

IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)	
Title	TG3 Coexistence graphing	
Date Submitted	[17 June, 2002]	
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Re:	[]	
Abstract	[This document contains the graph files used to create the graphs for the coexistence Annex for the draft standard, P802.15.3 D10.]	
Purpose	[The purpose of this document is to provide a record of files used to generate the coexistence graphs in draft D10.]	
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Release	The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15.	

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1. Introduction

This document contains the Gnuplot graph files and the data files that were used to generate the coexistence graphs for 802.15.3 draft standard, D10. Gnuplot is a 2D and 3D graphing program that is supported on multiple platforms. Gnuplot is freely available, but is not free software, <http://www.gnu.org>, nor is it one of the Free Software Foundations projects, <http://www.fsf.org>. Gnuplot may be used either in an interactive format, in batch mode or in a combination of the two. The coexistence graphs in D10 used a file to control the graph setup and used the “load” command in Gnuplot to read in the files and create the plots.

Gnuplot is available from <http://www.gnuplot.info>.

2. Gnuplot graph files

2.1 BER curves for each of the standards

The first graph provides a check against the calculations for the BER to verify that the formulas were implemented correctly. The source file for the graph is given below:

```

set data style lines
set grid
set logscale y
set yrange [1.0e-9:1]
set key bottom left
set xlabel "SNR in dB"
set xrange [-10:16]
set xtics 2
set mxtics 10
set ylabel "BER"
plot "BER curves.dat" u 1:3 t "1 Mb/s 802.11b", \
"BER curves.dat" u 1:4 t "2 Mb/s 802.11b", \
"BER curves.dat" u 1:5 t "5.5 Mb/s 802.11b", \
"BER curves.dat" u 1:6 t "11 Mb/s 802.11b", \
"BER curves.dat" u 1:2 t "22 Mb/s 802.15.3", \
"BER curves.dat" u 1:7 t "1 Mb/s 802.15.1"

```

The resulting graph is shown in Figure D.1.

