APPENDIX

Program Listings

In this Appendix we simply list the computer programs (in Fortran 4) used for the sample calculations given in the report and required for similar calculations. The programs are essentially self-explanatory via the comment statements, but some further explanation may be helpful.

The first two programs, APDA and APDB, compute the APD "measurement data" from the Middleton Class A and Class B models. The output is given in Table 1. The program APDB requires Subroutine CONHYP and FUNCTION GAMMA which are also given.

The next set of programs are for the Class A example. The program SYSCOR computes the theoretical performance and requires FUNCTION CERF. The program SYSGL computes performance via Gauss-Laguerre integration but obtains the required pdf of the envelope values directly from the Class A model and requires SUBROUTINE FUN. Finally, one of the main results is program SYSAPD which computes performance from measured APD values. Sections of this program normalize the APD and estimate the pdf from the measured APD. These routines are useful in their own right for various purposes. The outputs of these programs are contained in Table 3.

The final set of programs are for the Class B example, but can also be used for any noise example. The program SYSWR computes performance via Weddle's Rule integration. Two FUN1 subroutines are given for use with SYSWR. One calculates the envelope pdf from the mathematical model given by (30) and the other one calculates the envelope pdf from the measured APD. The outputs of SYSWR are given in Table 4.

In some of the programs IRAY and SYSTEMC are used. This is to suppress an exponent underflow error message for the particular computer used (CYBER 170/750) and is not, in general, required.

```
      PROGRAM APDA(INPUT,OUTPUT)
C     PROGRAM USED TO OBTAIN APD VALUES FROM CLASS A MODEL.
C     EQUATION 4 OF TEXT.
      DIMENSION IRAY(6)
      DATA IRAY/-1,-1,-1,0,-1,-1/
      CALL SYSTEMC(115,IRAY)
      PRINT 6
    6 FORMAT(1H1)
      A=0.35
      GAM=0.5E-3
      DO 40 I=1,31
      RDB=-59.+3.*(I-1.)
      R=10.**(RDB/20.)
      SM=0. $ FJ=1.
      DO 20 JJ=1,26
      J=JJ-1
      IF(J.NE.0) FJ=FJ*J
      SIGSQ=(J/A+GAM)/(1.+GAM)
      T=((A**J)FJ)*EXP(-R*R/SIGSQ)
      SM=SM+T
   20 CONTINUE
      P=SM*EXP(-A)
      IF(P.LT.1.0E-6) GO TO 10
      GO TO 15
   10 P=0.
   15 PRINT 7,RDB,P
   40 CONTINUE
    7 FORMAT(10X,2(1PE12.5,3X))
      END
```

```
      PROGRAM APDB(INPUT,OUTPUT)
C     PROGRAM USED TO OBTAIN APD VALUES FROM CLASS B MODEL.
C     EQUATION 6 OF TEXT.
      DIMENSION IRAY(6)
      DATA IRAY/-1,-1,-1,0,-1,-1/
      CALL SYSTEMC(115,IRAY)
      PRINT 6
    6 FORMAT(1H1)
      AA=1.
      ALPHA=1.2
      OMEGA=0.00079433
      DO 40 I=1,31
      RDB=-40.+3.*(I-1.)
      IF(RDB.GT.45.) GO TO 10
