

14.

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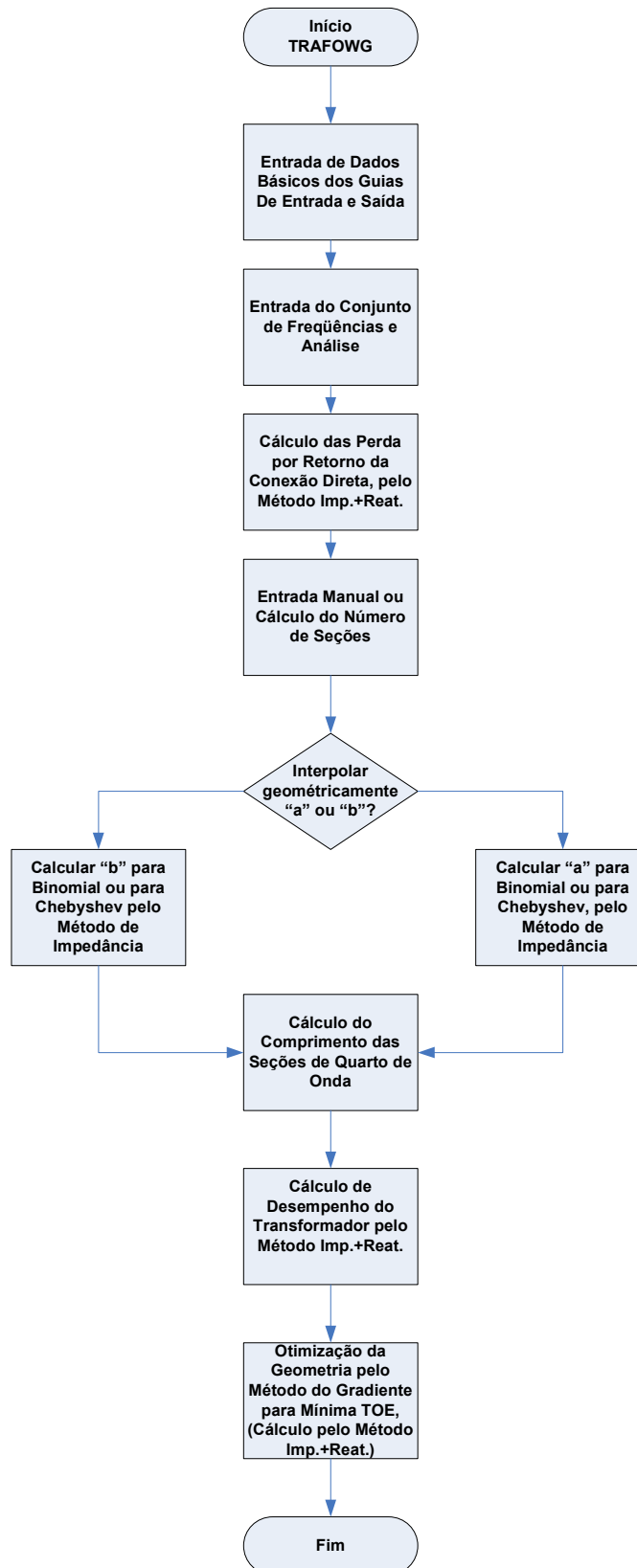
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Apêndice 1 - Macro-Fluxograma TRAFOWG



Apêndice 2 – Tabela de Guias de Onda Retangulares Comerciais

A tabela abaixo apresenta a série de guias de onda retangulares padronizados pela IEC-153:

Tabela 9 - Relação de Guias de Onda Retangulares Comerciais.

Desig. Banda USA	Designação do Guia de Onda		Frequência de Corte (GHz)	Frequências de Operação (GHz)	IEC - Dimensões Internas (mm)		Potência Teórica (MW)
	EIA	153 IEC -			a	b	
	WR-2300	R 3	0,256	0,32 - 0,49	584,20	292,10	205 - 290
	WR-2100	R 4	0,281	0,35 - 0,53	533,40	266,70	150 - 213
	WR-1800	R 5	0,328	0,41 - 0,62	457,20	228,60	104 - 148
	WR-1500	R 6	0,393	0,49 - 0,75	381,00	190,50	61.5 - 87.1
	WR-1150	R 8	0,513	0,64 - 0,98	292,10	146,05	44.2 - 62.6
	WR-975	R 9	0,605	0,76 - 1,15	247,65	123,82	27.6 - 39.1
	WR-770	R 12	0,766	0,96 - 1,46	195,58	97,79	19.6 - 27.8
L	WR-650	R 14	0,908	1,13 - 1,73	165,10	82,55	12 - 17
	WR-510	R 18	1,157	1,45 - 2,20	129,54	64,77	7.5 - 11.0
R	WR-430	R 22	1,372	1,72 - 2,61	109,22	54,61	5.2 - 7.5
	WR-340	R 26	1,736	2,17 - 3,30	86,36	43,18	3.4 - 4.8
S	WR-284	R 32	2,078	2,60 - 3,95	72,14	34,04	2.2 - 3.2
C	WR-229	R 40	2,577	3,22 - 4,90	58,17	29,08	1.6 - 2.2
	WR-187	R 48	3,152	3,94 - 5,99	47,549	22,149	0.94 - 1.32
	WR-159	R 58	3,711	4,64 - 7,05	40,386	20,193	0.79 - 1.0
	WR-137	R 70	4,301	5,38 - 8,17	34,849	15,799	0.56 - 0.71
	WR-112	R 84	5,259	6,57 - 9,99	28,499	12,624	0.35 - 0.46
X	WR-90	R 100	6,557	8,2 - 12,5	22,860	10,160	0.20 - 0.29
	WR-75	R 120	7,868	9,84 - 15,0	19,050	9,525	0.17 - 0.23
Ku	WR-62	R 140	9,486	11,9 - 18,0	15,799	7,899	0.12 - 0.16
	WR-51	R 180	11,574	14,5 - 22,0	12,954	6,477	0.08 - 0.107
	WR-42	R 220	14,047	17,6 - 26,7	10,668	4,318	0.043 - 0.058
	WR-34	R 260	17,328	21,7 - 33,0	8,636	4,318	0.034 - 0.048
Ka	WR-28	R 320	21,081	26,3 - 40,0	7,112	3,556	0.022 - 0.031
	WR-22	R 400	26,342	32,9 - 50,1	5,690	2,845	0.016 - 0.023
	WR-19	R 500	31,357	39,2 - 59,6	4,775	2,388	0.010 - 0.014
V	WR-15	R 620	39,863	49,8 - 75,8	3,759	1,880	0.07 - 0.0098
E	WR-12	R 740	48,35	60,5 - 91,9	3,0988	1,5494	0.0046-0.0066
W	WR-10	R 900	59,01	73,8 - 112	2,5400	1,2700	0.003-0.0042
	WR-8	R 1200	73,84	92,2 - 140	2,0320	1,0160	0.0019-0.0028
	WR-7	R 1400	90,84	113 - 173	1,6510	0,8255	0.0012-0.0017
T	WR-5	R 1800	115,75	145 - 220	1,2954	0,6477	0.00086
	WR-4	R 2200	131,52	172 - 261	1,0922	0,5461	0.00054
	WR-3	R 2600	173,28	217 - 330	0,8636	0,4318	

Apêndice 3 – Listagem do caso do transformador binomial, Plano H – somente Impedância

A listagem abaixo se refere ao caso apresentado na Seção 5.3 deste trabalho:

Plano: H

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância, Binomial

Modelo utilizado para análise: modelo de impedância

Sem otimização numérica

```
*****
trafo binomial - plano H - sem considerar reatâncias parasitas
*****

dados intrinsecos a estrutura de guia utilizada
=====

transformador em guia retangular

- o programa considera somente modos tel0
- "a" e a dimensao ortogonal ao campo eletrico
- "b" e a dimensao paralela ao campo eletrico
- impedancia guia=120*pi*b/a/sqrt(1-(lbda/sqrt(epsilon)/2/a)**2)

perda tipica da estrutura = 0.1000000E-03 dB/mtr.

dados dos guias de entrada e saida
=====
dimensoes do primeiro guia:
dimensao ao = 0.4038600E-01 metros
dimensao bo = 0.1579900E-01 metros

dimensoes do guia final:
dimensao af = 0.3484900E-01 metros
dimensao bf = 0.1579900E-01 metros

constante dieletrica no guia de entrada = 1.000000
constante dieletrica no guia de saida = 1.000000

frequencia de corte na linha de entrada = 0.3711589E+10 Hz
frequencia de corte na linha de saida = 0.4301307E+10 Hz

modos      frequencias de corte (em Hz.)
           primeiro guia      ultimo guia

te01      0.9487706E+10          0.9487706E+10
te11      0.1018786E+11          0.1041719E+11
te20      0.7423179E+10          0.8602615E+10
te02      0.1897541E+11          0.1897541E+11
*te12     0.1933500E+11          0.1945681E+11
te21      0.1204658E+11          0.1280709E+11

lista de frequencias
=====

numero de pontos a calcular = 19
frequencia n. 1 = 0.5300000E+10 Hz
frequencia n. 2 = 0.5400000E+10 Hz
frequencia n. 3 = 0.5500000E+10 Hz
frequencia n. 4 = 0.5600000E+10 Hz
frequencia n. 5 = 0.5700000E+10 Hz
```

```

frequencia n. 6 = 0.5800000E+10 Hz
frequencia n. 7 = 0.5900000E+10 Hz
frequencia n. 8 = 0.6000000E+10 Hz
frequencia n. 9 = 0.6100000E+10 Hz
frequencia n. 10 = 0.6200000E+10 Hz
frequencia n. 11 = 0.6300000E+10 Hz
frequencia n. 12 = 0.6400000E+10 Hz
frequencia n. 13 = 0.6500000E+10 Hz
frequencia n. 14 = 0.6600000E+10 Hz
frequencia n. 15 = 0.6700000E+10 Hz
frequencia n. 16 = 0.6800000E+10 Hz
frequencia n. 17 = 0.6900000E+10 Hz
frequencia n. 18 = 0.7000000E+10 Hz
frequencia n. 19 = 0.7100000E+10 Hz

```

lista de impedancias normalizadas de entrada(z0) e saida(zf)

=====

lista de impedancias de entrada(z0) e saida(zf)

	nao normaliz.	norm a z0(f1)	n.zguia(fn)	zguia(fn)
impedancia de normalizacao z0(f1) =	206.5968	206.5968		
real zo(1)=	206.5968	1.000000	1.000000	206.5968
imag.zo(1)=	0.000000	0.000000	0.000000	
real zf(1)=	292.5264	1.415929	1.000000	292.5264
imag.zf(1)=	0.000000	0.000000	0.000000	
real zo(2)=	203.0427	0.9827971	1.000000	203.0427
imag.zo(2)=	0.000000	0.000000	0.000000	
real zf(2)=	282.6903	1.368319	1.000000	282.6903
imag.zf(2)=	0.000000	0.000000	0.000000	
real zo(3)=	199.8442	0.9673152	1.000000	199.8442
imag.zo(3)=	0.000000	0.000000	0.000000	
real zf(3)=	274.2440	1.327436	1.000000	274.2440
imag.zf(3)=	0.000000	0.000000	0.000000	
real zo(4)=	196.9508	0.9533100	1.000000	196.9508
imag.zo(4)=	0.000000	0.000000	0.000000	
real zf(4)=	266.9064	1.291919	1.000000	266.9064
imag.zf(4)=	0.000000	0.000000	0.000000	
real zo(5)=	194.3212	0.9405817	1.000000	194.3212
imag.zo(5)=	0.000000	0.000000	0.000000	
real zf(5)=	260.4688	1.260759	1.000000	260.4688
imag.zf(5)=	0.000000	0.000000	0.000000	
real zo(6)=	191.9214	0.9289659	1.000000	191.9214
imag.zo(6)=	0.000000	0.000000	0.000000	
real zf(6)=	254.7729	1.233189	1.000000	254.7729
imag.zf(6)=	0.000000	0.000000	0.000000	
real zo(7)=	189.7229	0.9183246	1.000000	189.7229
imag.zo(7)=	0.000000	0.000000	0.000000	
real zf(7)=	249.6962	1.208616	1.000000	249.6962
imag.zf(7)=	0.000000	0.000000	0.000000	
real zo(8)=	187.7020	0.9085427	1.000000	187.7020
imag.zo(8)=	0.000000	0.000000	0.000000	
real zf(8)=	245.1422	1.186573	1.000000	245.1422
imag.zf(8)=	0.000000	0.000000	0.000000	
real zo(9)=	185.8384	0.8995222	1.000000	185.8384
imag.zo(9)=	0.000000	0.000000	0.000000	
real zf(9)=	241.0337	1.166686	1.000000	241.0337
imag.zf(9)=	0.000000	0.000000	0.000000	
real zo(10)=	184.1149	0.8911797	1.000000	184.1149
imag.zo(10)=	0.000000	0.000000	0.000000	
real zf(10)=	237.3084	1.148655	1.000000	237.3084
imag.zf(10)=	0.000000	0.000000	0.000000	
real zo(11)=	182.5166	0.8834434	1.000000	182.5166
imag.zo(11)=	0.000000	0.000000	0.000000	
real zf(11)=	233.9151	1.132230	1.000000	233.9151
imag.zf(11)=	0.000000	0.000000	0.000000	

real zo(12)=	181.0307	0.8762513	1.000000	181.0307
imag.zo(12)=	0.000000	0.000000	0.000000	
real zf(12)=	230.8115	1.117208	1.000000	230.8115
imag.zf(12)=	0.000000	0.000000	0.000000	
real zo(13)=	179.6462	0.8695499	1.000000	179.6462
imag.zo(13)=	0.000000	0.000000	0.000000	
real zf(13)=	227.9624	1.103417	1.000000	227.9624
imag.zf(13)=	0.000000	0.000000	0.000000	
real zo(14)=	178.3534	0.8632923	1.000000	178.3534
imag.zo(14)=	0.000000	0.000000	0.000000	
real zf(14)=	225.3381	1.090714	1.000000	225.3381
imag.zf(14)=	0.000000	0.000000	0.000000	
real zo(15)=	177.1438	0.8574374	1.000000	177.1438
imag.zo(15)=	0.000000	0.000000	0.000000	
real zf(15)=	222.9132	1.078977	1.000000	222.9132
imag.zf(15)=	0.000000	0.000000	0.000000	
real zo(16)=	176.0099	0.8519487	1.000000	176.0099
imag.zo(16)=	0.000000	0.000000	0.000000	
real zf(16)=	220.6662	1.068101	1.000000	220.6662
imag.zf(16)=	0.000000	0.000000	0.000000	
real zo(17)=	174.9450	0.8467944	1.000000	174.9450
imag.zo(17)=	0.000000	0.000000	0.000000	
real zf(17)=	218.5786	1.057996	1.000000	218.5786
imag.zf(17)=	0.000000	0.000000	0.000000	
real zo(18)=	173.9434	0.8419461	1.000000	173.9434
imag.zo(18)=	0.000000	0.000000	0.000000	
real zf(18)=	216.6344	1.048585	1.000000	216.6344
imag.zf(18)=	0.000000	0.000000	0.000000	
real zo(19)=	172.9997	0.8373784	1.000000	172.9997
imag.zo(19)=	0.000000	0.000000	0.000000	
real zf(19)=	214.8195	1.039801	1.000000	214.8195
imag.zf(19)=	0.000000	0.000000	0.000000	

lista de "toes" esperado sem transformador

toe (1- 0.5300000E+10 Hz.) =	1.416	return loss =	15.281 dB
toe (2- 0.5400000E+10 Hz.) =	1.392	return loss =	15.705 dB
toe (3- 0.5500000E+10 Hz.) =	1.372	return loss =	16.086 dB
toe (4- 0.5600000E+10 Hz.) =	1.355	return loss =	16.431 dB
toe (5- 0.5700000E+10 Hz.) =	1.340	return loss =	16.746 dB
toe (6- 0.5800000E+10 Hz.) =	1.327	return loss =	17.034 dB
toe (7- 0.5900000E+10 Hz.) =	1.316	return loss =	17.298 dB
toe (8- 0.6000000E+10 Hz.) =	1.306	return loss =	17.542 dB
toe (9- 0.6100000E+10 Hz.) =	1.297	return loss =	17.768 dB
toe (10- 0.6200000E+10 Hz.) =	1.289	return loss =	17.977 dB
toe (11- 0.6300000E+10 Hz.) =	1.282	return loss =	18.172 dB
toe (12- 0.6400000E+10 Hz.) =	1.275	return loss =	18.353 dB
toe (13- 0.6500000E+10 Hz.) =	1.269	return loss =	18.523 dB
toe (14- 0.6600000E+10 Hz.) =	1.263	return loss =	18.682 dB
toe (15- 0.6700000E+10 Hz.) =	1.258	return loss =	18.831 dB
toe (16- 0.6800000E+10 Hz.) =	1.254	return loss =	18.971 dB
toe (17- 0.6900000E+10 Hz.) =	1.249	return loss =	19.103 dB
toe (18- 0.7000000E+10 Hz.) =	1.245	return loss =	19.227 dB
toe (19- 0.7100000E+10 Hz.) =	1.242	return loss =	19.345 dB