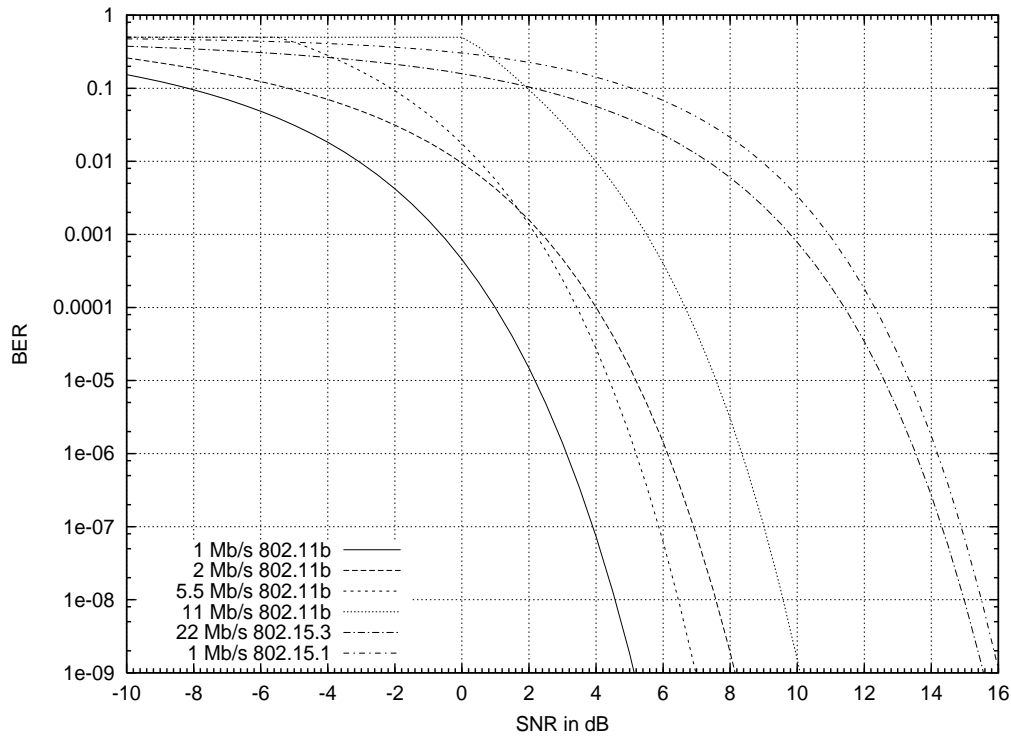


Figure D.1—BER results for 802.15.3, 802.11b and 802.15.1

2.2 802.15.3 receiver with 802.11b as the interferer

The next graphs are for the various interference scenarios. The source file for the graph that shows the impact of 802.11b in the adjacent and alternate channels on FER of an 802.15.3 DEV is given below:

```

set data style lines
set grid
set logscale xy
set yrange [1.0e-9:1]
set key bottom left
set xlabel "Distance in meters"
set xrange [0.1:10]
set xtics 0.1, 10, 10
set mxtics 10
set ylabel "FER"
plot "802.15.3 FER.dat" u 1:2 t "Adjacent channel", \
"802.15.3 FER.dat" u 1:3 t "Alternate channel"
    
```

The graph that results from this file is shown in Figure D.2.

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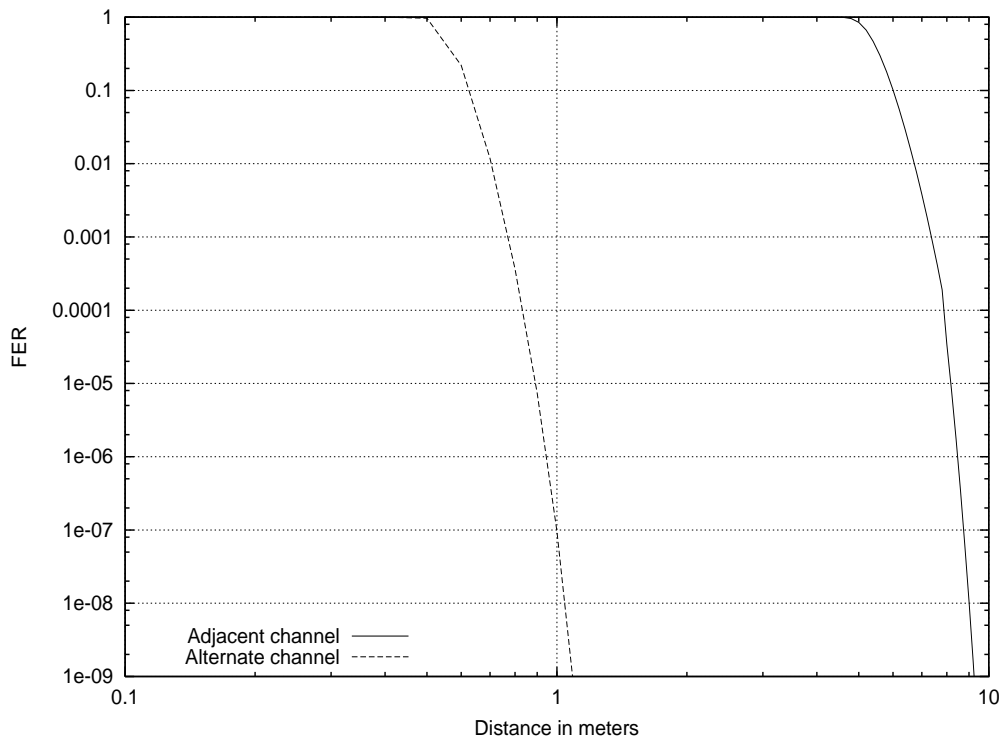


Figure D.2—FER results for 802.15.3 with 802.11b as the interferer

2.3 802.11b receiver with 802.15.3 as the interferer

The results for an 802.15.3 interferer in the adjacent channel of 802.11b for the 4 supported 802.11b data rates used the following graph files

```

set data style lines
set grid
set logscale y
set yrange [1.0e-9:1]
set key bottom left
set xlabel "Distance in meters"
set xrange [0.2:1.2]
set xtics 0.2
set mxtics 10
set ylabel "FER"
plot "802.11 adjacent FER.dat" u 1:2 t "1 Mb/s", \
"802.11 adjacent FER.dat" u 1:3 t "2 Mb/s", \
"802.11 adjacent FER.dat" u 1:4 t "5.5 Mb/s", \
"802.11 adjacent FER.dat" u 1:5 t "11 Mb/s"

```

The results from this are shown in Figure D.3.