      R=10.**(RDB/20.)
      ZN=R*R/OMEGA
      SM=0. $ FN=1. $ SM1=0.
      DO 20 N=1,25
      FN=FN*N
      CALL CONHYP(1.-N*ALPHA/2.,2.,ZN,S,IOVFLW)
      T=(((-AA)**N)/FN)*GAMMA(1.+N*ALPHA/2.)*S
      IF(IOVFLW.NE.1) GO TO 14
      SM1=SM1+T
      GO TO 20
   14 SM=SM+T
   20 CONTINUE
      FP=0.
      IF(ZN.LT.675.) FP=EXP(-ZN)
      P=FP-ZN*(FP*SM+SM1)
      GO TO 15
   10 P=0.
   15 PRINT 7, RDB,P
   40 CONTINUE
    7 FORMAT(10X,2(1PE12.5,3X))
      END
```

```
      SUBROUTINE CONHYP(A,B,X,S,IOVFLW)
C.....COMPUTES 1F1(A,B,X) FOR REAL A,B,X
C.....IF X GREATER THAN 741. AN OVERFLOW WILL OCCUR. SEE
C.....COMMENTS BELOW.
      S=1.  $ Y=1.
      IOVFLW=0
      KUNDEF=0
      IF(A.GT.0.)GO TO 101
      K=-A
      ENA=-K-1
      VA=A-ENA
      IF(VA.EQ.1..OR.VA.EQ.0.)GO TO 110
  101 IF(B.GT.0.)GO TO 130
      J=-B
      ENB=-J-1
      VB=B-ENB
      IF(VB.EQ.1..OR.VB.EQ.0.)120,130
  110 KUNDEF=1
      GO TO 101
  120 IF(KUNDEF.EQ.1)PRINT1000,A,B
      IF(KUNDEF.NE.1)PRINT1001,B
      RETURN
  130 IF(KUNDEF.EQ.1)GO TO 10
   5  IF(X.GE.100.) GO TO 60
   6  IF(X.GE.10.) GO TO 10
      NN=100
      GO TO 15
  10  NN=300
  15  IF(KUNDEF.EQ.1) NN=-A+1
      DO 20 N=1,NN
      D=N*((B+N-1.0)**2.)
      Y=(A+N-1.0)*(Y/D)
      Y=Y*(B+N-1.0)
      Y=Y*X
      IF(S.EQ.(S+Y))GO TO 50
      S=S+Y
   20 CONTINUE
   50 RETURN
C.....APPROXIMATES 1F1(A,B,X) FOR REAL A,B,X BY USING THE
C.....ASYMPTOTIC EXPANSION. SEE PAGE 1073, INTRODUCTION
C.....TO STATISTICAL COMMUNICATIONS THEORY, MIDDLETON.
C.....IF X.GE.675. AN OVERFLOW WILL OCCUR FROM EXP.
C.....TO AVOID THIS, THE VARIABLE IOVFLW IS SET TO 1 AND
C.....THE FUNCTION VALUE IS CALCULATED WITHOUT THE EXP(X) FACTOR.
C.....SO THAT THE VALUE RETURNED IS S/EXP(X)
  60  NN=20
      DO 100 N=1,NN
      Y=Y*(B-A+N-1.)*(N-A)
      Y=Y/(N*X)
      IF(S.EQ.(S+Y))GO TO 150
      S=S+Y
  100 CONTINUE
  150 S=S*(GAMMA(B)/GAMMA(A))*(X**(A-B))
      IF(X.LT.675.)GO TO 190
      IOVFLW=1
      GO TO 200
  190 S=S*EXP(X)
```

```
 200 RETURN
1000 FORMAT(//,1X,* CANNOT EVALUATE EXPRESSION SINCE BOTH*,
    1* A AND B ARE NEGATIVE INTEGERS OR ZERO, A=*,F10.2,* , B=*,
    2F10.2,//)
1001 FORMAT(//,1X,* BAD VALUE FOR B GIVES INFINITE RESULT FOR S*,
    1 *, B=*,F10.2,//)
     END
```

```
      FUNCTION GAMMA(X)
C     RETURNS THE GAMMA FUNCTION FOR REAL ARGUMENT.
C     NOTE. THE GAMMA FUNCTION IS NOT DEFINED FOR A NEGATIVE INTEGER OR ZER
C     INPUT
C       X = THE REAL ARGUMENT.
C     OUTPUT.
C       GAMMA(X) = THE GAMMA FUNCTION OF ARGUMENT X.
   75 FORMAT(66H GAMMA FUNCTION OF A NEGATIVE INTEGER, OR OF ZERO, IS NO
     1T DEFINED.)
    5 IF(X) 10,80,15
   10 N=-X
      EN=-N-1
      V=X-EN
      IF(V.EQ.1.)80,20
   15 N=X
      EN=N
      V=X-EN
   20 GAMMA=1.+V*(.422784337+V*(.4118402518+V*(.08157821878+V*