**** numero de seccoes do transformador ns = 2 ****
para "toe" maximo = 1.070

constantes dieletricas relativas das seccoes do transformador
=====

constante dieletrica da seccao (1) = 1.000
constante dieletrica da seccao (2) = 1.000

dimensoes iniciais do transformador
=====

as impedancias sao fornecidas p/ a frequencia = 0.6200000E+10 Hz

dimensao a(1) = 0.3881118E-01 metros
 dimensao b(1) = 0.1579900E-01 metros
 impedancia da seccao(1) = 196.1756

dimensao a(2) = 0.3605115E-01 metros
 dimensao b(2) = 0.1579900E-01 metros
 impedancia da seccao(2) = 222.7189

lista de comprimentos iniciais das seccoes do transformador

```
=====
comprimento da seccao( 1) = 0.1545290E-01 metros
comprimento da seccao( 2) = 0.1629613E-01 metros
*****
*****
Resultado do trafo plano H, método Binomial, sem computar reatâncias parasitas
*****
```

lista de impedancias esperadas com transformador

```
=====
nao normalz.      norm a z0(f1)      norm a z0(fn)      z0(fn)
impedancia de normalizacao z0(f1) = 206.5968

real zin( 1)= 196.1664      0.9495131      0.9495131      206.5968
imag.zin( 1)= -5.984871     -0.2896885E-01 -0.2896885E-01

real zin( 2)= 194.9178      0.9434696      0.9599841      203.0427
imag.zin( 2)= -3.614831     -0.1749703E-01 -0.1780330E-01

real zin( 3)= 193.7383      0.9377603      0.9694465      199.8442
imag.zin( 3)= -1.966773     -0.9519864E-02 -0.9841532E-02

real zin( 4)= 192.5690      0.9321008      0.9777521      196.9508
imag.zin( 4)= -0.8790275     -0.4254797E-02 -0.4463184E-02

real zin( 5)= 191.3652      0.9262738      0.9847882      194.3212
imag.zin( 5)= -0.2194703     -0.1062312E-02 -0.1129420E-02

real zin( 6)= 190.0951      0.9201263      0.9904845      191.9214
imag.zin( 6)= 0.1224419      0.5926614E-03 0.6379798E-03

real zin( 7)= 188.7391      0.9135626      0.9948144      189.7229
imag.zin( 7)= 0.2407812      0.1165464E-02 0.1269120E-02
real zin( 8)= 187.2887      0.9065419      0.9977978      187.7020
imag.zin( 8)= 0.2160343      0.1045681E-02 0.1150943E-02

real zin( 9)= 185.7444      0.8990669      0.9994939      185.8384
imag.zin( 9)= 0.1165734      0.5642555E-03 0.6272836E-03

real zin(10)= 184.1149      0.8911798      1.000000      184.1149
imag.zin(10)= -0.6129353E-05 -0.2966819E-07 -0.3329092E-07

real zin(11)= 182.4155      0.8829542      0.9994463      182.5166
imag.zin(11)= -0.8630150E-01 -0.4177291E-03 -0.4728420E-03

real zin(12)= 180.6660      0.8744861      0.9979856      181.0307
imag.zin(12)= -0.1044325     -0.5054893E-03 -0.5768771E-03

real zin(13)= 178.8899      0.8658888      0.9957896      179.6462
imag.zin(13)= -0.2541774E-01 -0.1230307E-03 -0.1414877E-03

real zin(14)= 177.1120      0.8572835      0.9930396      178.3534
imag.zin(14)= 0.1716150      0.8306759E-03 0.9622186E-03

real zin(15)= 175.3587      0.8487970      0.9899231      177.1438
imag.zin(15)= 0.5000216      0.2420277E-02 0.2822687E-02

real zin(16)= 173.6556      0.8405530      0.9866240      176.0099
imag.zin(16)= 0.9667207      0.4679263E-02 0.5492423E-02

real zin(17)= 172.0272      0.8326712      0.9833215      174.9450
imag.zin(17)= 1.572754      0.7612672E-02 0.8989988E-02

real zin(18)= 170.4966      0.8252623      0.9801842      173.9434
imag.zin(18)= 2.314515      0.1120305E-01 0.1330614E-01

real zin(19)= 169.0845      0.8184273      0.9773685      172.9997
```


imag.zin(19)= 3.184134 0.1541231E-01 0.1840543E-01

matriz "s" do transformador (real/imaginario)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	-0.2567078E-01	-0.6616763	-0.6616762	0.1195158E-01
	-0.1524105E-01	-0.7491946	-0.7491946	0.2735761E-01
0.5400000E+10	-0.2033227E-01	-0.7346248	-0.7346248	0.1086278E-01
	-0.9268131E-02	-0.6781050	-0.6781050	0.1952692E-01
0.5500000E+10	-0.1548847E-01	-0.7983926	-0.7983927	0.9141020E-02
	-0.5074558E-02	-0.6019158	-0.6019159	0.1349390E-01
0.5600000E+10	-0.1124402E-01	-0.8530974	-0.8530976	0.7155690E-02
	-0.2282099E-02	-0.5216246	-0.5216246	0.8968402E-02
0.5700000E+10	-0.7663923E-02	-0.8988755	-0.8988755	0.5173072E-02
	-0.5734455E-03	-0.4381360	-0.4381360	0.5683689E-02
0.5800000E+10	-0.4780383E-02	-0.9358799	-0.9358801	0.3381426E-02
	0.3220289E-03	-0.3522856	-0.3522857	0.3394326E-02
0.5900000E+10	-0.2599092E-02	-0.9642866	-0.9642866	0.1908657E-02
	0.6378769E-03	-0.2648459	-0.2648460	0.1875968E-02
0.6000000E+10	-0.1101983E-02	-0.9842921	-0.9842921	0.8328925E-03
	0.5767385E-03	-0.1765410	-0.1765409	0.9237840E-03
0.6100000E+10	-0.2529973E-03	-0.9961157	-0.9961158	0.1940260E-03
	0.3137997E-03	-0.8804698E-01	-0.8804698E-01	0.3533174E-03
0.6200000E+10	0.2247377E-07	-0.9999996	-0.9999998	-0.7059455E-07
	0.3775671E-13	-0.1106894E-05	-0.1106894E-05	-0.5993757E-13
0.6300000E+10	-0.2768314E-03	-0.9962080	-0.9962080	0.2316677E-03
	-0.2365551E-03	0.8699853E-01	0.8699852E-01	-0.2809693E-03
0.6400000E+10	-0.1008163E-02	-0.9850278	-0.9850277	0.8500469E-03
	-0.2890209E-03	0.1723905	0.1723905	-0.6142280E-03
0.6500000E+10	-0.2109701E-02	-0.9667675	-0.9667675	0.1798817E-02
	-0.7102254E-04	0.2556468	0.2556468	-0.1104590E-02
0.6600000E+10	-0.3492110E-02	-0.9417569	-0.9417569	0.3009181E-02
	0.4844813E-03	0.3362747	0.3362747	-0.1836962E-02
0.6700000E+10	-0.5061989E-02	-0.9103458	-0.9103457	0.4402442E-02
	0.1425662E-02	0.4138143	0.4138143	-0.2876585E-02
0.6800000E+10	-0.6725255E-02	-0.8729025	-0.8729027	0.5894536E-02
	0.2783244E-02	0.4878394	0.4878395	-0.4269606E-02
0.6900000E+10	-0.8388589E-02	-0.8298141	-0.8298142	0.7398034E-02
	0.4570779E-02	0.5579575	0.5579576	-0.6044012E-02
0.7000000E+10	-0.9961410E-02	-0.7814826	-0.7814825	0.8825323E-02
	0.6786541E-02	0.6238098	0.6238098	-0.8209771E-02
0.7100000E+10	-0.1135755E-01	-0.7283262	-0.7283261	0.1009058E-01
	0.9413712E-02	0.6850712	0.6850713	-0.1076070E-01

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.2985429E-01	0.9995539	0.9995539	0.2985430E-01
	-149.3019	-131.4504	-131.4504	66.40118
0.5400000E+10	0.2234501E-01	0.9997500	0.9997500	0.2234504E-01
	-155.4949	-137.2910	-137.2910	60.91292
0.5500000E+10	0.1629858E-01	0.9998667	0.9998668	0.1629858E-01
	-161.8594	-142.9870	-142.9870	55.88557
0.5600000E+10	0.1147327E-01	0.9999337	0.9999338	0.1147328E-01
	-168.5270	-148.5564	-148.5564	51.41441
0.5700000E+10	0.7685347E-02	0.9999701	0.9999701	0.7685375E-02
	-175.7209	-154.0142	-154.0142	47.69276
0.5800000E+10	0.4791218E-02	0.9999882	0.9999883	0.4791189E-02
	176.1461	-159.3726	-159.3726	45.10908
0.5900000E+10	0.2676223E-02	0.9999959	0.9999961	0.2676234E-02
	166.2108	-164.6421	-164.6421	44.50514
0.6000000E+10	0.1243782E-02	0.9999989	0.9999989	0.1243819E-02
	152.3740	-169.8316	-169.8316	47.96188
0.6100000E+10	0.4030854E-03	0.9999994	0.9999995	0.4030871E-03
	128.8771	-174.9487	-174.9487	61.22639
0.6200000E+10	0.2247377E-07	0.9999996	0.9999998	0.7059455E-07
	0.9625890E-04	-179.9999	-179.9999	-180.0000
0.6300000E+10	0.3641345E-03	0.9999995	0.9999995	0.3641616E-03
	-139.4858	175.0090	175.0090	-50.49339
0.6400000E+10	0.1048773E-02	0.9999992	0.9999990	0.1048740E-02
	-164.0034	170.0732	170.0732	-35.85117
0.6500000E+10	0.2110896E-02	0.9999974	0.9999974	0.2110891E-02
	-178.0719	165.1880	165.1880	-31.55261
0.6600000E+10	0.3525558E-02	0.9999934	0.9999934	0.3525564E-02

	172.1014	160.3498	160.3498	-31.40208
0.6700000E+10	0.5258921E-02	0.9999859	0.9999858	0.5258920E-02
	164.2706	155.5550	155.5550	-33.16087
0.6800000E+10	0.7278427E-02	0.9999731	0.9999732	0.7278399E-02
	157.5178	150.8005	150.8005	-35.91705
0.6900000E+10	0.9553034E-02	0.9999540	0.9999542	0.9553063E-02
	151.4149	146.0836	146.0836	-39.24798
0.7000000E+10	0.1205350E-01	0.9999268	0.9999268	0.1205349E-01
	145.7341	141.4018	141.4018	-42.93056
0.7100000E+10	0.1475168E-01	0.9998908	0.9998908	0.1475169E-01
	140.3464	136.7529	136.7529	-46.84075

lista de "toes" esperadas com transformador

```

=====
toe ( 1- 0.5300000E+10 Hz.) = 1.062 return loss = 30.500 dB
toe ( 2- 0.5400000E+10 Hz.) = 1.046 return loss = 33.016 dB
toe ( 3- 0.5500000E+10 Hz.) = 1.033 return loss = 35.757 dB
toe ( 4- 0.5600000E+10 Hz.) = 1.023 return loss = 38.806 dB
toe ( 5- 0.5700000E+10 Hz.) = 1.015 return loss = 42.287 dB
toe ( 6- 0.5800000E+10 Hz.) = 1.010 return loss = 46.391 dB
toe ( 7- 0.5900000E+10 Hz.) = 1.005 return loss = 51.449 dB
toe ( 8- 0.6000000E+10 Hz.) = 1.002 return loss = 58.105 dB
toe ( 9- 0.6100000E+10 Hz.) = 1.001 return loss = 67.892 dB
toe (10- 0.6200000E+10 Hz.) = 1.000 return loss = 143.233 dB
toe (11- 0.6300000E+10 Hz.) = 1.001 return loss = 68.774 dB
toe (12- 0.6400000E+10 Hz.) = 1.002 return loss = 59.587 dB
toe (13- 0.6500000E+10 Hz.) = 1.004 return loss = 53.511 dB
toe (14- 0.6600000E+10 Hz.) = 1.007 return loss = 49.056 dB
toe (15- 0.6700000E+10 Hz.) = 1.011 return loss = 45.582 dB
toe (16- 0.6800000E+10 Hz.) = 1.015 return loss = 42.759 dB
toe (17- 0.6900000E+10 Hz.) = 1.019 return loss = 40.397 dB
toe (18- 0.7000000E+10 Hz.) = 1.024 return loss = 38.378 dB
toe (19- 0.7100000E+10 Hz.) = 1.030 return loss = 36.623 dB

```

"toe" medio = 1.016 +/- 0.071

```

*****
*****

```

Apêndice 4 – Listagem do caso do transformador Chebyshev, Plano H – somente Impedância

A listagem abaixo se refere ao caso apresentado na Seção 5.3 deste trabalho:

Plano: H

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância, Chebyshev

Modelo utilizado para análise: modelo de impedância

Sem otimização numérica

```

*****
trafo Chebyshev - plano H - sem considerar reatâncias parasitas
*****
dimensoes iniciais do transformador
=====
as impedancias sao fornecidas p/ a frequencia = 0.620000E+10 Hz

dimensao a( 1) = 0.3877171E-01 metros
dimensao b( 1) = 0.1579900E-01 metros
dimensao c( 1) = 0.000000 metros
impedancia da seccao( 1) = 196.5022

dimensao a( 2) = 0.3608419E-01 metros
dimensao b( 2) = 0.1579900E-01 metros
dimensao c( 2) = 0.000000 metros
impedancia da seccao( 2) = 222.3486

      lista de comprimentos iniciais das seccoes do transformador
      =====
comprimento da seccao( 1) = 0.1546289E-01 metros
comprimento da seccao( 2) = 0.1628395E-01 metros
*****
*****

Resultados trafo Chebyshev - plano H - sem considerar reatâncias parasitas
*****
lista de impedancias esperadas com transformador
=====
      nao normalz.      norm a z0(f1)      norm a z0(fn)      z0(fn)
impedancia de normalizacao z0(f1) = 206.5968

real zin( 1) = 197.2288      0.9546554      0.9546554      206.5968
imag.zin( 1) = -4.934796     -0.2388612E-01 -0.2388612E-01
real zin( 2) = 196.0510      0.9489549      0.9655654      203.0427
imag.zin( 2) = -2.672934     -0.1293792E-01 -0.1316439E-01

real zin( 3) = 194.9310      0.9435337      0.9754150      199.8442
imag.zin( 3) = -1.139426     -0.5515215E-02 -0.5701570E-02

real zin( 4) = 193.8085      0.9381004      0.9840456      196.9508
imag.zin( 4) = -0.1710730     -0.8280525E-03 -0.8686078E-03

real zin( 5) = 192.6378      0.9324334      0.9913369      194.3212
imag.zin( 5) = 0.3660653      0.1771883E-02 0.1883816E-02

real zin( 6) = 191.3864      0.9263765      0.9972126      191.9214
imag.zin( 6) = 0.5846025      0.2829679E-02 0.3046052E-02

real zin( 7) = 190.0349      0.9198347      1.001644      189.7229
imag.zin( 7) = 0.5807140      0.2810857E-02 0.3060853E-02