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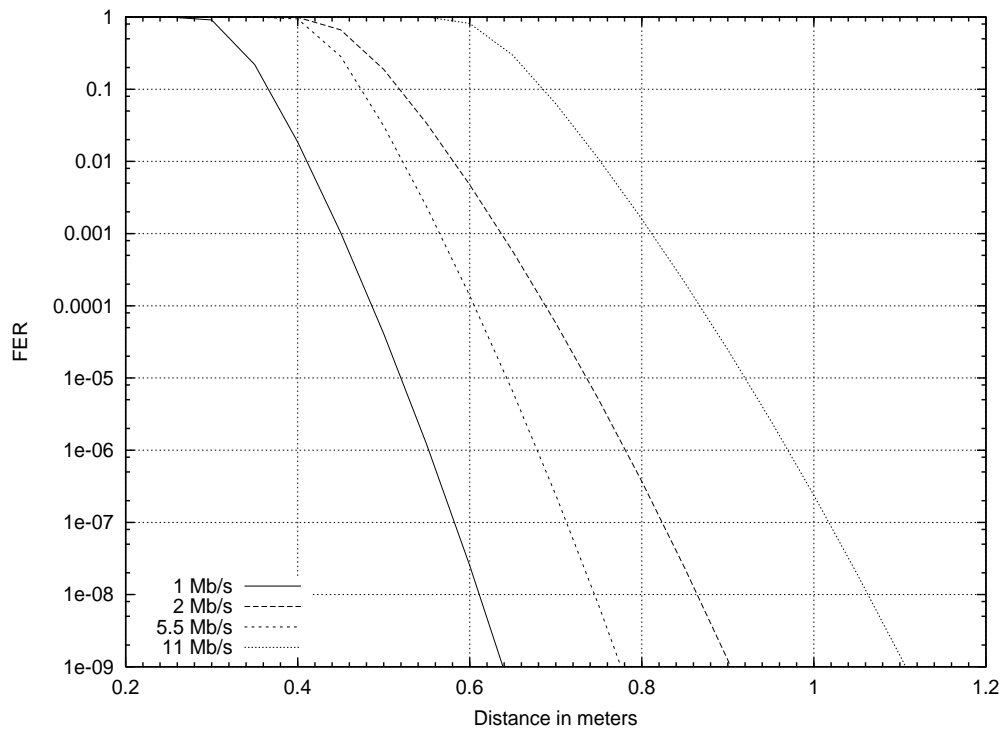


Figure D.3—FER results for 802.11b with 802.15.3 as the interferer in the adjacent channel.

The results for 802.15.3 in the alternate channel interfering with 802.11b for the 4 supported 802.11b data rates used the following file:

```

set data style lines
set grid
set logscale y
set yrange [1.0e-9:1]
set key bottom left
set xlabel "Distance in meters"
set xrange [0.1:0.6]
set xtics 0.1
set mxtics 10
set ylabel "FER"
plot "802.11 alternate FER.dat" u 1:2 t "1 Mb/s", \
"802.11 alternate FER.dat" u 1:3 t "2 Mb/s", \
"802.11 alternate FER.dat" u 1:4 t "5.5 Mb/s", \
"802.11 alternate FER.dat" u 1:5 t "11 Mb/s"

```

The resulting graph is shown in Figure D.4.