     1(.07423790761+V*(-.0002109074673+V*(.01097369584+V*(-.002466747981
     2+V*(.001539768105-V*(.0003442342046-V*.00006771057117))))))))
      IF(EN-2.) 37,25,30
   25 RETURN
   30 N=N-1
      DO 35 I=2,N
      FI=I
   35 GAMMA=GAMMA*(FI+V)
      RETURN
   37 N=2.-EN
      DO 40 I=1,N
      FI=2-I
   40 GAMMA=GAMMA/(FI+V)
      RETURN
   80 PRINT 75
      CALL EXIT
      END
```

```
      PROGRAM SYSCOR(INPUT,OUTPUT)
C     THIS PROGRAM COMPUTES THE PROBABILITY OF ERROR FOR BINARY
C     CPSK, CFSK, AND COHERENT ON-OFF IN CLASS A NOISE, THAT IS,
C     MIDDLETON"S CLASS A MODEL.
C     HERE, THE ERFC FUNCTION IS TERMED CERF, TO BYPASS THE
C     SYSTEMS INTERNAL ERFC ROUTINE.
C     FOR CPSK, AK=SQRT(S)
C     FOR CFSK, AK=SQRT(S/2.)
C     FOR ON-OFF, AK=SQRT(S/4.)
      A=0.35
      GAM=0.5E-3
      PRINT 6
    6 FORMAT(1H1)
      DO 40 J=1,29
      SDB=-30.+2.5*(J-1)
      S=10.**(SDB/10.)
      AK=SQRT(S)
      SUM=0. $ FK=1.
      DO 20 KK=1,26
      K=KK-1
      IF(K.NE.0) FK=FK*K
      SIGSQ=(K/A+GAM)/(1.+GAM)
      SIG=SQRT(SIGSQ)
      T=((A**K)/FK)*CERF(AK/SIG)
      SUM=SUM+T
   20 CONTINUE
      PE=EXP(-A)*SUM/2.
      IF(PE.LT.1.E-9) CALL EXIT
      PRINT 8, SDB,PE
   40 CONTINUE
    8 FORMAT(10X,2(1PE12.5,3X))
      END
```

```
      FUNCTION CERF(X)
C     SEE APPROXIMATIONS FOR DIGITAL COMPUTERS
C     BY C. HASTINGS, PRINCETON U. PRESS, 1955,
C     PAGE 169. ALSO IN ABRAMOWITZ AND STEGUN.
      E=1.0/(1.0+0.3275911*X)
      S=(((((0.940646070*E)-1.287822453)*E+1.259695130)*E-0.252128668)*E
     1+0.225836846)*E
      XSQ=X**2
      EXPFX=0.0
      IF(XSQ.LT.709.0)EXPFX=EXP(-XSQ)
      CERF=S*EXPFX*1.128379167
      RETURN
      END
```

```
      PROGRAM SYSGL(INPUT,OUTPUT)
C     THIS PROGRAM USES GAUSS-LAGUERRE QUADRATURES ALONG WITH
C     CLASS A NOISE MODEL TO COMPUTE SYSTEM PERFORMANCE.
C     SEE PROGRAM SYSAPD FOR FURTHUR DETAILS.
      DIMENSION IRAY(6),Z(15),H(15)
      DATA IRAY/-1,-1,-1,0,-1,-1/
      DATA Z/0.09330781,0.49269174,1.21559541,2.26994952,3.66762272,
     15.42533663,7.56591623,10.12022857,13.13028248,16.65440771,
     220.77647890,25.62389423,31.40751917,38.53068331,48.02608557/
      DATA H/.21823489,.34221018,.26302758,.12642582,.40206865E-1,
     1.85638778E-2,.12124361E-2,.11167439E-3,.64599268E-5,.22263169E-6,
     2.42274304E-8,.39218973E-10,.14565153E-12,.14830271E-15,
     3.16005949E-19/
      CALL SYSTEMC(115,IRAY)
      PRINT 6
    6 FORMAT(1H1)
      DO 50 N=1,29
      SDB=-30.+2.5*(N-1)
      S=10.**(SDB/10.)
      AK=S**0.5
      SUM=0.
      DO 30 K=1,15
      CALL FUN(Z(K),AK,F)
      SUM=SUM+F*H(K)
   30 CONTINUE
      PE=SUM/3.141592654
      PRINT8, SDB,PE
      IF(PE.LT.1.E-9) CALL EXIT
   50 CONTINUE
    8 FORMAT(10X,2(1PE12.5,3X))
      END


      SUBROUTINE FUN(X,P,Y)
C     THIS FUNCTION ROUTINE IS FOR CLASS A NOISE FOR USE