```

real zin(8)=	188.5750	0.9127682	1.004651	187.7020
imag.zin(8)=	0.4369205	0.2114846E-02	0.2327735E-02	
real zin(9)=	187.0081	0.9051837	1.006294	185.8384
imag.zin(9)=	0.2235872	0.1082239E-02	0.1203127E-02	
real zin(10)=	185.3442	0.8971300	1.006677	184.1149
imag.zin(10)=	0.5698989E-06	0.2758508E-08	0.3095344E-08	
real zin(11)=	183.5998	0.8886864	1.005935	182.5166
imag.zin(11)=	-0.1850442	-0.8956781E-03	-0.1013849E-02	
real zin(12)=	181.7964	0.8799575	1.004230	181.0307
imag.zin(12)=	-0.2925890	-0.1416232E-02	-0.1616240E-02	
real zin(13)=	179.9592	0.8710648	1.001742	179.6462
imag.zin(13)=	-0.2929270	-0.1417868E-02	-0.1630577E-02	
real zin(14)=	178.1150	0.8621381	0.9986629	178.3534
imag.zin(14)=	-0.1648255	-0.7978124E-03	-0.9241509E-03	
real zin(15)=	176.2915	0.8533118	0.9951885	177.1438
imag.zin(15)=	0.1051529	0.5089765E-03	0.5936020E-03	
real zin(16)=	174.5159	0.8447173	0.9915119	176.0099
imag.zin(16)=	0.5236972	0.2534876E-02	0.2975385E-02	
real zin(17)=	172.8142	0.8364807	0.9878203	174.9450
imag.zin(17)=	1.091546	0.5283461E-02	0.6239367E-02	
real zin(18)=	171.2106	0.8287186	0.9842894	173.9434
imag.zin(18)=	1.804448	0.8734154E-02	0.1037377E-01	
real zin(19)=	169.7270	0.8215375	0.9810827	172.9997
imag.zin(19)=	2.653841	0.1284551E-01	0.1534015E-01	

matriz "s" do transformador (real/imaginario)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	-0.2304554E-01	-0.6619773	-0.6619774	0.9572971E-02
	-0.1250178E-01	-0.7490645	-0.7490646	0.2440798E-01
0.5400000E+10	-0.1747328E-01	-0.7348605	-0.7348605	0.8197678E-02
	-0.6814573E-02	-0.6779583	-0.6779584	0.1686868E-01
0.5500000E+10	-0.1243710E-01	-0.7985694	-0.7985694	0.6237078E-02
	-0.2922193E-02	-0.6017665	-0.6017665	0.1114989E-01
0.5600000E+10	-0.8041284E-02	-0.8532236	-0.8532236	0.4060195E-02
	-0.4413565E-03	-0.5214825	-0.5214826	0.6954986E-02
0.5700000E+10	-0.4349553E-02	-0.8989589	-0.8989589	0.1932361E-02
	0.9500895E-03	-0.4380095	-0.4380096	0.4010935E-02
0.5800000E+10	-0.1393279E-02	-0.9359297	-0.9359295	0.4078950E-04
	0.1527265E-02	-0.3521802	-0.3521802	0.2066908E-02
0.5900000E+10	0.8238864E-03	-0.9643109	-0.9643110	-0.1488587E-02
	0.1527917E-02	-0.2647655	-0.2647655	0.8930059E-03
0.6000000E+10	0.2321362E-02	-0.9842990	-0.9842990	-0.2579211E-02
	0.1158470E-02	-0.1764873	-0.1764874	0.2798020E-03
0.6100000E+10	0.3137413E-02	-0.9961132	-0.9961131	-0.3193631E-02
	0.5977945E-03	-0.8802055E-01	-0.8802054E-01	0.3836512E-04
0.6200000E+10	0.3327247E-02	-0.9999939	-0.9999940	-0.3327289E-02
	0.3682507E-08	-0.1106767E-05	-0.1106767E-05	-0.3682531E-08
0.6300000E+10	0.2958841E-02	-0.9962057	-0.9962058	-0.3001373E-02
	-0.5039248E-03	0.8697449E-01	0.8697449E-01	0.1642973E-04
0.6400000E+10	0.2111044E-02	-0.9850336	-0.9850336	-0.2258895E-02
	-0.8047112E-03	0.1723452	0.1723453	-0.4013282E-04
0.6500000E+10	0.8709796E-03	-0.9667857	-0.9667857	-0.1159400E-02
	-0.8138752E-03	0.2555836	0.2555836	-0.2771268E-03
0.6600000E+10	-0.6687279E-03	-0.9417906	-0.9417905	0.2245327E-03
	-0.4627156E-03	0.3361976	0.3361976	-0.7816110E-03
0.6700000E+10	-0.2411484E-02	-0.9103972	-0.9103971	0.1810589E-02
	0.2982182E-03	0.4137274	0.4137273	-0.1620494E-02
0.6800000E+10	-0.4259828E-02	-0.8729731	-0.8729728	0.3510686E-02
	0.1500391E-02	0.4877469	0.4877468	-0.2841153E-02
0.6900000E+10	-0.6117296E-02	-0.8299038	-0.8299037	0.5233843E-02
	0.3157998E-02	0.5578635	0.5578636	-0.4472319E-02
0.7000000E+10	-0.7889926E-02	-0.7815914	-0.7815914	0.6888400E-02
	0.5269166E-02	0.6237178	0.6237179	-0.6524152E-02

```

0.7100000E+10 -0.9488435E-02 -0.7284532 -0.7284531 0.8384983E-02
                0.7816711E-02 0.6849849 0.6849849 -0.8990235E-02

```

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.2621815E-01	0.9996557	0.9996558	0.2621815E-01
	-151.5210	-131.4683	-131.4683	68.58456
0.5400000E+10	0.1875510E-01	0.9998237	0.9998237	0.1875511E-01
	-158.6942	-137.3064	-137.3064	64.08162
0.5500000E+10	0.1277579E-01	0.9999180	0.9999180	0.1277580E-01
	-166.7777	-142.9999	-142.9999	60.77801
0.5600000E+10	0.8053388E-02	0.9999673	0.9999673	0.8053386E-02
	-176.8584	-148.5671	-148.5671	59.72439
0.5700000E+10	0.4452109E-02	0.9999897	0.9999897	0.4452148E-02
	167.6782	-154.0228	-154.0228	64.27647
0.5800000E+10	0.2067309E-02	0.9999976	0.9999975	0.2067310E-02
	132.3733	-159.3792	-159.3792	88.86944
0.5900000E+10	0.1735891E-02	0.9999981	0.9999982	0.1735901E-02
	61.66548	-164.6470	-164.6470	149.0404
0.6000000E+10	0.2594374E-02	0.9999962	0.9999962	0.2594343E-02
	26.52137	-169.8347	-169.8347	173.8086
0.6100000E+10	0.3193856E-02	0.9999945	0.9999944	0.3193861E-02
	10.78768	-174.9502	-174.9502	179.3117
0.6200000E+10	0.3327247E-02	0.9999939	0.9999940	0.3327289E-02
	0.6341341E-04	-179.9999	-179.9999	-179.9999
0.6300000E+10	0.3001446E-02	0.9999952	0.9999953	0.3001418E-02
	-9.665396	175.0104	175.0104	179.6864
0.6400000E+10	0.2259218E-02	0.9999970	0.9999971	0.2259251E-02
	-20.86640	170.0758	170.0758	-178.9822
0.6500000E+10	0.1192056E-02	0.9999988	0.9999988	0.1192060E-02
	-43.05883	165.1918	165.1918	-166.5570
0.6600000E+10	0.8132051E-03	0.9999992	0.9999991	0.8132224E-03
	-145.3193	160.3546	160.3546	-73.97227
0.6700000E+10	0.2429854E-02	0.9999967	0.9999965	0.2429862E-02
	172.9503	155.5607	155.5607	-41.82884
0.6800000E+10	0.4516338E-02	0.9999895	0.9999893	0.4516311E-02
	160.5968	150.8071	150.8071	-38.98280
0.6900000E+10	0.6884349E-02	0.9999760	0.9999760	0.6884384E-02
	152.6954	146.0909	146.0909	-40.51389
0.7000000E+10	0.9487626E-02	0.9999545	0.9999546	0.9487603E-02
	146.2636	141.4098	141.4098	-43.44439
0.7100000E+10	0.1229355E-01	0.9999242	0.9999241	0.1229359E-01
	140.5178	136.7615	136.7615	-46.99504

lista de "toes" esperadas com transformador

=====

toe (1- 0.5300000E+10 Hz.) =	1.054	return loss =	31.628 dB
toe (2- 0.5400000E+10 Hz.) =	1.038	return loss =	34.538 dB
toe (3- 0.5500000E+10 Hz.) =	1.026	return loss =	37.872 dB
toe (4- 0.5600000E+10 Hz.) =	1.016	return loss =	41.881 dB
toe (5- 0.5700000E+10 Hz.) =	1.009	return loss =	47.029 dB
toe (6- 0.5800000E+10 Hz.) =	1.004	return loss =	53.692 dB
toe (7- 0.5900000E+10 Hz.) =	1.003	return loss =	55.210 dB
toe (8- 0.6000000E+10 Hz.) =	1.005	return loss =	51.719 dB
toe (9- 0.6100000E+10 Hz.) =	1.006	return loss =	49.914 dB
toe (10- 0.6200000E+10 Hz.) =	1.007	return loss =	49.558 dB
toe (11- 0.6300000E+10 Hz.) =	1.006	return loss =	50.453 dB
toe (12- 0.6400000E+10 Hz.) =	1.005	return loss =	52.921 dB
toe (13- 0.6500000E+10 Hz.) =	1.002	return loss =	58.474 dB
toe (14- 0.6600000E+10 Hz.) =	1.002	return loss =	61.796 dB
toe (15- 0.6700000E+10 Hz.) =	1.005	return loss =	52.288 dB
toe (16- 0.6800000E+10 Hz.) =	1.009	return loss =	46.904 dB
toe (17- 0.6900000E+10 Hz.) =	1.014	return loss =	43.243 dB
toe (18- 0.7000000E+10 Hz.) =	1.019	return loss =	40.457 dB
toe (19- 0.7100000E+10 Hz.) =	1.025	return loss =	38.206 dB

"toe" medio = 1.013 +/- 0.059

Apêndice 5 – Listagem do caso do transformador Binomial, Plano E – somente Impedância

A listagem abaixo se refere ao caso apresentado na Seção 5.4 deste trabalho:

Plano: E

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância; Binomial

Modelo utilizado para análise: modelo de impedância

Sem otimização numérica

```
*****
trafo binomial - plano E - sem considerar reatâncias parasitas
*****
dados intrinsecos a estrutura de guia utilizada
=====
```

transformador em guia retangular

```
- o programa considera somente modos te10
- "a" e a dimensao ortogonal ao campo eletrico
- "b" e a dimensao paralela ao campo eletrico
- impedancia guia=120*pi*b/a/sqrt(1-(lbd/sqrt(epsilon))/2/a)**2)
- perda tipica da estrutura = 0.1000000E-03 dB/mtr.
dados dos guias de entrada e saida
=====
```

```
dimensoes do primeiro guia:
dimensao ao = 0.3484900E-01 metros
dimensao bo = 0.2019300E-01 metros
```

```
dimensoes do guia final:
dimensao af = 0.3484900E-01 metros
dimensao bf = 0.1579900E-01 metros
```

```
constante dieletrica no guia de entrada = 1.000000
constante dieletrica no guia de saida = 1.000000
```

```
frequencia de corte na linha de entrada = 0.4301307E+10 Hz
frequencia de corte na linha de saida = 0.4301307E+10 Hz
```

modos	frequencias de corte (em Hz.)	
	primeiro guia	ultimo guia
te01	0.7423179E+10	0.9487706E+10
te11	0.8579325E+10	0.1041719E+11
te20	0.8602615E+10	0.8602615E+10
te02	0.1484636E+11	0.1897541E+11
*te12	0.1545689E+11	0.1945681E+11
te21	0.1136259E+11	0.1280709E+11

lista de frequencias

=====

numero de pontos a calcular = 19

```
frequencia n. 1 = 0.5300000E+10 Hz
frequencia n. 2 = 0.5400000E+10 Hz
frequencia n. 3 = 0.5500000E+10 Hz
frequencia n. 4 = 0.5600000E+10 Hz
frequencia n. 5 = 0.5700000E+10 Hz
frequencia n. 6 = 0.5800000E+10 Hz
frequencia n. 7 = 0.5900000E+10 Hz
```

```

frequencia n. 8 = 0.6000000E+10 Hz
frequencia n. 9 = 0.6100000E+10 Hz
frequencia n. 10 = 0.6200000E+10 Hz
frequencia n. 11 = 0.6300000E+10 Hz
frequencia n. 12 = 0.6400000E+10 Hz
frequencia n. 13 = 0.6500000E+10 Hz
frequencia n. 14 = 0.6600000E+10 Hz
frequencia n. 15 = 0.6700000E+10 Hz
frequencia n. 16 = 0.6800000E+10 Hz
frequencia n. 17 = 0.6900000E+10 Hz
frequencia n. 18 = 0.7000000E+10 Hz
frequencia n. 19 = 0.7100000E+10 Hz

```

lista de impedancias normalizadas de entrada(z0) e saida(zf)

lista de impedancias de entrada(z0) e saida(zf)

	nao normaliz.	norm a z0(f1)	n.zguia(fn)	zguia(fn)
impedancia de normalizacao z0(f1) =		373.8836		
real zo(1)=	373.8836	1.000000	1.000000	373.8836
imag.zo(1)=	0.000000	0.000000	0.000000	
real zf(1)=	292.5264	0.7823998	1.000000	292.5264
imag.zf(1)=	0.000000	0.000000	0.000000	
real zo(2)=	361.3119	0.9663753	1.000000	361.3119
imag.zo(2)=	0.000000	0.000000	0.000000	
real zf(2)=	282.6903	0.7560918	1.000000	282.6903
imag.zf(2)=	0.000000	0.000000	0.000000	
real zo(3)=	350.5165	0.9375017	1.000000	350.5165
imag.zo(3)=	0.000000	0.000000	0.000000	
real zf(3)=	274.2440	0.7335011	1.000000	274.2440
imag.zf(3)=	0.000000	0.000000	0.000000	
real zo(4)=	341.1381	0.9124179	1.000000	341.1381
imag.zo(4)=	0.000000	0.000000	0.000000	
real zf(4)=	266.9064	0.7138757	1.000000	266.9064
imag.zf(4)=	0.000000	0.000000	0.000000	
real zo(5)=	332.9101	0.8904112	1.000000	332.9101
imag.zo(5)=	0.000000	0.000000	0.000000	
real zf(5)=	260.4688	0.6966575	1.000000	260.4688
imag.zf(5)=	0.000000	0.000000	0.000000	
real zo(6)=	325.6302	0.8709400	1.000000	325.6302
imag.zo(6)=	0.000000	0.000000	0.000000	
real zf(6)=	254.7729	0.6814232	1.000000	254.7729
imag.zf(6)=	0.000000	0.000000	0.000000	
real zo(7)=	319.1415	0.8535852	1.000000	319.1415
imag.zo(7)=	0.000000	0.000000	0.000000	
real zf(7)=	249.6962	0.6678448	1.000000	249.6962
imag.zf(7)=	0.000000	0.000000	0.000000	
real zo(8)=	313.3209	0.8380173	1.000000	313.3209
imag.zo(8)=	0.000000	0.000000	0.000000	
real zf(8)=	245.1422	0.6556645	1.000000	245.1422
imag.zf(8)=	0.000000	0.000000	0.000000	
real zo(9)=	308.0698	0.8239725	1.000000	308.0698
imag.zo(9)=	0.000000	0.000000	0.000000	
real zf(9)=	241.0337	0.6446758	1.000000	241.0337
imag.zf(9)=	0.000000	0.000000	0.000000	
real zo(10)=	303.3083	0.8112375	1.000000	303.3083
imag.zo(10)=	0.000000	0.000000	0.000000	
real zf(10)=	237.3084	0.6347119	1.000000	237.3084
imag.zf(10)=	0.000000	0.000000	0.000000	
real zo(11)=	298.9713	0.7996374	1.000000	298.9713
imag.zo(11)=	0.000000	0.000000	0.000000	
real zf(11)=	233.9151	0.6256361	1.000000	233.9151
imag.zf(11)=	0.000000	0.000000	0.000000	
real zo(12)=	295.0046	0.7890280	1.000000	295.0046

```

imag.zo(12)= 0.000000      0.000000      0.000000
real zf(12)= 230.8115     0.6173353    1.000000      230.8115
imag.zf(12)= 0.000000      0.000000      0.000000

real zo(13)= 291.3631     0.7792884    1.000000      291.3631
imag.zo(13)= 0.000000      0.000000      0.000000
real zf(13)= 227.9624     0.6097150    1.000000      227.9624
imag.zf(13)= 0.000000      0.000000      0.000000

real zo(14)= 288.0089     0.7703170    1.000000      288.0089
imag.zo(14)= 0.000000      0.000000      0.000000
real zf(14)= 225.3381     0.6026958    1.000000      225.3381
imag.zf(14)= 0.000000      0.000000      0.000000
real zo(15)= 284.9096     0.7620275    1.000000      284.9096
imag.zo(15)= 0.000000      0.000000      0.000000
real zf(15)= 222.9132     0.5962101    1.000000      222.9132
imag.zf(15)= 0.000000      0.000000      0.000000

real zo(16)= 282.0377     0.7543462    1.000000      282.0377
imag.zo(16)= 0.000000      0.000000      0.000000
real zf(16)= 220.6662     0.5902003    1.000000      220.6662
imag.zf(16)= 0.000000      0.000000      0.000000

real zo(17)= 279.3695     0.7472098    1.000000      279.3695
imag.zo(17)= 0.000000      0.000000      0.000000
real zf(17)= 218.5786     0.5846168    1.000000      218.5786
imag.zf(17)= 0.000000      0.000000      0.000000

real zo(18)= 276.8845     0.7405635    1.000000      276.8845
imag.zo(18)= 0.000000      0.000000      0.000000
real zf(18)= 216.6344     0.5794166    1.000000      216.6344
imag.zf(18)= 0.000000      0.000000      0.000000

real zo(19)= 274.5649     0.7343594    1.000000      274.5649
imag.zo(19)= 0.000000      0.000000      0.000000
real zf(19)= 214.8195     0.5745627    1.000000      214.8195
imag.zf(19)= 0.000000      0.000000      0.000000