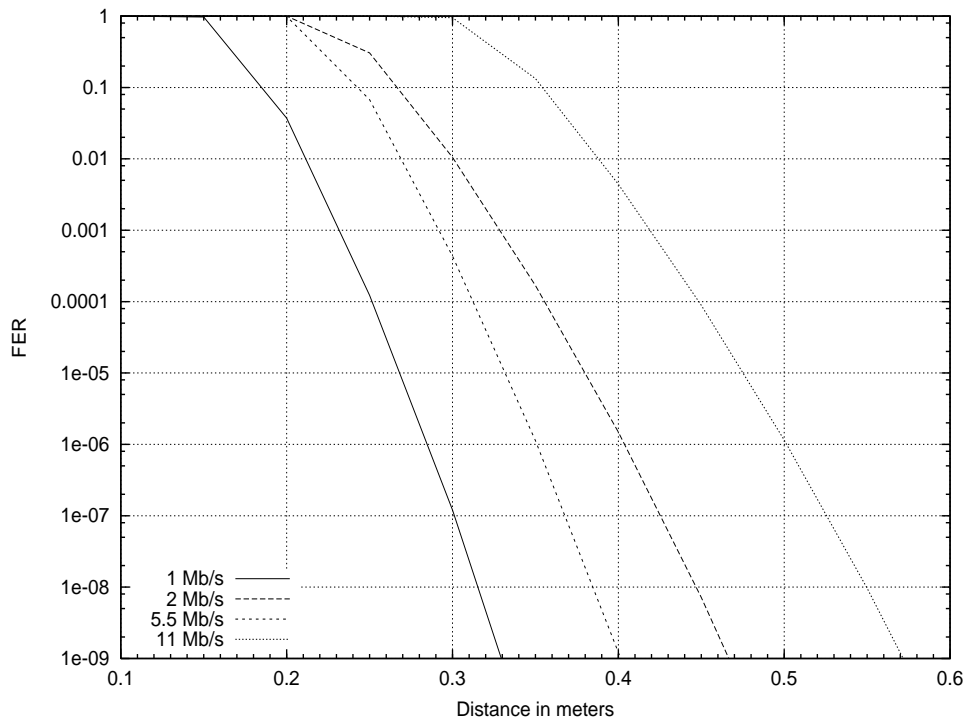


Figure D.4—FER results for 802.11b with 802.15.3 as the interferer in the alternate channel.

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2.4 802.15.3 and 802.15.1 interference

Only one graph was required to show the 802.15.1 interfering with 802.15.3 and 802.15.3 interfering with 802.15.1. The graph file used is listed below:

```

set data style lines
set grid
set logscale y
set yrange [1.0e-9:1]
set key bottom left
set xlabel "Distance in meters"
set xtics 5
set mxtics 10
set ylabel "Average FER"
plot "802.15.1 FER.dat" u 1:2 t "802.15.3 receiving", \
"802.15.1 FER.dat" u 1:3 t "802.15.1 receiving"
    
```

The resulting graph is shown in Figure D.5.

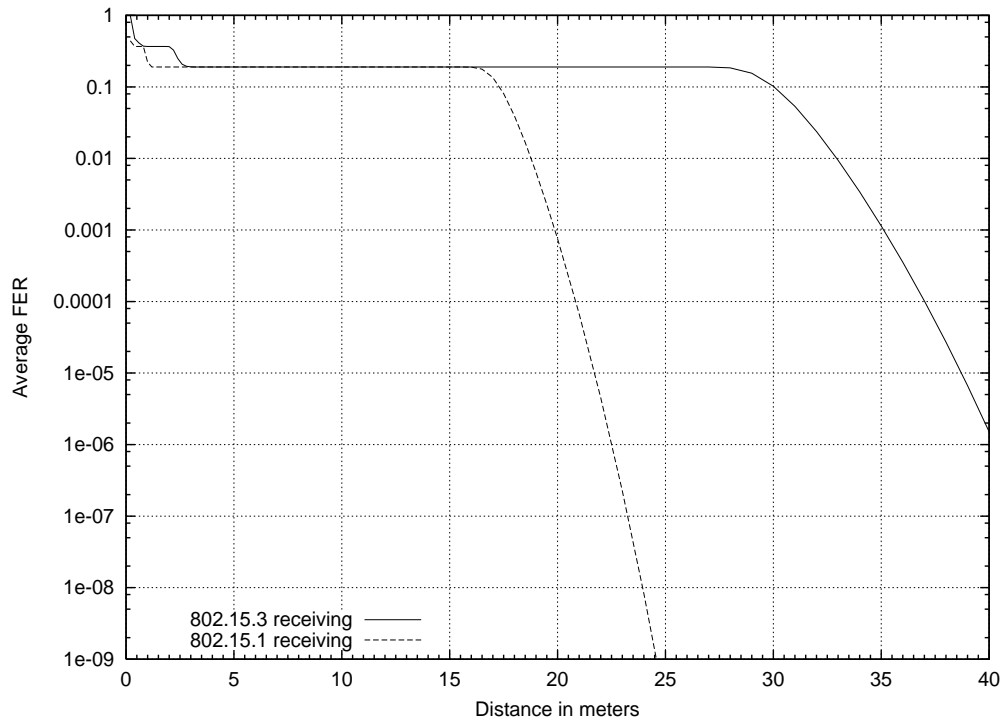


Figure D.5—Average FER results for 802.15.1 and 802.15.3

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3. Creating encapsulated postscript (EPS) files

In order to create the EPS files that are used in the Framemaker document, another gnuplot batch file was created. The files differed only in the name of the .gnu files that was used. An example of one of these files is shown below:

```
set term post eps mono dashed
set output "802.15.3 FER.eps"
load "802.15.3 FER.gnu"
set term windows
set output
```

4. Data files

File "BER curves.dat"