C     WITH PROGRAM SYSGL.
      A=0.35
      GAM=0.5E-3
      V=X+P
      SM=0. $ FJ=1.
      DO 20 JJ=1,26
      J=JJ-1
      IF(J.NE.0) FJ=FJ*J
      SIGSQ=(J/A+GAM)/(1.+GAM)
      T=(2.*V/SIGSQ)*((A**J)/FJ)*EXP(-V*V/SIGSQ)
      SM=SM+T
   20 CONTINUE
      Y=SM*EXP(X)*ACOS(P/V)*EXP(-A)
      RETURN
      END
```

```
      PROGRAM SYSAPD(INPUT,OUTPUT)
C     THIS PROGRAM MAKES DIRECT USE OF THE MEASURED APD DATA,31 LEVELS,
C     AND ESTIMATES THE PDF OF THE ENVELOPE FOR USE IN THE GENERAL
C     COHERENT SYSTEM PERFORMANCE ALGORITHM. THE PROB OF BIT ERROR
C     FOR BINARY CPSK,CFSK,AND COHERENT ON-OFF IS ESTIMATED. THE
C     SIGNAL POWER IS GIVEN BY S, AND THE NOISE IS
C     NORMALIZED SO THAT THE MEAN NOISE POWER IS UNITY. THEN
C     THE SIGNAL-TO-NOISE RATIO IS ALSO GIVEN BY S. SIGNAL-TO-NOISE
C     RATIOS FROM 40DB TO -30DB ARE COVERED IN 2.5DB STEPS. THE
C     PROGRAM USES GAUSS-LAQUERRE QUADRATURES TO EVALATE THE INTEGRALS.
C     FOR CPSK, AK=SQRT(S)
C     FOR CFSK, AK=SQRT(S/2.)
C     FOR OFF-ON, AK=SQRT(S/4.)
C     NOTE, BEFORE THIS PROGRAM IS EFFECTIVE, THE ENTIRE APD MUST
C     BE COVERED BY THE 31 (OR LESS) LEVELS. THAT IS, P SHOULD
C     RANGE FROM ABOUT 0.95 OR HIGHER DOWN TO ABOUT 1.0E-5 OR SMALLER.
      DIMENSION CL(31),SL(31),P(31),CX(31),SX(31),SP(31)
      DIMENSION Z(15),H(15)
      DATA CL/1.,4.,7.,10.,13.,16.,19.,22.,25.,28.,31.,34.,37.,
     140.,43.,46.,49.,52.,55.,58.,61.,64.,67.,70.,73.,76.,79.,
     282.,85.,88.,91./
      DATA P/.9982,.9965,.9930,.9860,.9724,.9460,.8964,.8085,.6696,
     1.4946,.3519,.2997,.2949,.2944,.2934,.2916,.2879,.2807,.2669,
     2.2415,.1981,.1343,.06372,.01670,.002116,.0001047,.000001072,
     3.0,.0,.0,.0/
C     CL IS THE APD LEVELS IN DB AND P IS THE PROBABILITIES AT
C     THESE LEVELS.
      DATA Z/0.09330781,0.49269174,1.21559541,2.26994952,3.66762272,
     15.42533663,7.56591623,10.12022857,13.13028248,16.65440771,
     220.77647890,25.62389423,31.40751917,38.53068331,48.02608557/
      DATA H/.21823489,.34221018,.26302758,.12642582,.40206865E-1,
     1.85638778E-2,.12124361E-2,.11167439E-3,.64599268E-5,.22263169E-6,
     2.42274304E-8,.39218973E-10,.14565153E-12,.14830271E-15,
     3.16005949E-19/
C     H AND Z ARE AS GIVEN IN EQ. 28 OF TEXT.
      CX(1)=1.5*CL(1)-0.5*CL(2)
      SX(1)=10.**(CX(1)/20.)
      DO 20 I=2,31
      CX(I)=(CL(I-1)+CL(I))/2.
      SX(I)=10.**(CX(I)/20.)
   20 CONTINUE
C     COMPUTE RMS
      SUM=SX(1)*SX(1)*(1.-P(1))
      DO 30 J=2,31
      T=SX(J)*SX(J)*(P(J-1)-P(J))
      SUM=SUM+T
   30 CONTINUE
      RMS=(SUM+10.**(CL(31)/20.)*P(31))**0.5
C     NORMALIZE TO RMS LEVEL AND COMPUTE PDF
      CL(1)=CL(1)-20.*ALOG10(RMS)
      SL(1)=10.**(CL(1)/20.)
      SX(1)=SX(1)/RMS
      CX(1)=20.*ALOG10(SX(1))
      SP(1)=(1.-P(1))/SL(1)
```

```
      DO 40 K=2,31
      CL(K)=CL(K)-20.*ALOG10(RMS)