```

lista de "toes" esperado sem transformador

```

toe ( 1- 0.5300000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 2- 0.5400000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 3- 0.5500000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 4- 0.5600000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 5- 0.5700000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 6- 0.5800000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 7- 0.5900000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 8- 0.6000000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe ( 9- 0.6100000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (10- 0.6200000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (11- 0.6300000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (12- 0.6400000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (13- 0.6500000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (14- 0.6600000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (15- 0.6700000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (16- 0.6800000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (17- 0.6900000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (18- 0.7000000E+10 Hz.) = 1.278      return loss = 18.267 dB
toe (19- 0.7100000E+10 Hz.) = 1.278      return loss = 18.267 dB

```

```

**** numero de seccoes do transformador ns = 2 ****
constantes dieletricas relativas das seccoes do transformador
=====
constante dieletrica da seccao ( 1) = 1.000
constante dieletrica da seccao ( 2) = 1.000

```

dimensoes iniciais do transformador

as impedancias sao fornecidas p/ a frequencia = 0.6200000E+10 Hz

```

dimensao a( 1) = 0.3484900E-01 metros
dimensao b( 1) = 0.1899145E-01 metros
impedancia da seccao( 1) = 285.2604

```

```

dimensao a( 2) = 0.3484900E-01 metros

```


dimensao b(2) = 0.1679857E-01 metros
 impedancia da seccao(2) = 252.3224

lista de comprimentos iniciais das seccoes do transformador
 =====

comprimento da seccao(1) = 0.1678463E-01 metros
 comprimento da seccao(2) = 0.1678463E-01 metros

Resultados trafo binomial - plano E - sem considerar reatâncias parasitas

lista de impedancias esperadas com transformador
 =====

	nao normalz.	norm a z0(f1)	norm a z0(fn)	z0(fn)
impedancia de normalizacao z0(f1) = 373.8836				
real zin(1)=	384.9122	1.029497	1.029497	373.8836
imag.zin(1)=	16.70137	0.4466997E-01	0.4466997E-01	
real zin(2)=	371.1609	0.9927177	1.027259	361.3119
imag.zin(2)=	11.49120	0.3073470E-01	0.3180410E-01	
real zin(3)=	358.7084	0.9594120	1.023371	350.5165
imag.zin(3)=	7.513238	0.2009513E-01	0.2143476E-01	
real zin(4)=	347.4966	0.9294245	1.018639	341.1381
imag.zin(4)=	4.603734	0.1231328E-01	0.1349522E-01	
real zin(5)=	337.4790	0.9026312	1.013724	332.9101
imag.zin(5)=	2.586136	0.6916954E-02	0.7768270E-02	
real zin(6)=	328.6069	0.8789016	1.009141	325.6302
imag.zin(6)=	1.282851	0.3431151E-02	0.3939596E-02	
real zin(7)=	320.8236	0.8580843	1.005271	319.1415
imag.zin(7)=	0.5235323	0.1400255E-02	0.1640440E-02	
real zin(8)=	314.0636	0.8400038	1.002370	313.3209
imag.zin(8)=	0.1498725	0.4008533E-03	0.4783353E-03	
real zin(9)=	308.2524	0.8244610	1.000593	308.0698
imag.zin(9)=	0.1808076E-01	0.4835933E-04	0.5869047E-04	
real zin(10)=	303.3084	0.8112377	1.000000	303.3083
imag.zin(10)=	0.1303134E-04	0.3485402E-07	0.4296401E-07	
real zin(11)=	299.1434	0.8000978	1.000576	298.9713
imag.zin(11)=	-0.1677680E-01	-0.4487171E-04	-0.5611508E-04	
real zin(12)=	295.6640	0.7907916	1.002235	295.0046
imag.zin(12)=	-0.1290048	-0.3450400E-03	-0.4372975E-03	
real zin(13)=	292.7724	0.7830576	1.004837	291.3631
imag.zin(13)=	-0.4179533	-0.1117870E-02	-0.1434476E-02	
real zin(14)=	290.3669	0.7766238	1.008187	288.0089
imag.zin(14)=	-0.9492911	-0.2539002E-02	-0.3296048E-02	
real zin(15)=	288.3432	0.7712113	1.012052	284.9096
imag.zin(15)=	-1.772951	-0.4741988E-02	-0.6222856E-02	
real zin(16)=	286.5951	0.7665358	1.016159	282.0377
imag.zin(16)=	-2.922441	-0.7816446E-02	-0.1036188E-01	
real zin(17)=	285.0168	0.7623143	1.020214	279.3695
imag.zin(17)=	-4.414622	-0.1180748E-01	-0.1580209E-01	
real zin(18)=	283.5038	0.7582676	1.023906	276.8845
imag.zin(18)=	-6.248902	-0.1671350E-01	-0.2256862E-01	
real zin(19)=	281.9562	0.7541283	1.026920	274.5649
imag.zin(19)=	-8.407269	-0.2248633E-01	-0.3062033E-01	
matriz "s" do transformador (real/imaginario)				

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.1501146E-01	-0.5690712	-0.5690712	-0.1501148E-01
	0.2167996E-01	-0.8218646	-0.8218647	-0.2167993E-01
0.5400000E+10	0.1368907E-01	-0.6624589	-0.6624588	-0.1368910E-01
	0.1547355E-01	-0.7488128	-0.7488129	-0.1547348E-01
0.5500000E+10	0.1166139E-01	-0.7440040	-0.7440040	-0.1166147E-01
	0.1047007E-01	-0.6679907	-0.6679907	-0.1047002E-01
0.5600000E+10	0.9277728E-02	-0.8138332	-0.8138332	-0.9277773E-02
	0.6623324E-02	-0.5809858	-0.5809860	-0.6623269E-02
0.5700000E+10	0.6830018E-02	-0.8721268	-0.8721268	-0.6830059E-02
	0.3831318E-02	-0.4892163	-0.4892164	-0.3831299E-02
0.5800000E+10	0.4553808E-02	-0.9191125	-0.9191126	-0.4553797E-02
	0.1951946E-02	-0.3939633	-0.3939634	-0.1951891E-02
0.5900000E+10	0.2629133E-02	-0.9550621	-0.9550623	-0.2629169E-02
	0.8159184E-03	-0.2963914	-0.2963915	-0.8159535E-03
0.6000000E+10	0.1183838E-02	-0.9802881	-0.9802883	-0.1183847E-02
	0.2386037E-03	-0.1975676	-0.1975676	-0.2385890E-03
0.6100000E+10	0.2963438E-03	-0.9951394	-0.9951395	-0.2963458E-03
	0.2932927E-04	-0.9846991E-01	-0.9846993E-01	-0.2932288E-04
0.6200000E+10	0.5066445E-07	-0.9999993	-0.9999994	-0.4996565E-07
	0.8116754E-13	-0.1106749E-05	-0.1106749E-05	-0.9763141E-13
0.6300000E+10	0.2876808E-03	-0.9952832	-0.9952832	-0.2876802E-03
	-0.2804104E-04	0.9700856E-01	0.9700856E-01	0.2804293E-04
0.6400000E+10	0.1116342E-02	-0.9814343	-0.9814343	-0.1116348E-02
	-0.2181638E-03	0.1917934	0.1917934	0.2181609E-03
0.6500000E+10	0.2413010E-02	-0.9589251	-0.9589251	-0.2413020E-02
	-0.7137747E-03	0.2836470	0.2836471	0.7137627E-03
0.6600000E+10	0.4079570E-02	-0.9282526	-0.9282526	-0.4079570E-02
	-0.1634572E-02	0.3719231	0.3719231	0.1634572E-02
0.6700000E+10	0.5999207E-02	-0.8899383	-0.8899384	-0.5999209E-02
	-0.3074187E-02	0.4560303	0.4560304	0.3074176E-02
0.6800000E+10	0.8041030E-02	-0.8445249	-0.8445250	-0.8041037E-02
	-0.5098055E-02	0.5354310	0.5354310	0.5098045E-02
0.6900000E+10	0.1006664E-01	-0.7925753	-0.7925752	-0.1006668E-01
	-0.7743209E-02	0.6096411	0.6096413	0.7743180E-02
0.7000000E+10	0.1193473E-01	-0.7346696	-0.7346697	-0.1193473E-01
	-0.1101789E-01	0.6782297	0.6782298	0.1101789E-01
0.7100000E+10	0.1350637E-01	-0.6714052	-0.6714051	-0.1350638E-01
	-0.1490274E-01	0.7408172	0.7408171	0.1490273E-01

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.2636977E-01	0.9996517	0.9996517	0.2636975E-01
	55.30082	-124.6993	-124.6993	-124.6993
0.5400000E+10	0.2065966E-01	0.9997862	0.9997862	0.2065963E-01
	48.50161	-131.4985	-131.4985	-131.4986
0.5500000E+10	0.1567196E-01	0.9998767	0.9998767	0.1567199E-01
	41.91879	-138.0815	-138.0815	-138.0815
0.5600000E+10	0.1139933E-01	0.9999345	0.9999346	0.1139933E-01
	35.52285	-144.4774	-144.4774	-144.4775
0.5700000E+10	0.7831228E-02	0.9999688	0.9999689	0.7831255E-02
	29.29037	-150.7099	-150.7099	-150.7099
0.5800000E+10	0.4954520E-02	0.9999874	0.9999875	0.4954488E-02
	23.20193	-156.7984	-156.7984	-156.7986
0.5900000E+10	0.2752828E-02	0.9999957	0.9999959	0.2752873E-02
	17.24107	-162.7589	-162.7589	-162.7585
0.6000000E+10	0.1207644E-02	0.9999989	0.9999990	0.1207650E-02
	11.39535	-168.6052	-168.6052	-168.6054
0.6100000E+10	0.2977916E-03	0.9999994	0.9999995	0.2977930E-03
	5.652180	-174.3489	-174.3489	-174.3491
0.6200000E+10	0.5066445E-07	0.9999993	0.9999994	0.4996565E-07
	0.9179133E-04	-179.9999	-179.9999	-179.9999
0.6300000E+10	0.2890442E-03	0.9999996	0.9999997	0.2890438E-03
	-5.567191	174.4331	174.4331	174.4324
0.6400000E+10	0.1137460E-02	0.9999990	0.9999990	0.1137465E-02
	-11.05780	168.9425	168.9425	168.9424
0.6500000E+10	0.2516364E-02	0.9999965	0.9999965	0.2516371E-02
	-16.47836	163.5220	163.5219	163.5220
0.6600000E+10	0.4394851E-02	0.9999899	0.9999898	0.4394851E-02
	-21.83463	158.1655	158.1655	158.1654
0.6700000E+10	0.6741002E-02	0.9999769	0.9999770	0.6740999E-02

	-27.13207	152.8681	152.8681	152.8680
0.6800000E+10	0.9520941E-02	0.9999543	0.9999545	0.9520942E-02
	-32.37491	147.6252	147.6252	147.6252
0.6900000E+10	0.1270018E-01	0.9999189	0.9999190	0.1270019E-01
	-37.56730	142.4329	142.4329	142.4329
0.7000000E+10	0.1624290E-01	0.9998675	0.9998676	0.1624290E-01
	-42.71254	137.2875	137.2875	137.2875
0.7100000E+10	0.2011252E-01	0.9997975	0.9997974	0.2011252E-01
	-47.81396	132.1861	132.1861	132.1861

lista de "toes" esperadas com transformador

=====

toe (1-	0.5300000E+10 Hz.) =	1.054	return loss =	31.578 dB
toe (2-	0.5400000E+10 Hz.) =	1.042	return loss =	33.698 dB
toe (3-	0.5500000E+10 Hz.) =	1.032	return loss =	36.098 dB
toe (4-	0.5600000E+10 Hz.) =	1.023	return loss =	38.862 dB
toe (5-	0.5700000E+10 Hz.) =	1.016	return loss =	42.123 dB
toe (6-	0.5800000E+10 Hz.) =	1.010	return loss =	46.100 dB
toe (7-	0.5900000E+10 Hz.) =	1.006	return loss =	51.204 dB
toe (8-	0.6000000E+10 Hz.) =	1.002	return loss =	58.361 dB
toe (9-	0.6100000E+10 Hz.) =	1.001	return loss =	70.521 dB
toe (10-	0.6200000E+10 Hz.) =	1.000	return loss =	136.565 dB
toe (11-	0.6300000E+10 Hz.) =	1.001	return loss =	70.777 dB
toe (12-	0.6400000E+10 Hz.) =	1.002	return loss =	58.881 dB
toe (13-	0.6500000E+10 Hz.) =	1.005	return loss =	51.985 dB
toe (14-	0.6600000E+10 Hz.) =	1.009	return loss =	47.141 dB
toe (15-	0.6700000E+10 Hz.) =	1.014	return loss =	43.425 dB
toe (16-	0.6800000E+10 Hz.) =	1.019	return loss =	40.426 dB
toe (17-	0.6900000E+10 Hz.) =	1.026	return loss =	37.924 dB
toe (18-	0.7000000E+10 Hz.) =	1.033	return loss =	35.787 dB
toe (19-	0.7100000E+10 Hz.) =	1.041	return loss =	33.931 dB

"toe" medio = 1.018 +/- 0.070

Apêndice 6 – Listagem do caso do transformador binomial, Plano H – Impedância combinado com Reatância

A listagem abaixo se refere ao caso apresentado na Seção 7.2 deste trabalho:

Plano: H

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância; Binomial

Modelo utilizado para análise: modelo de impedância combinado com reatância concentrada