-10	3.7591E-01	1.5413E-01	2.6030E-01	5.0000E-01	5.0000E-01	4.7561E-01
-9.5	3.6883E-01	1.3847E-01	2.4118E-01	5.0000E-01	5.0000E-01	4.7272E-01
-9	3.6136E-01	1.2340E-01	2.2269E-01	5.0000E-01	5.0000E-01	4.6950E-01
-8.5	3.5352E-01	1.0897E-01	2.0480E-01	5.0000E-01	5.0000E-01	4.6590E-01
-8	3.4528E-01	9.5222E-02	1.8747E-01	5.0000E-01	5.0000E-01	4.6191E-01
-7.5	3.3662E-01	8.2238E-02	1.7069E-01	5.0000E-01	5.0000E-01	4.5746E-01
-7	3.2755E-01	7.0086E-02	1.5446E-01	5.0000E-01	5.0000E-01	4.5253E-01
-6.5	3.1805E-01	5.8842E-02	1.3879E-01	5.0000E-01	5.0000E-01	4.4705E-01
-6	3.0812E-01	4.8577E-02	1.2370E-01	5.0000E-01	5.0000E-01	4.4099E-01
-5.5	2.9775E-01	3.9352E-02	1.0926E-01	5.0000E-01	5.0000E-01	4.3428E-01
-5	2.8694E-01	3.1210E-02	9.5498E-02	4.2729E-01	5.0000E-01	4.2688E-01
-4.5	2.7570E-01	2.4172E-02	8.2497E-02	3.5047E-01	5.0000E-01	4.1872E-01
-4	2.6403E-01	1.8229E-02	7.0327E-02	2.8197E-01	5.0000E-01	4.0975E-01
-3.5	2.5196E-01	1.3344E-02	5.9064E-02	2.2201E-01	5.0000E-01	3.9992E-01
-3	2.3949E-01	9.4479E-03	4.8778E-02	1.7061E-01	5.0000E-01	3.8917E-01
-2.5	2.2666E-01	6.4441E-03	3.9531E-02	1.2761E-01	5.0000E-01	3.7745E-01
-2	2.1350E-01	4.2155E-03	3.1367E-02	9.2589E-02	5.0000E-01	3.6472E-01
-1.5	2.0006E-01	2.6316E-03	2.4306E-02	6.4934E-02	5.0000E-01	3.5095E-01
-1	1.8640E-01	1.5590E-03	1.8341E-02	4.3836E-02	5.0000E-01	3.3611E-01
-0.5	1.7257E-01	8.7092E-04	1.3435E-02	2.8357E-02	5.0000E-01	3.2021E-01
0	1.5866E-01	4.5561E-04	9.5188E-03	1.7486E-02	5.0000E-01	3.0327E-01
0.5	1.4474E-01	2.2143E-04	6.4978E-03	1.0220E-02	3.6826E-01	2.8532E-01
1	1.3093E-01	9.9099E-05	4.2544E-03	5.6247E-03	2.4179E-01	2.6644E-01
1.5	1.1732E-01	4.0435E-05	2.6586E-03	2.8940E-03	1.5447E-01	2.4674E-01
2	1.0403E-01	1.4875E-05	1.5768E-03	1.3806E-03	9.5886E-02	2.2637E-01
2.5	9.1180E-02	4.8718E-06	8.8199E-04	6.0521E-04	5.7692E-02	2.0550E-01
3	7.8896E-02	1.4008E-06	4.6206E-04	2.4127E-04	3.3512E-02	1.8438E-01
3.5	6.7296E-02	3.4805E-07	2.2493E-04	8.6477E-05	1.8688E-02	1.6324E-01
4	5.6495E-02	7.3413E-08	1.0084E-04	2.7510E-05	9.9303E-03	1.4240E-01
4.5	4.6595E-02	1.2887E-08	4.1230E-05	7.6555E-06	4.9836E-03	1.2217E-01
5	3.7679E-02	1.8409E-09	1.5201E-05	1.8337E-06	2.3382E-03	1.0287E-01
5.5	2.9806E-02	2.0873E-10	4.9914E-06	3.7120E-07	1.0143E-03	8.4821E-02
6	2.3007E-02	1.8262E-11	1.4393E-06	6.2224E-08	4.0196E-04	6.8311E-02
6.5	1.7279E-02	1.1946E-12	3.5874E-07	8.4412E-09	1.4367E-04	5.3581E-02
7	1.2587E-02	5.6391E-14	7.5940E-08	9.0313E-10	4.5682E-05	4.0800E-02
7.5	8.8611E-03	1.8461E-15	1.3384E-08	7.4038E-11	1.2726E-05	3.0051E-02