      SL(K)=10.**(CL(K)/20.)
      SX(K)=SX(K)/RMS
      CX(K)=20.*ALOG10(SX(K))
      SP(K)=(P(K-1)-P(K))/(SL(K)-SL(K-1))
   40 CONTINUE
      PRINT 6
    6 FORMAT(1H1)
      DO 80 N=1,29
      SDB=-30.+2.5*(N-1)
      S=10.**(SDB/10.)
      AK=SQRT(S)
      SUM=0. $ MM=2
      DO 70 L=1,15
      V=Z(L)+AK
      IF(V.LT.SX(1).OR.V.GT.SX(31)) 15,16
   16 DO 17 M=MM,31
      IF(V.LE.SX(M).AND.V.GT.SX(M-1)) GO TO 18
   17 CONTINUE
   18 IF(SP(M-1).EQ.0..OR.SP(M).EQ.0.) GO TO 15
      YDB=(20.*ALOG10(V)-CX(M-1))/(CX(M)-CX(M-1))
      YDB=YDB*(20.*ALOG10(SP(M))-20.*ALOG10(SP(M-1)))
      YDB= YDB+20.*ALOG10(SP(M-1))
      Y=10.**(YDB/20.)
      MM=M
      GO TO 19
   15 Y=0.
   19 T=Y*EXP(Z(L))*ACOS(AK/V)
      SUM=SUM+T*H(L)
   70 CONTINUE
      PE=SUM/3.141592654
      PRINT 8, SDB,PE
      IF(PE.LT.1.E-9) CALL EXIT
   80 CONTINUE
    8 FORMAT(10X,2(1PE12.5,3X))
      END
```

```
      PROGRAM SYSWR(INPUT,OUTPUT)
C     THIS PROGRAM USES WEDDLES RULE FOR THE
C     INTEGRATIONS REQUIRED IN THE DETERMINATION OF
C     SYSTEM PERFORMANCE.
C     DIFFERENT FUN1 SUBROUTINES ARE USED FOR
C     DIFFERENT NOISE MODELS AND/OR NOISE MEASUREMENTS.
      DIMENSION Z(7)
      COMMON/QQQ/AA,ALPHA,OMEGA,AK
      PRINT 6
    6 FORMAT(1H1)
      AA=1.0
      ALPHA=1.2
      OMEGA=0.00079433
      AK=1.
      CALL FUN1(1.,ZZ)
      DO 60 J=1,15
      SDB=-30.+5.*(J-1)
      S=10.**(SDB/10.)
      AK=S**0.5
      SUM=0.
      DO 50 I=1,15
      AKDB=20.*ALOG10(AK)
      ADB=AKDB+4.*(I-1)
      BDB=AKDB+4.*I
      A=10.**(ADB/20.)
      B=10.**(BDB/20.)
      DX=(B-A)/6.
      DO 40 K=1,7
      X=A+(K-1)*DX
      CALL FUN2(X,Z(K))
   40 CONTINUE
      SS=0.3*DX*(Z(1)+5.*Z(2)+Z(3)+6.*Z(4)+Z(5)+5.*Z(6)+Z(7))
      IF(SS.EQ.0.)  GO TO 55
      SUM=SUM+SS
   50 CONTINUE
   55 PE=SUM/3.141592654
      PRINT 8, SDB, PE
      IF(PE.LT.1.E-7) CALL EXIT
   60 CONTINUE
    8 FORMAT(10X,F5.1,2X,1PE12.5)
      END
```

```
      SUBROUTINE FUN1(X,Y)
C     THIS SUBROUTINE IS FOR USE WITH PROGRAM SYSWR.
C     IT MAKES USE OF MEASURED APD DATA. SEE PROGRAM
C     SYSAPD FOR FURTHUR DETAILS.
      DIMENSION CL(31),SL(31),P(31),CX(31),SX(31),SP(31)
      COMMON/Q/AK
      DATA CL/1.,4.,7.,10.,13.,16.,19.,22.,25.,28.,31.,34.,37.,
     140.,43.,46.,49.,52.,55.,58.,61.,64.,67.,70.,73.,76.,79.,
     282.,85.,88.,91./
      DATA P/.9435,.8914,.7984,.6491,.4516,.2631,.1445,.08575,.05387,
     1.03468,.02259,.01481,.009736,.006414,.004230,.002792,.001843,
     2.001217,.0008041,.0005312,.0003509,.0002318,.0001532,.0001012,
     3.00006685,.00004417,.00002918,.00001928,.00001274,0.,0./
C     CL IS THE APD LEVELS IN DB AND P IS THE PROBABILITIES AT
C     THESE LEVELS.
      CX(1)=1.5*CL(1)-0.5*CL(2)
      SX(1)=10.**(CX(1)/20.)
      DO 20 I=2,31
      CX(I)=(CL(I-1)+CL(I))/2.
      SX(I)=10.**(CX(I)/20.)