Sem otimização numérica

lista de "toes" esperado sem transformador

toe (1-	0.5300000E+10 Hz.) =	1.222	return loss =	20.024 dB
toe (2-	0.5400000E+10 Hz.) =	1.201	return loss =	20.784 dB
toe (3-	0.5500000E+10 Hz.) =	1.184	return loss =	21.494 dB
toe (4-	0.5600000E+10 Hz.) =	1.169	return loss =	22.161 dB
toe (5-	0.5700000E+10 Hz.) =	1.156	return loss =	22.791 dB
toe (6-	0.5800000E+10 Hz.) =	1.145	return loss =	23.388 dB
toe (7-	0.5900000E+10 Hz.) =	1.135	return loss =	23.956 dB
toe (8-	0.6000000E+10 Hz.) =	1.127	return loss =	24.498 dB
toe (9-	0.6100000E+10 Hz.) =	1.119	return loss =	25.016 dB
toe (10-	0.6200000E+10 Hz.) =	1.112	return loss =	25.513 dB
toe (11-	0.6300000E+10 Hz.) =	1.106	return loss =	25.991 dB
toe (12-	0.6400000E+10 Hz.) =	1.100	return loss =	26.451 dB
toe (13-	0.6500000E+10 Hz.) =	1.095	return loss =	26.894 dB
toe (14-	0.6600000E+10 Hz.) =	1.090	return loss =	27.322 dB
toe (15-	0.6700000E+10 Hz.) =	1.086	return loss =	27.736 dB
toe (16-	0.6800000E+10 Hz.) =	1.082	return loss =	28.138 dB
toe (17-	0.6900000E+10 Hz.) =	1.078	return loss =	28.527 dB
toe (18-	0.7000000E+10 Hz.) =	1.074	return loss =	28.905 dB
toe (19-	0.7100000E+10 Hz.) =	1.071	return loss =	29.273 dB

trafo binomial - plano H - Impedancia + Reatancia

lista de impedancias esperadas com transformador

```
=====
                nao normalz.      norm a z0(f1)      norm a z0(fn)      z0(fn)
impedancia de normalizacao z0(f1) =      206.5968

real zin( 1)=      201.2603          0.9741694          0.9741694          206.5968
imag.zin( 1)=     -4.041394          -0.1956175E-01     -0.1956175E-01

real zin( 2)=      199.1796          0.9640984          0.9809740          203.0427
imag.zin( 2)=     -2.572656          -0.1245254E-01     -0.1267051E-01

real zin( 3)=      197.2023          0.9545276          0.9867803          199.8442
imag.zin( 3)=     -1.630605          -0.7892692E-02     -0.8159379E-02

real zin( 4)=      195.2907          0.9452746          0.9915711          196.9508
imag.zin( 4)=     -1.071532          -0.5186585E-02     -0.5440607E-02

real zin( 5)=      193.4199          0.9362194          0.9953621          194.3212
imag.zin( 5)=     -0.7855164          -0.3802171E-02     -0.4042361E-02

real zin( 6)=      191.5751          0.9272897          0.9981956          191.9214
imag.zin( 6)=     -0.6878311          -0.3329341E-02     -0.3583921E-02
```

real zin(7)=	189.7489	0.9184502	1.000137	189.7229
imag.zin(7)=	-0.7125896	-0.3449180E-02	-0.3755949E-02	
real zin(8)=	187.9401	0.9096950	1.001268	187.7020
imag.zin(8)=	-0.8086084	-0.3913944E-02	-0.4307936E-02	
real zin(9)=	186.1513	0.9010369	1.001684	185.8384
imag.zin(9)=	-0.9366224	-0.4533576E-02	-0.5039983E-02	
real zin(10)=	184.3881	0.8925024	1.001484	184.1149
imag.zin(10)=	-1.066882	-0.5164080E-02	-0.5794657E-02	
real zin(11)=	182.6578	0.8841268	1.000774	182.5166
imag.zin(11)=	-1.177450	-0.5699263E-02	-0.6451193E-02	
real zin(12)=	180.9684	0.8759494	0.9996555	181.0307
imag.zin(12)=	-1.252803	-0.6064000E-02	-0.6920389E-02	
real zin(13)=	179.3285	0.8680119	0.9982312	179.6462
imag.zin(13)=	-1.282686	-0.6208646E-02	-0.7140068E-02	
real zin(14)=	177.7463	0.8603534	0.9965956	178.3534
imag.zin(14)=	-1.261123	-0.6104270E-02	-0.7070918E-02	
real zin(15)=	176.2292	0.8530105	0.9948370	177.1438
imag.zin(15)=	-1.185513	-0.5738294E-02	-0.6692377E-02	
real zin(16)=	174.7842	0.8460158	0.9930362	176.0099
imag.zin(16)=	-1.056132	-0.5112043E-02	-0.6000412E-02	
real zin(17)=	173.4167	0.8393970	0.9912642	174.9450
imag.zin(17)=	-0.8753147	-0.4236826E-02	-0.5003370E-02	
real zin(18)=	172.1316	0.8331764	0.9895841	173.9434
imag.zin(18)=	-0.6470460	-0.3131927E-02	-0.3719866E-02	
real zin(19)=	170.9322	0.8273709	0.9880490	172.9997
imag.zin(19)=	-0.3765945	-0.1822848E-02	-0.2176851E-02	

matriz "s" do transformador (real/imaginario)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	-0.1298489E-01	-0.6514854	-0.6514854	0.7963087E-02
	-0.1003757E-01	-0.7584830	-0.7584831	0.1435088E-01
0.5400000E+10	-0.9563114E-02	-0.7254817	-0.7254816	0.6953070E-02
	-0.6457276E-02	-0.6881443	-0.6881443	0.9208906E-02
0.5500000E+10	-0.6636883E-02	-0.7903602	-0.7903603	0.5658902E-02
	-0.4134185E-02	-0.6125916	-0.6125917	0.5396017E-02
0.5600000E+10	-0.4224790E-02	-0.8462171	-0.8462172	0.4299886E-02
	-0.2743391E-02	-0.5328135	-0.5328135	0.2624133E-02
0.5700000E+10	-0.2320152E-02	-0.8931675	-0.8931675	0.3012925E-02
	-0.2030577E-02	-0.4497125	-0.4497125	0.6546886E-03
0.5800000E+10	-0.8998208E-03	-0.9313469	-0.9313469	0.1878719E-02
	-0.1795218E-02	-0.3641269	-0.3641269	-0.7088839E-03
0.5900000E+10	0.7193168E-04	-0.9609154	-0.9609153	0.9380747E-03
	-0.1877693E-02	-0.2768354	-0.2768354	-0.1628160E-02
0.6000000E+10	0.6384220E-03	-0.9820567	-0.9820567	0.2036958E-03
	-0.2151227E-02	-0.1885700	-0.1885700	-0.2234690E-02
0.6100000E+10	0.8475680E-03	-0.9949819	-0.9949818	-0.3299022E-03
	-0.2515741E-02	-0.1000169	-0.1000169	-0.2634102E-02
0.6200000E+10	0.7498973E-03	-0.9999251	-0.9999253	-0.6813083E-03
	-0.2893003E-02	-0.1182248E-01	-0.1182248E-01	-0.2909922E-02
0.6300000E+10	0.3969853E-03	-0.9971472	-0.9971472	-0.8772033E-03
	-0.3223058E-02	0.7540552E-01	0.7540552E-01	-0.3126706E-02
0.6400000E+10	-0.1602806E-03	-0.9869323	-0.9869320	-0.9487337E-03
	-0.3461336E-02	0.1610972	0.1610971	-0.3332631E-02
0.6500000E+10	-0.8724228E-03	-0.9695873	-0.9695873	-0.9291862E-03
	-0.3576304E-02	0.2447169	0.2447169	-0.3561985E-02
0.6600000E+10	-0.1692525E-02	-0.9454420	-0.9454420	-0.8518454E-03
	-0.3547451E-02	0.3257656	0.3257656	-0.3837115E-02
0.6700000E+10	-0.2576953E-02	-0.9148464	-0.9148465	-0.7482400E-03
	-0.3363429E-02	0.4037785	0.4037785	-0.4170583E-02
0.6800000E+10	-0.3485048E-02	-0.8781701	-0.8781700	-0.6479037E-03
	-0.3021152E-02	0.4783258	0.4783258	-0.4566516E-02
0.6900000E+10	-0.4380718E-02	-0.8357990	-0.8357990	-0.5762921E-03

	-0.2523651E-02	0.5490116	0.5490116	-0.5022670E-02
0.7000000E+10	-0.5231716E-02	-0.7881359	-0.7881359	-0.5554402E-03
	-0.1879466E-02	0.6154757	0.6154758	-0.5531251E-02
0.7100000E+10	-0.6010212E-02	-0.7355971	-0.7355970	-0.6035061E-03
	-0.1101505E-02	0.6773911	0.6773911	-0.6080438E-02

matriz "s" do transformador. (mod./fase)

```

=====
freq. (Hz)          s11          s12          s21          s22
0.5300000E+10      0.1641219E-01  0.9998648  0.9998649  0.1641214E-01
                   -142.2953      -130.6603  -130.6603  60.97476
0.5400000E+10      0.1153905E-01  0.9999331  0.9999331  0.1153903E-01
                   -145.9717      -136.5130  -136.5130  52.94582
0.5500000E+10      0.7819188E-02  0.9999688  0.9999691  0.7819218E-02
                   -148.0808      -142.2215  -142.2215  43.63777
0.5600000E+10      0.5037365E-02  0.9999868  0.9999869  0.5037369E-02
                   -147.0021      -147.8038  -147.8038  31.39487
0.5700000E+10      0.3083237E-02  0.9999948  0.9999948  0.3083234E-02
                   -138.8079      -153.2746  -153.2746  12.25941
0.5800000E+10      0.2008105E-02  0.9999977  0.9999977  0.2008009E-02
                   -116.6215      -158.6461  -158.6461  -20.67265
0.5900000E+10      0.1879071E-02  0.9999981  0.9999980  0.1879066E-02
                   -87.80616      -163.9285  -163.9285  -60.05133
0.6000000E+10      0.2243961E-02  0.9999970  0.9999970  0.2243954E-02
                   -73.47063      -169.1306  -169.1306  -84.79179
0.6100000E+10      0.2654680E-02  0.9999962  0.9999961  0.2654681E-02
                   -71.38103      -174.2598  -174.2598  -97.13871
0.6200000E+10      0.2988614E-02  0.9999951  0.9999952  0.2988616E-02
                   -75.46815      -179.3226  -179.3226  -103.1775
0.6300000E+10      0.3247414E-02  0.9999943  0.9999943  0.3247426E-02
                   -82.97823      175.6755   175.6755   -105.6716
0.6400000E+10      0.3465045E-02  0.9999938  0.9999936  0.3465043E-02
                   -92.65125      170.7294   170.7294   -105.8906
0.6500000E+10      0.3681178E-02  0.9999930  0.9999930  0.3681185E-02
                   -103.7093      165.8348   165.8348   -104.6205
0.6600000E+10      0.3930528E-02  0.9999919  0.9999920  0.3930534E-02
                   -115.5063      160.9879   160.9879   -102.5168
0.6700000E+10      0.4237138E-02  0.9999905  0.9999906  0.4237172E-02
                   -127.4582      156.1852   156.1852   -100.1712
0.6800000E+10      0.4612257E-02  0.9999891  0.9999890  0.4612250E-02
                   -139.0783      151.4236   151.4236   -98.07531
0.6900000E+10      0.5055641E-02  0.9999868  0.9999869  0.5055624E-02
                   -150.0546      146.7003   146.7003   -96.54539
0.7000000E+10      0.5559069E-02  0.9999843  0.9999843  0.5559070E-02
                   -160.2394      142.0128   142.0128   -95.73434
0.7100000E+10      0.6110316E-02  0.9999809  0.9999809  0.6110315E-02
                   -169.6145      137.3589   137.3589   -95.66826

```

lista de "toes" esperadas com transformador

```

=====
toe ( 1- 0.5300000E+10 Hz.) = 1.033      return loss = 35.697 dB
toe ( 2- 0.5400000E+10 Hz.) = 1.023      return loss = 38.757 dB
toe ( 3- 0.5500000E+10 Hz.) = 1.016      return loss = 42.137 dB
toe ( 4- 0.5600000E+10 Hz.) = 1.010      return loss = 45.956 dB
toe ( 5- 0.5700000E+10 Hz.) = 1.006      return loss = 50.220 dB
toe ( 6- 0.5800000E+10 Hz.) = 1.004      return loss = 53.944 dB
toe ( 7- 0.5900000E+10 Hz.) = 1.004      return loss = 54.521 dB
toe ( 8- 0.6000000E+10 Hz.) = 1.004      return loss = 52.980 dB
toe ( 9- 0.6100000E+10 Hz.) = 1.005      return loss = 51.520 dB
toe (10- 0.6200000E+10 Hz.) = 1.006      return loss = 50.491 dB
toe (11- 0.6300000E+10 Hz.) = 1.007      return loss = 49.769 dB
toe (12- 0.6400000E+10 Hz.) = 1.007      return loss = 49.206 dB
toe (13- 0.6500000E+10 Hz.) = 1.007      return loss = 48.680 dB
toe (14- 0.6600000E+10 Hz.) = 1.008      return loss = 48.111 dB
toe (15- 0.6700000E+10 Hz.) = 1.009      return loss = 47.459 dB
toe (16- 0.6800000E+10 Hz.) = 1.009      return loss = 46.722 dB
toe (17- 0.6900000E+10 Hz.) = 1.010      return loss = 45.924 dB
toe (18- 0.7000000E+10 Hz.) = 1.011      return loss = 45.100 dB
toe (19- 0.7100000E+10 Hz.) = 1.012      return loss = 44.279 dB

```

"toe" medio = 1.010 +/- 0.031

Apêndice 7 – Listagem do caso do transformador binomial, Plano E – Impedância combinado com Reatância

A listagem abaixo se refere ao caso apresentado na Seção 7.3 deste trabalho:

Plano: E

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância; Binomial

Modelo utilizado para análise: modelo de impedância combinado com reatância concentrada

Sem otimização numérica

```
*****
trafo binomial - plano E - Impedancia + Reatancia
*****
lista de impedancias esperadas com transformador
=====
                nao normalz.      norm a z0(f1)      norm a z0(fn)      z0(fn)
impedancia de normalizacao z0(f1) = 373.8836

real zin( 1)= 382.8931          1.024097          1.024097          373.8836
imag.zin( 1)= 17.52313         0.4686787E-01    0.4686787E-01
real zin( 2)= 369.3864         0.9879718        1.022348          361.3119
imag.zin( 2)= 12.50781         0.3345376E-01    0.3461777E-01
real zin( 3)= 357.1805         0.9553256        1.019012          350.5165
imag.zin( 3)= 8.680063         0.2321595E-01    0.2476364E-01
real zin( 4)= 346.2108         0.9259855        1.014870          341.1381
imag.zin( 4)= 5.884647         0.1573925E-01    0.1725004E-01
real zin( 5)= 336.4271         0.8998177        1.010564          332.9101
imag.zin( 5)= 3.953188         0.1057331E-01    0.1187464E-01
real zin( 6)= 327.7797         0.8766892        1.006601          325.6302
imag.zin( 6)= 2.715480         0.7262903E-02    0.8339155E-02
real zin( 7)= 320.2130         0.8564510        1.003357          319.1415
imag.zin( 7)= 2.007174         0.5368446E-02    0.6289292E-02
real zin( 8)= 313.6637         0.8389341        1.001094          313.3209
imag.zin( 8)= 1.674659         0.4479092E-02    0.5344869E-02
real zin( 9)= 308.0605         0.8239478        0.9999701         308.0698
imag.zin( 9)= 1.577385         0.4218922E-02    0.5120222E-02
real zin(10)= 303.3254         0.8112830        1.000056          303.3083
imag.zin(10)= 1.588983         0.4249941E-02    0.5238837E-02
real zin(11)= 299.3737         0.8007137        1.001346          298.9713
imag.zin(11)= 1.597506         0.4272738E-02    0.5343344E-02
real zin(12)= 296.1158         0.7920001        1.003767          295.0046
imag.zin(12)= 1.505467         0.4026566E-02    0.5103198E-02
real zin(13)= 293.4570         0.7848888        1.007187          291.3631
imag.zin(13)= 1.229683         0.3288945E-02    0.4220447E-02
real zin(14)= 291.2984         0.7791152        1.011421          288.0089
imag.zin(14)= 0.7015041        0.1876263E-02    0.2435703E-02
```

```

real zin(15)= 289.5374      0.7744052      1.016243      284.9096
imag.zin(15)= -0.1329199  -0.3555114E-03 -0.4665336E-03
real zin(16)= 288.0688      0.7704774      1.021384      282.0377
imag.zin(16)= -1.311854    -0.3508725E-02 -0.4651345E-02
real zin(17)= 286.7863      0.7670470      1.026548      279.3695
imag.zin(17)= -2.857307    -0.7642237E-02 -0.1022770E-01
real zin(18)= 285.5837      0.7638307      1.031418      276.8845
imag.zin(18)= -4.774407    -0.1276977E-01 -0.1724332E-01
real zin(19)= 284.3578      0.7605519      1.035667      274.5649
imag.zin(19)= -7.050407    -0.1885723E-01 -0.2567847E-01
matriz "s" do transformador (real/imaginario)
=====