8	6.0044E-03	4.0086E-17	1.9205E-09	4.5022E-12	3.0550E-06	2.1324E-02	1
8.5	3.8986E-03	5.4913E-19	2.1885E-10	1.9582E-13	6.2037E-07	1.4511E-02	2
9	2.4133E-03	4.4864E-21	1.9256E-11	5.8481E-15	1.0439E-07	9.4212E-03	3
9.5	1.4161E-03	2.0526E-23	1.2676E-12	1.1455E-16	1.4225E-08	5.8029E-03	4
10	7.8282E-04	4.8995E-26	6.0265E-14	1.3978E-18	1.5298E-09	3.3690E-03	5
10.5	4.0460E-04	5.6365E-29	1.9887E-15	1.0031E-20	1.2614E-10	1.8304E-03	6
11	1.9400E-04	2.8589E-32	4.3571E-17	3.9674E-23	7.7204E-12	9.2310E-04	7
11.5	8.5514E-05	5.7851E-36	6.0288E-19	8.0434E-26	3.3825E-13	4.2824E-04	8
12	3.4304E-05	4.1753E-40	4.9813E-21	7.7040E-29	1.0185E-14	1.8089E-04	9
12.5	1.2381E-05	9.4774E-45	2.3080E-23	3.1814E-32	2.0133E-16	6.8784E-05	10
13	3.9693E-06	5.8753E-50	5.5878E-26	5.1116E-36	2.4823E-18	2.3244E-05	11
13.5	1.1143E-06	8.4905E-56	6.5314E-29	2.8479E-40	1.8020E-20	6.8810E-06	12
14	2.6952E-07	2.3947E-62	3.3724E-32	4.8353E-45	7.2206E-23	1.7558E-06	13
14.5	5.5161E-08	1.0799E-69	6.9622E-36	2.1640E-50	1.4853E-25	3.7925E-07	14
15	9.3611E-09	6.2257E-78	5.1389E-40	2.1697E-56	1.4461E-28	6.7947E-08	15
15.5	1.2875E-09	3.5701E-87	1.1962E-44	4.0605E-63	6.0821E-32	9.8695E-09	16
16	1.3990E-10	1.5366E-97	7.6285E-50	1.1557E-70	9.9753E-36	1.1329E-09	17

File "802.15.3 FER.dat"

0.1	1.0000E+00	1.0000E+00					18
0.2	1.0000E+00	1.0000E+00					19
0.3	1.0000E+00	1.0000E+00					20
0.4	1.0000E+00	1.0000E+00					21
0.5	1.0000E+00	9.6701E-01					22
0.6	1.0000E+00	2.2015E-01					23
0.7	1.0000E+00	1.1772E-02					24
0.8	1.0000E+00	3.6672E-04					25
0.9	1.0000E+00	7.3638E-06					26
1	1.0000E+00	9.5600E-08					27
1.2	1.0000E+00	4.5475E-12					28
1.4	1.0000E+00	0.0000E+00					29
1.6	1.0000E+00	0.0000E+00					30
1.8	1.0000E+00	0.0000E+00					31
2	1.0000E+00	0.0000E+00					32
2.2	1.0000E+00	0.0000E+00					33
2.4	1.0000E+00	0.0000E+00					34
2.6	1.0000E+00	0.0000E+00					35
2.8	1.0000E+00	0.0000E+00					36
3	1.0000E+00	0.0000E+00					37
3.2	1.0000E+00	0.0000E+00					38
3.4	1.0000E+00	0.0000E+00					39
3.6	1.0000E+00	0.0000E+00					40
3.8	1.0000E+00	0.0000E+00					41
4	1.0000E+00	0.0000E+00					42
4.2	1.0000E+00	0.0000E+00					43
4.4	9.9978E-01	0.0000E+00					44
4.6	9.9448E-01	0.0000E+00					45
4.8	9.5748E-01	0.0000E+00					46
5	8.4787E-01	0.0000E+00					47
5.2	6.6790E-01	0.0000E+00					48
5.4	4.6924E-01	0.0000E+00					49
5.6	3.0043E-01	0.0000E+00					50
5.8	1.7946E-01	0.0000E+00					51

