL INTERFERER IN THE DOWNLINK? Y-YES, N-NO: N
123. IS FADING PRESENT IN THE UHF - DOWNLINK CHANNEL? Y-YES, N-NO: Y
124. IS A SPACE DIVERSITY RECEIVER BEING USED? Y-YES, N-NO: N
125. THE DOWNLINK FADING CHANNEL IS PRESENT
126. SET PARAMETERS FOR FADING CHANNEL.
127. TYPES OF FADING CHANNELS AVAILABLE:
128. 1: NO SPECULAR COMPONENT (RALEIGH FADING)
129. 2: SPECULAR COMPONENT, SHORTEST PATH
130. 3: SPECULAR COMPONENT, MEAN PATH
131. INPUT TYPE OF CHANNEL: 2
132. ENTER THE MULTIPATH SPREAD TIME (IN MICROSECONDS, F9.2): 500.00 MICROSECONDS
133. ENTER THE DOPPLER SPREAD BANDWIDTH (IN HERTZ, F7.2): 1.00 HZ
134. Are multiple values of the specular to multipath power
135. ratio to be tested? (Y/N): Y
136. Input the range of values to be tested (in DB):
137. Input the initial value (-99 -- +99, I3): 14DB
138. Input the increment value (-99 -- +99, I2): 25DB
139. Input the final value (01 -- 99, I2): 90DB
140. Are multiple SNR values to be tested? Y-yes, N-no: Y
141. Input the range of SNR values to be tested (in Db):
142. Input the initial value of SNR (-99 -- +99, I3): 1 DB
143. Input the increment value (01 -- 99, I2): 5 DB
144. Input the ending value of SNR (-99 -- +99, I3): 40 DB
145. IS A SPACE DIVERSITY RECEIVER REQUIRED? (Y/N) N
146. Input the approximate duration of simulation in seconds (0.01 - 9.99, F5.2): 0.02 SEC.
147. Type of performance measurement available:
148. 1. Compare recovered output signal to original input signal
149. 2. Measure output signal to noise ratio
150. Input type: 2
151. Do you want output to be plotted? (Y/N): N
152. 1- Specular to multipath power ratio- UHF Uplink Channel.
153. 2- Specular to multipath power ratio- S-BAND Downlink Channel.
154. 3- Specular to multipath power ratio- S-BAND Uplink Channel.
155. 4- Specular to multipath power ratio- UHF Downlink Channel.
156. 5- Input SNR Value
157. 6- Output SNR Value
158. 1
159. 2
160. 3
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181.	10.00	11.00	12.00	14.00	1.00000000	31.8197632
182.	10.00	11.00	12.00	14.00	6.00000000	34.6829987
183.	10.00	11.00	12.00	14.00	11.00000000	38.5540161
184.	10.00	11.00	12.00	14.00	16.00000000	40.3591614
185.	10.00	11.00	12.00	14.00	21.00000000	36.0269775
186.	10.00	11.00	12.00	14.00	26.00000000	40.2135925
187.	10.00	11.00	12.00	14.00	31.00000000	41.0075531
188.	10.00	11.00	12.00	14.00	36.00000000	41.8792419
189.	10.00	11.00	37.00	14.00	1.00000000	32.0381775
190.	10.00	11.00	37.00	14.00	6.00000000	38.1804352
191.	10.00	11.00	37.00	14.00	11.00000000	37.1580200
192.	10.00	11.00	37.00	14.00	16.00000000	42.1793671
193.	10.00	11.00	37.00	14.00	21.00000000	43.2643585
194.	10.00	11.00	37.00	14.00	26.00000000	46.9673157
195.	10.00	11.00	37.00	14.00	31.00000000	48.9451447
196.	10.00	11.00	37.00	14.00	36.00000000	42.9842072
197.	10.00	11.00	62.00	14.00	1.00000000	33.0088196
198.	10.00	11.00	62.00	14.00	6.00000000	37.2350464
199.	10.00	11.00	62.00	14.00	11.00000000	41.6312103
200.	10.00	11.00	62.00	14.00	16.00000000	42.7033001
201.	10.00	11.00	62.00	14.00	21.00000000	39.6892242
202.	10.00	11.00	62.00	14.00	26.00000000	39.7191010
203.	10.00	11.00	62.00	14.00	31.00000000	44.9123077
204.	10.00	11.00	62.00	14.00	36.00000000	39.7061920
205.	10.00	11.00	87.00	14.00	1.00000000	20.8714905
206.	10.00	11.00	87.00	14.00	6.00000000	36.3129120
207.	10.00	11.00	87.00	14.00	11.00000000	40.2752686
208.	10.00	11.00	87.00	14.00	16.00000000	42.8176880
209.	10.00	11.00	87.00	14.00	21.00000000	40.7845306
210.	10.00	11.00	87.00	14.00	26.00000000	45.0499725
211.	10.00	11.00	87.00	14.00	31.00000000	40.1223450
212.	10.00	11.00	87.00	14.00	36.00000000	45.1003876
213.	10.00	36.00	12.00	14.00	1.00000000	32.4762726
214.	10.00	36.00	12.00	14.00	6.00000000	34.8208313
215.	10.00	36.00	12.00	14.00	11.00000000	37.4087982
216.	10.00	36.00	12.00	14.00	16.00000000	42.6144714
217.	10.00	36.00	12.00	14.00	21.00000000	38.4624634
218.	10.00	36.00	12.00	14.00	26.00000000	43.3883820
219.	10.00	36.00	12.00	14.00	31.00000000	40.4772797
220.	10.00	36.00	12.00	14.00	36.00000000	43.5606537
221.	10.00	36.00	37.00	14.00	1.00000000	33.0967865
222.	10.00	36.00	37.00	14.00	6.00000000	37.3872528
223.	10.00	36.00	37.00	14.00	11.00000000	30.3372498
224.	10.00	36.00	37.00	14.00	16.00000000	40.9699707
225.	10.00	36.00	37.00	14.00	21.00000000	43.6113129
226.	10.00	36.00	37.00	14.00	26.00000000	45.5793457
227.	10.00	36.00	37.00	14.00	31.00000000	44.4579315
228.	10.00	36.00	37.00	14.00	36.00000000	43.0029449
229.	10.00	36.00	62.00	14.00	1.00000000	31.4471283
230.	10.00	36.00	62.00	14.00	6.00000000	35.7543030
231.	10.00	36.00	62.00	14.00	11.00000000	41.5781708
232.	10.00	36.00	62.00	14.00	16.00000000	43.9695587
233.	10.00	36.00	62.00	14.00	21.00000000	41.0463257
234.	10.00	36.00	62.00	14.00	26.00000000	43.2192688
235.	10.00	36.00	62.00	14.00	31.00000000	41.2209320
236.	10.00	36.00	62.00	14.00	36.00000000	42.5592041
237.	10.00	36.00	87.00	14.00	1.00000000	31.7581329
238.	10.00	36.00	87.00	14.00	6.00000000	36.1853180
239.	10.00	36.00	87.00	14.00	11.00000000	40.9545441

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