```

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.1243460E-01	-0.5751491	-0.5751492	-0.1731925E-01
	0.2286708E-01	-0.8176340	-0.8176340	-0.1943107E-01
0.5400000E+10	0.1134020E-01	-0.6682943	-0.6682941	-0.1562090E-01
	0.1692347E-01	-0.7436177	-0.7436176	-0.1307640E-01
0.5500000E+10	0.9565564E-02	-0.7494646	-0.7494647	-0.1323754E-01
	0.1214791E-01	-0.6618632	-0.6618633	-0.7989881E-02
0.5600000E+10	0.7452804E-02	-0.8187960	-0.8187960	-0.1052975E-01
	0.8497558E-02	-0.5739728	-0.5739728	-0.4108162E-02
0.5700000E+10	0.5289045E-02	-0.8764776	-0.8764777	-0.7795412E-02
	0.5874887E-02	-0.4813767	-0.4813767	-0.1311357E-02
0.5800000E+10	0.3306950E-02	-0.9227476	-0.9227476	-0.5270600E-02
	0.4142131E-02	-0.3853677	-0.3853676	0.5598635E-03
0.5900000E+10	0.1685725E-02	-0.9578877	-0.9578879	-0.3131696E-02
	0.3134101E-02	-0.2871197	-0.2871198	0.1690095E-02
0.6000000E+10	0.5537923E-03	-0.9822206	-0.9822206	-0.1499206E-02
	0.2669499E-02	-0.1877083	-0.1877083	0.2277143E-02
0.6100000E+10	-0.8473249E-05	-0.9961063	-0.9961064	-0.4411135E-03
	0.2560164E-02	-0.8811896E-01	-0.8811896E-01	0.2521890E-02
0.6200000E+10	0.3488132E-04	-0.9999387	-0.9999384	0.2143977E-04
	0.2619242E-02	0.1073969E-01	0.1073969E-01	0.2619385E-02
0.6300000E+10	0.6796914E-03	-0.9941432	-0.9941432	-0.9076217E-04
	0.2668056E-02	0.1080320	0.1080320	0.2751789E-02
0.6400000E+10	0.1886334E-02	-0.9791759	-0.9791756	-0.7203218E-03
	0.2542000E-02	0.2029880	0.2029880	0.3082380E-02
0.6500000E+10	0.3584758E-02	-0.9555192	-0.9555193	-0.1780521E-02
	0.2095161E-02	0.2948982	0.2948982	0.3751040E-02
0.6600000E+10	0.5679728E-02	-0.9236826	-0.9236826	-0.3160116E-02
	0.1204083E-02	0.3831137	0.3831137	0.4870593E-02
0.6700000E+10	0.8056127E-02	-0.8841981	-0.8841981	-0.4730865E-02
	-0.2295130E-03	0.4670416	0.4670416	0.6524765E-02
0.6800000E+10	0.1058423E-01	-0.8376206	-0.8376208	-0.6352703E-02
	-0.2276643E-02	0.5461441	0.5461442	0.8766574E-02
0.6900000E+10	0.1312544E-01	-0.7845246	-0.7845246	-0.7880304E-02
	-0.4980606E-02	0.6199380	0.6199380	0.1161830E-01
0.7000000E+10	0.1553702E-01	-0.7255017	-0.7255018	-0.9168577E-02
	-0.8356341E-02	0.6879935	0.6879936	0.1507204E-01
0.7100000E+10	0.1767736E-01	-0.6611602	-0.6611603	-0.1007805E-01
	-0.1239121E-01	0.7499337	0.7499337	0.1909093E-01

matriz "s" do transformador. (mod./fase)

```

=====
freq. (Hz)      s11      s12      s21      s22
0.5300000E+10  0.2602926E-01  0.9996608  0.9996609  0.2602927E-01
61.46366      -125.1237    -125.1237    -131.7112
0.5400000E+10  0.2037164E-01  0.9997922  0.9997920  0.2037167E-01
56.17446      -131.9463    -131.9462    -140.0670
0.5500000E+10  0.1546194E-01  0.9998801  0.9998801  0.1546191E-01
51.78222      -138.5518    -138.5518    -148.8858
0.5600000E+10  0.1130278E-01  0.9999359  0.9999359  0.1130277E-01
48.74754      -144.9697    -144.9697    -158.6869
0.5700000E+10  0.7904953E-02  0.9999682  0.9999683  0.7904941E-02
48.00392      -151.2236    -151.2236    -170.4510
0.5800000E+10  0.5300298E-02  0.9999856  0.9999856  0.5300252E-02
51.39721      -157.3331    -157.3331    173.9366
0.5900000E+10  0.3558688E-02  0.9999933  0.9999935  0.3558643E-02
61.72572      -163.3143    -163.3143    151.6454
0.6000000E+10  0.2726336E-02  0.9999958  0.9999959  0.2726352E-02

```


	78.28013	-169.1809	-169.1809	123.3598
0.6100000E+10	0.2560178E-02	0.9999963	0.9999964	0.2560178E-02
	90.18963	-174.9446	-174.9446	99.92146
0.6200000E+10	0.2619474E-02	0.9999964	0.9999961	0.2619473E-02
	89.23702	179.3846	179.3846	89.53104
0.6300000E+10	0.2753272E-02	0.9999958	0.9999958	0.2753285E-02
	75.70782	173.7981	173.7981	91.88910
0.6400000E+10	0.3165442E-02	0.9999948	0.9999945	0.3165428E-02
	53.42212	168.2882	168.2882	103.1534
0.6500000E+10	0.4152131E-02	0.9999909	0.9999910	0.4152175E-02
	30.30474	162.8484	162.8484	115.3925
0.6600000E+10	0.5805956E-02	0.9999828	0.9999828	0.5805946E-02
	11.96930	157.4729	157.4729	122.9761
0.6700000E+10	0.8059395E-02	0.9999671	0.9999671	0.8059382E-02
	-1.631872	152.1566	152.1566	125.9445
0.6800000E+10	0.1082631E-01	0.9999408	0.9999411	0.1082634E-01
	-12.13923	146.8949	146.8949	125.9290
0.6900000E+10	0.1403865E-01	0.9999009	0.9999009	0.1403867E-01
	-20.77984	141.6839	141.6839	124.1477
0.7000000E+10	0.1764164E-01	0.9998438	0.9998441	0.1764169E-01
	-28.27289	136.5200	136.5200	121.3129
0.7100000E+10	0.2158775E-01	0.9997666	0.9997667	0.2158774E-01
	-35.02911	131.4002	131.4002	117.8294

lista de "toes" esperadas com transformador

```

=====
toe ( 1- 0.5300000E+10 Hz.) = 1.053 return loss = 31.691 dB
toe ( 2- 0.5400000E+10 Hz.) = 1.042 return loss = 33.819 dB
toe ( 3- 0.5500000E+10 Hz.) = 1.031 return loss = 36.215 dB
toe ( 4- 0.5600000E+10 Hz.) = 1.023 return loss = 38.936 dB
toe ( 5- 0.5700000E+10 Hz.) = 1.016 return loss = 42.042 dB
toe ( 6- 0.5800000E+10 Hz.) = 1.011 return loss = 45.514 dB
toe ( 7- 0.5900000E+10 Hz.) = 1.007 return loss = 48.974 dB
toe ( 8- 0.6000000E+10 Hz.) = 1.005 return loss = 51.288 dB
toe ( 9- 0.6100000E+10 Hz.) = 1.005 return loss = 51.835 dB
toe (10- 0.6200000E+10 Hz.) = 1.005 return loss = 51.636 dB
toe (11- 0.6300000E+10 Hz.) = 1.006 return loss = 51.203 dB
toe (12- 0.6400000E+10 Hz.) = 1.006 return loss = 49.991 dB
toe (13- 0.6500000E+10 Hz.) = 1.008 return loss = 47.635 dB
toe (14- 0.6600000E+10 Hz.) = 1.012 return loss = 44.722 dB
toe (15- 0.6700000E+10 Hz.) = 1.016 return loss = 41.874 dB
toe (16- 0.6800000E+10 Hz.) = 1.022 return loss = 39.310 dB
toe (17- 0.6900000E+10 Hz.) = 1.028 return loss = 37.053 dB
toe (18- 0.7000000E+10 Hz.) = 1.036 return loss = 35.069 dB
toe (19- 0.7100000E+10 Hz.) = 1.044 return loss = 33.316 dB
=====

```

"toe" medio = 1.020 +/- 0.065

Apêndice 8 – Listagem do caso do transformador binomial, WR159-WR137 – somente Impedância

A listagem abaixo se refere ao caso apresentado na Seção 9.2 deste trabalho:

Portas e entrada e saída: WR159 e WR137

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância; Binomial

Modelo utilizado para análise: modelo de impedância

Sem otimização numérica

```

dados dos guias de entrada e saida
=====
dimensoes do primeiro guia:
dimensao ao = 0.4038600E-01 metros
dimensao bo = 0.2019300E-01 metros
dimensao co = 0.000000 metros

dimensoes do guia final:
dimensao af = 0.3484900E-01 metros
dimensao bf = 0.1579900E-01 metros
dimensao cf = 0.000000 metros

constante dieletrica no guia de entrada = 1.000000
constante dieletrica no guia de saida = 1.000000

frequencia de corte na linha de entrada = 0.3711589E+10 Hz
frequencia de corte na linha de saida = 0.4301307E+10 Hz

modos      frequencias de corte (em Hz.)
           primeiro guia      ultimo guia

te01      0.7423179E+10      0.9487706E+10
te11      0.8299366E+10      0.1041719E+11
te20      0.7423179E+10      0.8602615E+10
te02      0.1484636E+11      0.1897541E+11
*te12     0.1530328E+11      0.1945681E+11
te21      0.1049796E+11      0.1280709E+11

lista de frequencias
=====

numero de pontos a calcular = 19

frequencia n. 1 = 0.5300000E+10 Hz
frequencia n. 2 = 0.5400000E+10 Hz
frequencia n. 3 = 0.5500000E+10 Hz
frequencia n. 4 = 0.5600000E+10 Hz
frequencia n. 5 = 0.5700000E+10 Hz
frequencia n. 6 = 0.5800000E+10 Hz
frequencia n. 7 = 0.5900000E+10 Hz
frequencia n. 8 = 0.6000000E+10 Hz
frequencia n. 9 = 0.6100000E+10 Hz
frequencia n. 10 = 0.6200000E+10 Hz
frequencia n. 11 = 0.6300000E+10 Hz
frequencia n. 12 = 0.6400000E+10 Hz
frequencia n. 13 = 0.6500000E+10 Hz
frequencia n. 14 = 0.6600000E+10 Hz
frequencia n. 15 = 0.6700000E+10 Hz
frequencia n. 16 = 0.6800000E+10 Hz
frequencia n. 17 = 0.6900000E+10 Hz
frequencia n. 18 = 0.7000000E+10 Hz

```

frequencia n. 19 = 0.7100000E+10 Hz

lista de impedancias normalizadas de entrada(z0) e saida(zf)

=====

lista de impedancias de entrada(z0) e saida(zf)

	nao normaliz.	norm a z0(f1)	n.zguia(fn)	zguia(fn)
impedancia de normalizacao z0(f1) =	264.0553	264.0553		
real zo(1)=	264.0553	1.000000	1.000000	264.0553
imag.zo(1)=	0.000000	0.000000	0.000000	
real zf(1)=	292.5264	1.107823	1.000000	292.5264
imag.zf(1)=	0.000000	0.000000	0.000000	
real zo(2)=	259.5128	0.9827971	1.000000	259.5128
imag.zo(2)=	0.000000	0.000000	0.000000	
real zf(2)=	282.6903	1.070572	1.000000	282.6903
imag.zf(2)=	0.000000	0.000000	0.000000	
real zo(3)=	255.4247	0.9673152	1.000000	255.4247
imag.zo(3)=	0.000000	0.000000	0.000000	
real zf(3)=	274.2440	1.038586	1.000000	274.2440
imag.zf(3)=	0.000000	0.000000	0.000000	
real zo(4)=	251.7265	0.9533100	1.000000	251.7265
imag.zo(4)=	0.000000	0.000000	0.000000	
real zf(4)=	266.9064	1.010797	1.000000	266.9064
imag.zf(4)=	0.000000	0.000000	0.000000	
real zo(5)=	248.3656	0.9405818	1.000000	248.3656
imag.zo(5)=	0.000000	0.000000	0.000000	
real zf(5)=	260.4688	0.9864175	1.000000	260.4688
imag.zf(5)=	0.000000	0.000000	0.000000	
real zo(6)=	245.2984	0.9289659	1.000000	245.2984
imag.zo(6)=	0.000000	0.000000	0.000000	
real zf(6)=	254.7729	0.9648470	1.000000	254.7729
imag.zf(6)=	0.000000	0.000000	0.000000	
real zo(7)=	242.4885	0.9183246	1.000000	242.4885
imag.zo(7)=	0.000000	0.000000	0.000000	
real zf(7)=	249.6962	0.9456209	1.000000	249.6962
imag.zf(7)=	0.000000	0.000000	0.000000	
real zo(8)=	239.9055	0.9085427	1.000000	239.9055
imag.zo(8)=	0.000000	0.000000	0.000000	
real zf(8)=	245.1422	0.9283744	1.000000	245.1422
imag.zf(8)=	0.000000	0.000000	0.000000	
real zo(9)=	237.5236	0.8995222	1.000000	237.5236
imag.zo(9)=	0.000000	0.000000	0.000000	
real zf(9)=	241.0337	0.9128152	1.000000	241.0337
imag.zf(9)=	0.000000	0.000000	0.000000	
real zo(10)=	235.3207	0.8911797	1.000000	235.3207
imag.zo(10)=	0.000000	0.000000	0.000000	
real zf(10)=	237.3084	0.8987071	1.000000	237.3084
imag.zf(10)=	0.000000	0.000000	0.000000	
real zo(11)=	233.2779	0.8834434	1.000000	233.2779
imag.zo(11)=	0.000000	0.000000	0.000000	
real zf(11)=	233.9151	0.8858564	1.000000	233.9151
imag.zf(11)=	0.000000	0.000000	0.000000	
real zo(12)=	231.3788	0.8762513	1.000000	231.3788
imag.zo(12)=	0.000000	0.000000	0.000000	
real zf(12)=	230.8115	0.8741031	1.000000	230.8115
imag.zf(12)=	0.000000	0.000000	0.000000	
real zo(13)=	229.6093	0.8695500	1.000000	229.6093
imag.zo(13)=	0.000000	0.000000	0.000000	
real zf(13)=	227.9624	0.8633133	1.000000	227.9624
imag.zf(13)=	0.000000	0.000000	0.000000	
real zo(14)=	227.9569	0.8632924	1.000000	227.9569
imag.zo(14)=	0.000000	0.000000	0.000000	

```

real zf(14)= 225.3381      0.8533745      1.000000      225.3381
imag.zf(14)= 0.000000      0.000000      0.000000

real zo(15)= 226.4109      0.8574374      1.000000      226.4109
imag.zo(15)= 0.000000      0.000000      0.000000
real zf(15)= 222.9132      0.8441913      1.000000      222.9132
imag.zf(15)= 0.000000      0.000000      0.000000

real zo(16)= 224.9616      0.8519487      1.000000      224.9616
imag.zo(16)= 0.000000      0.000000      0.000000
real zf(16)= 220.6662      0.8356818      1.000000      220.6662
imag.zf(16)= 0.000000      0.000000      0.000000

real zo(17)= 223.6006      0.8467944      1.000000      223.6006
imag.zo(17)= 0.000000      0.000000      0.000000
real zf(17)= 218.5786      0.8277759      1.000000      218.5786
imag.zf(17)= 0.000000      0.000000      0.000000

real zo(18)= 222.3203      0.8419461      1.000000      222.3203
imag.zo(18)= 0.000000      0.000000      0.000000
real zf(18)= 216.6344      0.8204129      1.000000      216.6344
imag.zf(18)= 0.000000      0.000000      0.000000

real zo(19)= 221.1142      0.8373785      1.000000      221.1142
imag.zo(19)= 0.000000      0.000000      0.000000
real zf(19)= 214.8195      0.8135400      1.000000      214.8195
imag.zf(19)= 0.000000      0.000000      0.000000

```

lista de "toes" esperado sem transformador

```

toe (1- 0.5300000E+10 Hz.) = 1.108      return loss = 25.822 dB
toe (2- 0.5400000E+10 Hz.) = 1.089      return loss = 27.382 dB
toe (3- 0.5500000E+10 Hz.) = 1.074      return loss = 28.988 dB
toe (4- 0.5600000E+10 Hz.) = 1.060      return loss = 30.672 dB
toe (5- 0.5700000E+10 Hz.) = 1.049      return loss = 32.474 dB
toe (6- 0.5800000E+10 Hz.) = 1.039      return loss = 34.449 dB
toe (7- 0.5900000E+10 Hz.) = 1.030      return loss = 36.687 dB
toe (8- 0.6000000E+10 Hz.) = 1.022      return loss = 39.335 dB
toe (9- 0.6100000E+10 Hz.) = 1.015      return loss = 42.692 dB
toe (10- 0.6200000E+10 Hz.) = 1.008      return loss = 47.524 dB
toe (11- 0.6300000E+10 Hz.) = 1.003      return loss = 57.305 dB
toe (12- 0.6400000E+10 Hz.) = 1.002      return loss = 58.221 dB
toe (13- 0.6500000E+10 Hz.) = 1.007      return loss = 48.876 dB
toe (14- 0.6600000E+10 Hz.) = 1.012      return loss = 44.765 dB
toe (15- 0.6700000E+10 Hz.) = 1.016      return loss = 42.176 dB
toe (16- 0.6800000E+10 Hz.) = 1.019      return loss = 40.319 dB
toe (17- 0.6900000E+10 Hz.) = 1.023      return loss = 38.895 dB
toe (18- 0.7000000E+10 Hz.) = 1.026      return loss = 37.752 dB
toe (19- 0.7100000E+10 Hz.) = 1.029      return loss = 36.809 dB