6	1.0190E-01	0.0000E+00			1
6.2	5.5693E-02	0.0000E+00			2
6.4	2.9540E-02	0.0000E+00			3
6.6	1.5279E-02	0.0000E+00			4
6.8	7.7282E-03	0.0000E+00			5
7	3.8285E-03	0.0000E+00			6
7.2	1.8591E-03	0.0000E+00			7
7.4	8.8537E-04	0.0000E+00			8
7.6	4.1359E-04	0.0000E+00			9
7.8	1.8953E-04	0.0000E+00			10
8	3.4243E-05	0.0000E+00			11
8.2	8.0525E-06	0.0000E+00			12
8.4	1.7471E-06	0.0000E+00			13
8.6	3.4883E-07	0.0000E+00			14
8.8	6.3926E-08	0.0000E+00			15
9	1.0724E-08	0.0000E+00			16
9.2	1.6425E-09	0.0000E+00			17
9.4	2.2919E-10	0.0000E+00			18
9.6	2.9104E-11	0.0000E+00			19
9.8	3.6380E-12	0.0000E+00			20
10	0.0000E+00	0.0000E+00			21

File "802.11 adjacent FER.dat"

0.1	1.0000E+000	1.0000E+000	1.0000E+000	1.0000E+000	25
0.15	1.0000E+000	1.0000E+000	1.0000E+000	1.0000E+000	26
0.2	1.0000E+000	1.0000E+000	1.0000E+000	1.0000E+000	27
0.25	1.0000E+000	1.0000E+000	1.0000E+000	1.0000E+000	28
0.3	9.0929E-001	1.0000E+000	1.0000E+000	1.0000E+000	29
0.35	2.1929E-001	1.0000E+000	1.0000E+000	1.0000E+000	30
0.4	1.8500E-002	9.9235E-001	9.4104E-001	1.0000E+000	31
0.45	1.0266E-003	6.6324E-001	2.8403E-001	1.0000E+000	32
0.5	4.1098E-005	1.8792E-001	3.0875E-002	1.0000E+000	33
0.55	1.1945E-006	3.3469E-002	2.3347E-003	9.9929E-001	34
0.6	2.5181E-008	4.7438E-003	1.3816E-004	8.1367E-001	35
0.65	3.8472E-010	5.6666E-004	6.4705E-006	2.9491E-001	36
0.7	4.5475E-012	5.7619E-005	2.3990E-007	6.2895E-002	37
0.75	0.0000E+000	4.9923E-006	7.0368E-009	1.0717E-002	38
0.8	0.0000E+000	3.6847E-007	1.6280E-010	1.5914E-003	39
0.85	0.0000E+000	2.3158E-008	2.7285E-012	2.0966E-004	40
0.9	0.0000E+000	1.2387E-009	0.0000E+000	2.4573E-005	41
0.95	0.0000E+000	5.6389E-011	0.0000E+000	2.5627E-006	42
1	0.0000E+000	1.8190E-012	0.0000E+000	2.3776E-007	43
1.05	0.0000E+000	0.0000E+000	0.0000E+000	1.9621E-008	44
1.1	0.0000E+000	0.0000E+000	0.0000E+000	1.4397E-009	45
1.15	0.0000E+000	0.0000E+000	0.0000E+000	9.3678E-011	46
1.2	0.0000E+000	0.0000E+000	0.0000E+000	5.4570E-012	47
1.25	0.0000E+000	0.0000E+000	0.0000E+000	0.0000E+000	48
1.3	0.0000E+000	0.0000E+000	0.0000E+000	0.0000E+000	49
1.35	0.0000E+000	0.0000E+000	0.0000E+000	0.0000E+000	50
1.4	0.0000E+000	0.0000E+000	0.0000E+000	0.0000E+000	51
1.45	0.0000E+000	0.0000E+000	0.0000E+000	0.0000E+000	52
1.5	0.0000E+000	0.0000E+000	0.0000E+000	0.0000E+000	53
					54

File "802.11 alternate FER.dat"