   20 CONTINUE
C     COMPUTE RMS
      SUM=SX(1)*SX(1)*(1.-P(1))
      DO 30 J=2,31
      T=SX(J)*SX(J)*(P(J-1)-P(J))
      SUM=SUM+T
   30 CONTINUE
      RMS=(SUM+10.**(CL(31)/20.)*P(31))**0.5
C     NORMALIZE TO RMS LEVEL AND COMPUTE PDF
      CL(1)=CL(1)-20.*ALOG10(RMS)
      SL(1)=10.**(CL(1)/20.)
      SX(1)=SX(1)/RMS
      CX(1)=20.*ALOG10(SX(1))
      SP(1)=(1.-P(1))/SL(1)
      DO 40 K=2,31
      CL(K)=CL(K)-20.*ALOG10(RMS)
      SL(K)=10.**(CL(K)/20.)
      SX(K)=SX(K)/RMS
      CX(K)=20.*ALOG10(SX(K))
      SP(K)=(P(K-1)-P(K))/(SL(K)-SL(K-1))
   40 CONTINUE
      MM=M
      ENTRY FUN2
      V=X
      IF(V.LT.SX(1).OR.V.GT.SX(31)) 15,16
   16 DO 17 M=2,31
      IF(V.LE.SX(M).AND.V.GT.SX(M-1)) GO TO 18
   17 CONTINUE
   18 IF(SP(M-1).EQ.0..OR.SP(M).EQ.0.) GO TO 15
      YDB=(20.*ALOG10(V)-CX(M-1))/(CX(M)-CX(M-1))
      YDB=YDB*(20.*ALOG10(SP(M))-20.*ALOG10(SP(M-1)))
      YDB= YDB+20.*ALOG10(SP(M-1))
      PDF=10.**(YDB/20.)
      GO TO 19
   15 PDF=0.
   19 Y=PDF*ACOS(AK/V)
      RETURN
      END
```

```
      SUBROUTINE FUN1(X,Y)
C     THIS FUNCTION ROUTINE IS FOR CLASS B NOISE FOR USE
C     WITH PROGRAM SYSWR.
      COMMON/QQQ/AA,ALPHA,OMEGA,AK
      ENTRY FUN2
      V=X
      ZN=V*V/OMEGA
      SM=0. $ FN=1. $ SM1=0.
      DO 20 NN=1,26
      N=NN-1
      IF(N.NE.0) FN=FN*N
      CALL CONHYP(1.-N*ALPHA/2.,2.,ZN,S,IOVFLW)
      CALL CONHYP(1.-N*ALPHA/2.,3.,ZN,SS,IOVFLW)
      SSS=(ZN/2.)*(1.+N*ALPHA/2.)*SS
      T=(((-AA)**N)/FN)*GAMMA(1.+N*ALPHA/2.)*(S-SSS)
      IF(IOVFLW.NE.1) GO TO 14
      SM1=SM1+T
      GO TO 20
   14 SM=SM+T
   20 CONTINUE
      FP=0.
      IF(ZN.LT.675.) FP=EXP(-ZN)
      PDF=(2.*V/OMEGA)*(FP*SM+SM1)
      Y=PDF*ACOS(AK/V)
      RETURN
      END
```

FORM **NTIA-29**
(4-80)

U.S. DEPARTMENT OF COMMERCE
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15. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This report summarizes techniques that use the measured instantaneous envelope statistics of arbitrary noise or interference processes to calculate the degradation these processes cause to digital communication systems. Computer implementation of the techniques are also given. The computer algorithms are designed for the data obtained from a general purpose noise measurement device, termed the DM-4 (for "distribution meter-model number 4") recently developed by NTIA/ITS. For illustration and for comparison with theoretical results, two noise examples are employed, one for "narrowband" interference, and one for "broadband" interference. These examples are taken from the noise models recently developed by Middleton.

16. Key Words *(Alphabetical order, separated by semicolons)*

computer algorithms; digital system performance; non-Gaussian noise; system performance software.

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