```

**** numero de seccoes do transformador ns = 2 ****

constantes dieletricas relativas das seccoes do transformador

=====

constante dieletrica da seccao (1) = 1.000

constante dieletrica da seccao (2) = 1.000

dimensoes iniciais do transformador

=====

as impedancias sao fornecidas p/ a frequencia = 0.6200000E+10 Hz

dimensao a(1) = 0.3894019E-01 metros

dimensao b(1) = 0.1909450E-01 metros

dimensao c(1) = 0.000000 metros

impedancia da seccao(1) = 235.8161

dimensao a(2) = 0.3616812E-01 metros

dimensao b(2) = 0.1689750E-01 metros

dimensao c(2) = 0.000000 metros

impedancia da seccao(2) = 236.8099

lista de comprimentos iniciais das seccoes do transformador

=====

comprimento da seccao(1) = 0.1542060E-01 metros

comprimento da seccao(2) = 0.1625329E-01 metros

trafo ab bin sem X

lista de impedancias esperadas com transformador

=====

	nao normalz.	norm a z0(f1)	norm a z0(fn)	z0(fn)
impedancia de normalizacao	z0(f1) =	264.0553		
real zin(1)=	258.7479	0.9799005	0.9799005	264.0553
imag.zin(1)=	-0.1459188	-0.5526068E-03	-0.5526068E-03	
real zin(2)=	256.0054	0.9695145	0.9864848	259.5128
imag.zin(2)=	0.4843777	0.1834380E-02	0.1866489E-02	
real zin(3)=	253.2396	0.9590399	0.9914451	255.4247
imag.zin(3)=	0.7129025	0.2699823E-02	0.2791048E-02	
real zin(4)=	250.4713	0.9485563	0.9950135	251.7265
imag.zin(4)=	0.7050076	0.2669924E-02	0.2800688E-02	
real zin(5)=	247.7272	0.9381641	0.9974296	248.3656
imag.zin(5)=	0.5760172	0.2181426E-02	0.2319231E-02	
real zin(6)=	245.0361	0.9279727	0.9989309	245.2984
imag.zin(6)=	0.4038438	0.1529391E-02	0.1646337E-02	
real zin(7)=	242.4264	0.9180896	0.9997441	242.4885
imag.zin(7)=	0.2385321	0.9033413E-03	0.9836841E-03	
real zin(8)=	239.9236	0.9086112	1.000075	239.9055
imag.zin(8)=	0.1090197	0.4128670E-03	0.4544278E-03	
real zin(9)=	237.5495		0.8996201	1.000109
237.5236				
imag.zin(9)=	0.2880418E-01	0.1090839E-03	0.1212687E-03	
real zin(10)=	235.3207		0.8911796	0.9999999
235.3207				
imag.zin(10)=	0.1179602E-06	0.4467255E-09	0.5012744E-09	
real zin(11)=	233.2490		0.8833339	0.9998762
233.2779				
imag.zin(11)=	0.1676286E-01	0.6348237E-04	0.7185789E-04	
real zin(12)=	231.3411		0.8761084	0.9998369
231.3788				
imag.zin(12)=	0.6789635E-01	0.2571293E-03	0.2934424E-03	
real zin(13)=	229.5984		0.8695089	0.9999527
229.6093				
imag.zin(13)=	0.1389471	0.5262044E-03	0.6051457E-03	
real zin(14)=	228.0186		0.8635259	1.000271
227.9569				
imag.zin(14)=	0.2137104	0.8093396E-03	0.9375034E-03	
real zin(15)=	226.5945		0.8581327	1.000811
226.4109				
imag.zin(15)=	0.2757050	0.1044119E-02	0.1217720E-02	
real zin(16)=	225.3158		0.8532901	1.001575
224.9616				
imag.zin(16)=	0.3089560	0.1170043E-02	0.1373372E-02	
real zin(17)=	224.1689	0.8489470	1.002542	223.6006
imag.zin(17)=	0.2989225	0.1132045E-02	0.1336859E-02	
real zin(18)=	223.1380	0.8450425	1.003678	222.3203
imag.zin(18)=	0.2329900	0.8823529E-03	0.1047992E-02	
real zin(19)=	222.2049	0.8415090	1.004933	221.1142
imag.zin(19)=	0.1010038	0.3825102E-03	0.4567948E-03	
matriz "s" do transformador (real/imaginario)				
=====				
freq. (Hz)	s11	s12	s21	s22
	0.5300000E+10	-0.1015163E-01	-0.6680511	-0.6680510
				-0.8091590E-03

	-0.2819776E-03	-0.7440462	-0.7440461	0.1012326E-01
0.5400000E+10	-0.6802666E-02	-0.7393866	-0.7393866	-0.3062650E-03
	0.9460045E-03	-0.6732460	-0.6732459	0.6861335E-02
0.5500000E+10	-0.4293876E-02	-0.8018448	-0.8018447	-0.1209698E-03
	0.1407528E-02	-0.5975153	-0.5975153	0.4517057E-02
0.5600000E+10	-0.2497471E-02	-0.8555041	-0.8555039	-0.8854578E-04
	0.1407351E-02	-0.5177879	-0.5177878	0.2865338E-02
0.5700000E+10	-0.1285564E-02	-0.9004653	-0.9004653	-0.1113865E-03
	0.1162593E-02	-0.4349245	-0.4349245	0.1729707E-02
0.5800000E+10	-0.5342021E-03	-0.9368506	-0.9368504	-0.1364894E-03
	0.8240523E-03	-0.3497283	-0.3497282	0.9725076E-03
0.5900000E+10	-0.1277733E-03	-0.9648092	-0.9648090	-0.1395080E-03
	0.4919482E-03	-0.2629507	-0.2629507	0.4887502E-03
0.6000000E+10	0.3792241E-04	-0.9845151	-0.9845150	-0.1139913E-03
	0.2272216E-03	-0.1752994	-0.1752994	0.2001783E-03
0.6100000E+10	0.5445784E-04	-0.9961697	-0.9961697	-0.6421893E-04
	0.6062334E-04	-0.8744004E-01	-0.8744005E-01	0.5020621E-04
0.6200000E+10	-0.9089322E-08	-1.000000	-1.000000	-0.2444723E-07
	0.2506551E-09	-0.1223882E-05	-0.1223882E-05	0.2505503E-09
0.6300000E+10	-0.6189507E-04	-0.9962581	-0.9962581	0.6719096E-04
	0.3593048E-04	0.8642653E-01	0.8642653E-01	0.2472611E-04
0.6400000E+10	-0.8160497E-04	-0.9852212	-0.9852210	0.1262848E-03
	0.1467635E-03	0.1712869	0.1712869	0.1106206E-03
0.6500000E+10	-0.2346796E-04	-0.9671888	-0.9671887	0.1691642E-03
	0.3025687E-03	0.2540581	0.2540581	0.2519598E-03
0.6600000E+10	0.1354775E-03	-0.9424832	-0.9424831	0.1900563E-03
	0.4686395E-03	0.3342530	0.3342530	0.4492586E-03
0.6700000E+10	0.4056655E-03	-0.9114463	-0.9114463	0.1879053E-03
	0.6083840E-03	0.4114181	0.4114181	0.7066614E-03
0.6800000E+10	0.7872434E-03	-0.8744400	-0.8744398	0.1649511E-03
	0.6855669E-03	0.4851328	0.4851326	0.1030811E-02
0.6900000E+10	0.1269847E-02	-0.8318417	-0.8318417	0.1281101E-03
	0.6666946E-03	0.5550110	0.5550109	0.1428448E-02
0.7000000E+10	0.1835740E-02	-0.7840463	-0.7840463	0.8692555E-04
	0.5221164E-03	0.6206993	0.6206993	0.1906587E-02
0.7100000E+10	0.2460251E-02	-0.7314616	-0.7314613	0.5436674E-04
	0.2273356E-03	0.6818784	0.6818783	0.2470134E-02

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.1015554E-01	0.9999485	0.9999484	0.1015554E-01
	-178.4089	-131.9195	-131.9195	94.56998
0.5400000E+10	0.6868129E-02	0.9999764	0.9999763	0.6868167E-02
	172.0830	-137.6807	-137.6807	92.55578
0.5500000E+10	0.4518684E-02	0.9999898	0.9999897	0.4518677E-02
	161.8509	-143.3074	-143.3074	91.53405
0.5600000E+10	0.2866705E-02	0.9999958	0.9999955	0.2866706E-02
	150.5983	-148.8159	-148.8159	91.77001
0.5700000E+10	0.1733290E-02	0.9999985	0.9999985	0.1733289E-02
	137.8756	-154.2195	-154.2195	93.68455
0.5800000E+10	0.9820560E-03	0.9999995	0.9999992	0.9820389E-03
	122.9538	-159.5293	-159.5293	97.98917
0.5900000E+10	0.5082706E-03	0.9999999	0.9999998	0.5082708E-03
	104.5597	-164.7548	-164.7548	105.9308
0.6000000E+10	0.2303644E-03	0.9999999	0.9999998	0.2303592E-03
	80.52489	-169.9039	-169.9039	119.6593
0.6100000E+10	0.8149138E-04	0.9999999	0.9999999	0.8151525E-04
	48.06670	-174.9836	-174.9836	141.9818
0.6200000E+10	0.9092778E-08	1.000000	1.000000	0.2444852E-07
	178.4204	-179.9999	-179.9999	179.4128
0.6300000E+10	0.7156815E-04	0.9999999	0.9999999	0.7159613E-04
	149.8646	175.0419	175.0419	20.20349
0.6400000E+10	0.1679253E-03	1.000000	0.9999998	0.1678831E-03
	119.0754	170.1373	170.1373	41.21711
0.6500000E+10	0.3034775E-03	0.9999999	0.9999998	0.3034803E-03
	94.43512	165.2822	165.2822	56.12284
0.6600000E+10	0.4878290E-03	0.9999999	0.9999998	0.4878060E-03
	73.87611	160.4729	160.4729	67.06948
0.6700000E+10	0.7312289E-03	0.9999996	0.9999996	0.7312173E-03
	56.30497	155.7060	155.7060	75.10930
0.6800000E+10	0.1043913E-02	0.9999995	0.9999993	0.1043926E-02
	41.05081	150.9788	150.9788	80.90857
0.6900000E+10	0.1434222E-02	0.9999989	0.9999989	0.1434181E-02
	27.70035	146.2885	146.2885	84.87515
0.7000000E+10	0.1908546E-02	0.9999982	0.9999982	0.1908568E-02

	15.87668	141.6327	141.6327	87.38956
0.7100000E+10	0.2470732E-02	0.9999971	0.9999968	0.2470732E-02
	5.279335	137.0092	137.0092	88.73914

lista de "toes" esperadas com transformador

```

=====
toe ( 1- 0.5300000E+10 Hz.) = 1.021      return loss = 39.866 dB
toe ( 2- 0.5400000E+10 Hz.) = 1.014      return loss = 43.263 dB
toe ( 3- 0.5500000E+10 Hz.) = 1.009      return loss = 46.900 dB
toe ( 4- 0.5600000E+10 Hz.) = 1.006      return loss = 50.852 dB
toe ( 5- 0.5700000E+10 Hz.) = 1.003      return loss = 55.223 dB
toe ( 6- 0.5800000E+10 Hz.) = 1.002      return loss = 60.157 dB
toe ( 7- 0.5900000E+10 Hz.) = 1.001      return loss = 65.878 dB
toe ( 8- 0.6000000E+10 Hz.) = 1.000      return loss = 72.754 dB
toe ( 9- 0.6100000E+10 Hz.) = 1.000      return loss = 81.779 dB
toe (10- 0.6200000E+10 Hz.) = 1.000      return loss = 143.494 dB
toe (11- 0.6300000E+10 Hz.) = 1.000      return loss = 82.901 dB
toe (12- 0.6400000E+10 Hz.) = 1.000      return loss = 75.501 dB
toe (13- 0.6500000E+10 Hz.) = 1.001      return loss = 70.357 dB
toe (14- 0.6600000E+10 Hz.) = 1.001      return loss = 66.235 dB
toe (15- 0.6700000E+10 Hz.) = 1.001      return loss = 62.719 dB
toe (16- 0.6800000E+10 Hz.) = 1.002      return loss = 59.627 dB
toe (17- 0.6900000E+10 Hz.) = 1.003      return loss = 56.868 dB
toe (18- 0.7000000E+10 Hz.) = 1.004      return loss = 54.386 dB
toe (19- 0.7100000E+10 Hz.) = 1.005      return loss = 52.143 dB

```

"toe" medio = 1.004 +/- 0.023

Apêndice 9 – Listagem do caso do transformador binomial, WR159-WR137 – Impedância combinado com Reatância

A listagem abaixo se refere ao caso apresentado na Seção 11.2 deste trabalho:

Portas e entrada e saída: WR159 e WR137

Número de seções: 2

Modelo utilizado para a síntese: modelo de impedância; Binomial

Modelo utilizado para análise: modelo modelo de impedância combinado com reatância concentrada

Sem otimização numérica

lista de "toes" esperado sem transformador

toe (1-	0.5300000E+10 Hz.) =	1.060	return loss =	30.691 dB
toe (2-	0.5400000E+10 Hz.) =	1.077	return loss =	28.649 dB
toe (3-	0.5500000E+10 Hz.) =	1.092	return loss =	27.166 dB
toe (4-	0.5600000E+10 Hz.) =	1.105	return loss =	26.037 dB
toe (5-	0.5700000E+10 Hz.) =	1.117	return loss =	25.147 dB
toe (6-	0.5800000E+10 Hz.) =	1.128	return loss =	24.425 dB
toe (7-	0.5900000E+10 Hz.) =	1.138	return loss =	23.826 dB
toe (8-	0.6000000E+10 Hz.) =	1.146	return loss =	23.320 dB
toe (9-	0.6100000E+10 Hz.) =	1.155	return loss =	22.887 dB
toe (10-	0.6200000E+10 Hz.) =	1.162	return loss =	22.511 dB
toe (11-	0.6300000E+10 Hz.) =	1.169	return loss =	22.182 dB
toe (12-	0.6400000E+10 Hz.) =	1.175	return loss =	21.890 dB
toe (13-	0.6500000E+10 Hz.) =	1.181	return loss =	21.630 dB
toe (14-	0.6600000E+10 Hz.) =	1.186	return loss =	21.397 dB
toe (15-	0.6700000E+10 Hz.) =	1.191	return loss =	21.186 dB
toe (16-	0.6800000E+10 Hz.) =	1.196	return loss =	20.994 dB
toe (17-	0.6900000E+10 Hz.) =	1.200	return loss =	20.819 dB
toe (18-	0.7000000E+10 Hz.) =	1.204	return loss =	20.659 dB
toe (19-	0.7100000E+10 Hz.) =	1.208	return loss =	20.511 dB

 trafo binomial - planos E & H - Impedancia + Reatancia

lista de impedancias esperadas com transformador

```
=====
                nao normalz.      norm a z0(f1)      norm a z0(fn)      z0(fn)
impedancia de normalizacao z0(f1) =      264.0553

real zin( 1)=      264.6941          1.002419          1.002419          264.0553
imag.zin( 1)=      3.232244          0.1224079E-01     0.1224079E-01

real zin( 2)=      260.9602          0.9882786          1.005577          259.5128
imag.zin( 2)=      2.659876          0.1007318E-01     0.1024950E-01

real zin( 3)=      257.2175          0.9741046          1.007019          255.4247
imag.zin( 3)=      1.982883          0.7509348E-02     0.7763083E-02

real zin( 4)=      253.5327          0.9601498          1.007175          251.7265
imag.zin( 4)=      1.338674          0.5069672E-02     0.5317968E-02

real zin( 5)=      249.9710          0.9466617          1.006464          248.3656
imag.zin( 5)=      0.8062692          0.3053410E-02     0.3246300E-02
```