0.1	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
0.15	9.7330E-01	1.0000E+00	1.0000E+00	1.0000E+00
0.2	3.7300E-02	9.9913E-01	9.9164E-01	1.0000E+00
0.25	1.2275E-04	3.0578E-01	6.7667E-02	1.0000E+00
0.3	1.2010E-07	1.0486E-02	4.3387E-04	9.5172E-01
0.35	3.5470E-11	1.6847E-04	1.1266E-06	1.3325E-01
0.4	0.0000E+00	1.4824E-06	1.2187E-09	4.4109E-03
0.45	0.0000E+00	7.1550E-09	9.0949E-13	8.8714E-05
0.5	0.0000E+00	1.9099E-11	0.0000E+00	1.1517E-06
0.55	0.0000E+00	0.0000E+00	0.0000E+00	9.6506E-09
0.6	0.0000E+00	0.0000E+00	0.0000E+00	5.1841E-11
0.65	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.7	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.75	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.8	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.85	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.9	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.95	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.05	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.1	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.15	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.2	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.25	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.3	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.35	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.4	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.45	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.5	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00

File "802.15.1 FER.dat"

0.2	9.9638E-01	4.41E-001
0.4	4.7431E-01	3.67E-001
0.6	4.1183E-01	3.67E-001
0.8	3.7112E-01	3.67E-001
1	3.6712E-01	2.21E-001
1.2	3.6709E-01	1.90E-001
1.4	3.6709E-01	1.90E-001
1.6	3.6709E-01	1.90E-001
1.8	3.6709E-01	1.90E-001
2	3.6568E-01	1.90E-001
2.2	3.2649E-01	1.90E-001
2.4	2.4909E-01	1.90E-001
2.6	2.0698E-01	1.90E-001
2.8	1.9389E-01	1.90E-001
3	1.9070E-01	1.90E-001
3.2	1.9003E-01	1.90E-001
3.4	1.8990E-01	1.90E-001
3.6	1.8988E-01	1.90E-001
3.8	1.8987E-01	1.90E-001
4	1.8987E-01	1.90E-001

4.2	1.8987E-01	1.90E-001	1
4.4	1.8987E-01	1.90E-001	2
4.6	1.8987E-01	1.90E-001	3
4.8	1.8987E-01	1.90E-001	4
5	1.8987E-01	1.90E-001	5
5.2	1.8987E-01	1.90E-001	6
5.4	1.8987E-01	1.90E-001	7
5.6	1.8987E-01	1.90E-001	8
5.8	1.8987E-01	1.90E-001	9
6	1.8987E-01	1.90E-001	10
6.4	1.8987E-01	1.90E-001	11
6.8	1.8987E-01	1.90E-001	12
7.2	1.8987E-01	1.90E-001	13
7.6	1.8987E-01	1.90E-001	14
8	1.8987E-01	1.90E-001	15
8.4	1.8987E-01	1.90E-001	16
8.8	1.8987E-01	1.90E-001	17
9.2	1.8987E-01	1.90E-001	18
9.6	1.8987E-01	1.90E-001	19
10	1.8987E-01	1.90E-001	20
10.5	1.8987E-01	1.90E-001	21
11	1.8987E-01	1.90E-001	22
11.5	1.8987E-01	1.90E-001	23
12	1.8987E-01	1.90E-001	24
12.5	1.8987E-01	1.90E-001	25
13	1.8987E-01	1.90E-001	26
13.5	1.8987E-01	1.90E-001	27
14	1.8987E-01	1.90E-001	28
14.5	1.8987E-01	1.90E-001	29
15	1.8987E-01	1.90E-001	30
15.5	1.8987E-01	1.90E-001	31
16	1.8987E-01	1.89E-001	32
16.5	1.8987E-01	1.77E-001	33
17	1.8987E-01	1.35E-001	34
17.5	1.8987E-01	8.05E-002	35
18	1.8987E-01	3.93E-002	36
18.5	1.8987E-01	1.67E-002	37
19	1.8987E-01	6.40E-003	38
19.5	1.8987E-01	2.27E-003	39
20	1.8987E-01	7.52E-004	40
21	1.8987E-01	6.71E-005	41
22	1.8987E-01	4.51E-006	42
23	1.8987E-01	2.26E-007	43
24	1.8987E-01	8.22E-009	44
25	1.8987E-01	2.15E-010	45
26	1.8987E-01	3.97E-012	46
27	1.8970E-01	0.00E+000	47
28	1.8432E-01	0.00E+000	48
29	1.5512E-01	0.00E+000	49
30	1.0219E-01	0.00E+000	50
31	5.3621E-02	0	51
32	2.3846E-02	0	52
33	9.4348E-03	0	53
34	3.4112E-03	0	54

35 1.1403E-03 0
36 3.5368E-04 0
37 1.0178E-04 0
38 2.7126E-05 0
39 6.6788E-06 0
40 1.5152E-06 0

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