real zin(6)=	246.5912	0.9338619	1.005270	245.2984
imag.zin(6)=	0.4224706	0.1599932E-02	0.1722272E-02	
real zin(7)=	243.4422	0.9219364	1.003933	242.4885
imag.zin(7)=	0.1940007	0.7346972E-03	0.8000408E-03	
real zin(8)=	240.5618	0.9110281	1.002736	239.9055
imag.zin(8)=	0.1066473	0.4038825E-03	0.4445388E-03	
real zin(9)=	237.9757	0.9012343	1.001903	237.5236
imag.zin(9)=	0.1323085	0.5010636E-03	0.5570331E-03	
real zin(10)=	235.6984	0.8926101	1.001605	235.3207
imag.zin(10)=	0.2341637	0.8867979E-03	0.9950832E-03	
real zin(11)=	233.7339	0.8851703	1.001955	233.2779
imag.zin(11)=	0.3706836	0.1403811E-02	0.1589022E-02	
real zin(12)=	232.0762	0.8788923	1.003014	231.3788
imag.zin(12)=	0.4984871	0.1887813E-02	0.2154420E-02	
real zin(13)=	230.7106	0.8737207	1.004796	229.6093
imag.zin(13)=	0.5744973	0.2175670E-02	0.2502065E-02	
real zin(14)=	229.6145	0.8695700	1.007272	227.9569
imag.zin(14)=	0.5577344	0.2112188E-02	0.2446666E-02	
real zin(15)=	228.7587	0.8663287	1.010370	226.4109
imag.zin(15)=	0.4104784	0.1554517E-02	0.1812980E-02	
real zin(16)=	228.1072	0.8638613	1.013983	224.9616
imag.zin(16)=	0.9963295E-01	0.3773185E-03	0.4428888E-03	
real zin(17)=	227.6190	0.8620124	1.017971	223.6006
imag.zin(17)=	-0.4024626	-0.1524160E-02	-0.1799918E-02	
real zin(18)=	227.2487	0.8606104	1.022168	222.3203
imag.zin(18)=	-1.116988	-0.4230130E-02	-0.5024228E-02	
real zin(19)=	226.9476	0.8594700	1.026382	221.1142
imag.zin(19)=	-2.057832	-0.7793184E-02	-0.9306645E-02	

matriz "s" do transformador (real/imaginario)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.1245479E-02	-0.6633337	-0.6633337	-0.5911941E-02
	0.6105432E-02	-0.7482978	-0.7482978	-0.1968798E-02
0.5400000E+10	0.2806883E-02	-0.7356696	-0.7356696	-0.5310295E-02
	0.5096187E-02	-0.6773155	-0.6773155	-0.2377129E-02
0.5500000E+10	0.3511987E-02	-0.7990338	-0.7990339	-0.4676273E-02
	0.3854360E-02	-0.6012633	-0.6012633	-0.2307176E-02
0.5600000E+10	0.3581589E-02	-0.8534868	-0.8534868	-0.3984741E-02
	0.2639959E-02	-0.5210953	-0.5210953	-0.1979664E-02
0.5700000E+10	0.3224127E-02	-0.8991164	-0.8991163	-0.3258072E-02
	0.1612660E-02	-0.4376950	-0.4376949	-0.1542908E-02
0.5800000E+10	0.2629006E-02	-0.9360377	-0.9360376	-0.2542246E-02
	0.8566330E-03	-0.3518885	-0.3518885	-0.1087405E-02
0.5900000E+10	0.1962910E-02	-0.9643974	-0.9643974	-0.1891515E-02
	0.3984584E-03	-0.2644494	-0.2644495	-0.6584791E-03
0.6000000E+10	0.1365896E-02	-0.9843702	-0.9843703	-0.1358001E-02
	0.2216591E-03	-0.1761058	-0.1761058	-0.2656584E-03
0.6100000E+10	0.9507605E-03	-0.9961602	-0.9961603	-0.9847160E-03
	0.2779776E-03	-0.8754177E-01	-0.8754178E-01	0.1078878E-03
0.6200000E+10	0.8021266E-03	-0.9999995	-0.9999993	-0.8015864E-03
	0.4967442E-03	0.5975203E-03	0.5975202E-03	0.4977023E-03
0.6300000E+10	0.9770427E-03	-0.9961455	-0.9961455	-0.8234916E-03
	0.7929652E-03	0.8770683E-01	0.8770683E-01	0.9514974E-03
0.6400000E+10	0.1505789E-02	-0.9848821	-0.9848820	-0.1048963E-02
	0.1073980E-02	0.1732166	0.1732166	0.1523298E-02
0.6500000E+10	0.2394041E-02	-0.9665159	-0.9665158	-0.1461230E-02
	0.1245036E-02	0.2565931	0.2565931	0.2268546E-02
0.6600000E+10	0.3624144E-02	-0.9413759	-0.9413759	-0.2027911E-02
	0.1214476E-02	0.3373381	0.3373381	0.3239863E-02
0.6700000E+10	0.5158893E-02	-0.9098119	-0.9098120	-0.2704452E-02
	0.8971876E-03	0.4149875	0.4149876	0.4483837E-02
0.6800000E+10	0.6942848E-02	-0.8721937	-0.8721938	-0.3434511E-02
	0.2183859E-03	0.4891110	0.4891110	0.6037808E-02
0.6900000E+10	0.8906444E-02	-0.8289081	-0.8289081	-0.4153271E-02

```

-0.8839556E-03  0.5593132      0.5593132      0.7928171E-02
0.7000000E+10  0.1096853E-01 -0.7803584     -0.7803584     -0.4790111E-02
-0.2457282E-02  0.6252310      0.6252310      0.1016871E-01
0.7100000E+10  0.1303997E-01 -0.7269639     -0.7269638     -0.5270734E-02
-0.4532851E-02  0.6865367      0.6865367      0.1275956E-01
    
```

matriz "s" do transformador. (mod./fase)

```

=====
freq. (Hz)      s11      s12      s21      s22
    
```

0.5300000E+10	0.6231173E-02	0.9999806	0.9999806	0.6231148E-02
	78.47013	-131.5556	-131.5556	-161.5812
0.5400000E+10	0.5818051E-02	0.9999830	0.9999830	0.5818073E-02
	61.15486	-137.3649	-137.3649	-155.8846
0.5500000E+10	0.5214417E-02	0.9999863	0.9999864	0.5214460E-02
	47.66107	-143.0390	-143.0390	-153.7392
0.5600000E+10	0.4449400E-02	0.9999900	0.9999900	0.4449409E-02
	36.39362	-148.5939	-148.5939	-153.5813
0.5700000E+10	0.3604950E-02	0.9999936	0.9999934	0.3604941E-02
	26.57353	-154.0429	-154.0429	-154.6594
0.5800000E+10	0.2765049E-02	0.9999961	0.9999959	0.2765043E-02
	18.04763	-159.3970	-159.3970	-156.8419
0.5900000E+10	0.2002944E-02	0.9999979	0.9999980	0.2002853E-02
	11.47477	-164.6657	-164.6657	-160.8058
0.6000000E+10	0.1383765E-02	0.9999989	0.9999990	0.1383741E-02
	9.217666	-169.8570	-169.8570	-168.9313
0.6100000E+10	0.9905640E-03	0.9999993	0.9999994	0.9906086E-03
	16.29754	-174.9778	-174.9778	173.7475
0.6200000E+10	0.9434839E-03	0.9999997	0.9999995	0.9435298E-03
	31.76927	179.9658	179.9658	148.1640
0.6300000E+10	0.1258335E-02	0.9999992	0.9999992	0.1258366E-02
	39.06269	174.9683	174.9683	130.8752
0.6400000E+10	0.1849550E-02	0.9999984	0.9999983	0.1849530E-02
	35.49775	170.0251	170.0251	124.5518
0.6500000E+10	0.2698434E-02	0.9999965	0.9999964	0.2698424E-02
	27.47698	165.1319	165.1319	122.7866
0.6600000E+10	0.3822221E-02	0.9999928	0.9999927	0.3822190E-02
	18.52636	160.2851	160.2851	122.0435
0.6700000E+10	0.5236328E-02	0.9999862	0.9999864	0.5236301E-02
	9.865686	155.4811	155.4811	121.0965
0.6800000E+10	0.6946282E-02	0.9999757	0.9999758	0.6946294E-02
	1.801633	150.7171	150.7171	119.6327
0.6900000E+10	0.8950202E-02	0.9999599	0.9999599	0.8950171E-02
	-5.667987	145.9901	145.9901	117.6484
0.7000000E+10	0.1124041E-01	0.9999366	0.9999366	0.1124046E-01
	-12.62749	141.2979	141.2979	115.2234
0.7100000E+10	0.1380534E-01	0.9999046	0.9999046	0.1380533E-01
	-19.16807	136.6382	136.6382	112.4446

lista de "toes" esperadas com transformador

```

=====
toe ( 1- 0.5300000E+10 Hz.) = 1.013      return loss = 44.109 dB
toe ( 2- 0.5400000E+10 Hz.) = 1.012      return loss = 44.704 dB
toe ( 3- 0.5500000E+10 Hz.) = 1.010      return loss = 45.656 dB
toe ( 4- 0.5600000E+10 Hz.) = 1.009      return loss = 47.034 dB
toe ( 5- 0.5700000E+10 Hz.) = 1.007      return loss = 48.862 dB
toe ( 6- 0.5800000E+10 Hz.) = 1.006      return loss = 51.166 dB
toe ( 7- 0.5900000E+10 Hz.) = 1.004      return loss = 53.967 dB
toe ( 8- 0.6000000E+10 Hz.) = 1.003      return loss = 57.178 dB
toe ( 9- 0.6100000E+10 Hz.) = 1.002      return loss = 60.081 dB
toe (10- 0.6200000E+10 Hz.) = 1.002      return loss = 60.505 dB
toe (11- 0.6300000E+10 Hz.) = 1.003      return loss = 58.004 dB
toe (12- 0.6400000E+10 Hz.) = 1.004      return loss = 54.658 dB
toe (13- 0.6500000E+10 Hz.) = 1.005      return loss = 51.378 dB
toe (14- 0.6600000E+10 Hz.) = 1.008      return loss = 48.354 dB
toe (15- 0.6700000E+10 Hz.) = 1.011      return loss = 45.619 dB
toe (16- 0.6800000E+10 Hz.) = 1.014      return loss = 43.165 dB
toe (17- 0.6900000E+10 Hz.) = 1.018      return loss = 40.963 dB
toe (18- 0.7000000E+10 Hz.) = 1.023      return loss = 38.984 dB
toe (19- 0.7100000E+10 Hz.) = 1.028      return loss = 37.199 dB
*****
    
```

Apêndice 10 – Listagem do caso do transformador binomial, WR159-WR137 – com otimização

A listagem abaixo se refere ao caso apresentado na Seção deste trabalho:

Portas e entrada e saída: WR159 e WR137

Número de seções: 2; Binomial

Modelo utilizado para a síntese: modelo de impedância

Modelo utilizado para análise: modelo de impedância com correção de reatância concentrada

Com otimização numérica

```
*****
trafo ab com reat otimizado binomial
*****
```

```
dados intrinsecos a estrutura de guia utilizada
=====
```

```
transformador em guia retangular
```

- o programa considera somente modos te_{10}
- "a" e a dimensao ortogonal ao campo eletrico
- "b" e a dimensao paralela ao campo eletrico
- "c" deve ser ignorado durante a entrada/saida
- impedancia guia= $120 \cdot \pi \cdot b/a / \sqrt{1 - (\lambda / \sqrt{\epsilon}) / 2/a}^2$
- as juncoes dos guias sao analizadas de acordo com marcuwitz

```
perda tipica da estrutura = 0.2500000E-01 dB/mtr.
```

```
dados dos guias de entrada e saida
=====
```

```
dimensoes do primeiro guia:
dimensao ao = 0.4038600E-01 metros
dimensao bo = 0.2019300E-01 metros
dimensao co = 0.000000 metros
```

```
dimensoes do guia final:
dimensao af = 0.3484900E-01 metros
dimensao bf = 0.1579900E-01 metros
dimensao cf = 0.000000 metros
```

```
constante dieletrica no guia de entrada = 1.000000
```

constante dieletrica no guia de saida = 1.000000

frequencia de corte na linha de entrada = 0.3711589E+10 Hz
 frequencia de corte na linha de saida = 0.4301307E+10 Hz

modos	frequencias de corte (em Hz.)	
	primeiro guia	ultimo guia
te01	0.7423179E+10	0.9487706E+10
te11	0.8299366E+10	0.1041719E+11
te20	0.7423179E+10	0.8602615E+10
te02	0.1484636E+11	0.1897541E+11
*te12	0.1530328E+11	0.1945681E+11
te21	0.1049796E+11	0.1280709E+11

lista de frequencias

=====

numero de pontos a calcular = 19

frequencia n. 1 =	0.5300000E+10 Hz
frequencia n. 2 =	0.5400000E+10 Hz
frequencia n. 3 =	0.5500000E+10 Hz
frequencia n. 4 =	0.5600000E+10 Hz
frequencia n. 5 =	0.5700000E+10 Hz
frequencia n. 6 =	0.5800000E+10 Hz
frequencia n. 7 =	0.5900000E+10 Hz
frequencia n. 8 =	0.6000000E+10 Hz
frequencia n. 9 =	0.6100000E+10 Hz
frequencia n. 10 =	0.6200000E+10 Hz
frequencia n. 11 =	0.6300000E+10 Hz
frequencia n. 12 =	0.6400000E+10 Hz
frequencia n. 13 =	0.6500000E+10 Hz
frequencia n. 14 =	0.6600000E+10 Hz
frequencia n. 15 =	0.6700000E+10 Hz
frequencia n. 16 =	0.6800000E+10 Hz
frequencia n. 17 =	0.6900000E+10 Hz
frequencia n. 18 =	0.7000000E+10 Hz
frequencia n. 19 =	0.7100000E+10 Hz

lista de impedancias normalizadas de entrada(z0) e saida(zf)

=====

lista de impedancias de entrada(z0) e saida(zf)

	nao normaliz.	norm a z0(f1)	n.zguia(fn)	zguia(fn)
impedancia de normalizacao z0(f1) = 264.0553				
real zo(1)=	264.0553	1.000000	1.000000	264.0553
imag.zo(1)=	0.000000	0.000000	0.000000	
real zf(1)=	292.5264	1.107823	1.000000	292.5264
imag.zf(1)=	0.000000	0.000000	0.000000	
real zo(2)=	259.5128	0.9827971	1.000000	259.5128
imag.zo(2)=	0.000000	0.000000	0.000000	
real zf(2)=	282.6903	1.070572	1.000000	282.6903
imag.zf(2)=	0.000000	0.000000	0.000000	
real zo(3)=	255.4247	0.9673152	1.000000	255.4247
imag.zo(3)=	0.000000	0.000000	0.000000	
real zf(3)=	274.2440	1.038586	1.000000	274.2440
imag.zf(3)=	0.000000	0.000000	0.000000	
real zo(4)=	251.7265	0.9533100	1.000000	251.7265
imag.zo(4)=	0.000000	0.000000	0.000000	
real zf(4)=	266.9064	1.010797	1.000000	266.9064
imag.zf(4)=	0.000000	0.000000	0.000000	
real zo(5)=	248.3656	0.9405818	1.000000	248.3656
imag.zo(5)=	0.000000	0.000000	0.000000	

real zf(5)=	260.4688	0.9864175	1.000000	260.4688
imag.zf(5)=	0.000000	0.000000	0.000000	
real zo(6)=	245.2984	0.9289659	1.000000	245.2984
imag.zo(6)=	0.000000	0.000000	0.000000	
real zf(6)=	254.7729	0.9648470	1.000000	254.7729
imag.zf(6)=	0.000000	0.000000	0.000000	
real zo(7)=	242.4885	0.9183246	1.000000	242.4885
imag.zo(7)=	0.000000	0.000000	0.000000	
real zf(7)=	249.6962	0.9456209	1.000000	249.6962
imag.zf(7)=	0.000000	0.000000	0.000000	
real zo(8)=	239.9055	0.9085427	1.000000	239.9055
imag.zo(8)=	0.000000	0.000000	0.000000	
real zf(8)=	245.1422	0.9283744	1.000000	245.1422
imag.zf(8)=	0.000000	0.000000	0.000000	
real zo(9)=	237.5236	0.8995222	1.000000	237.5236
imag.zo(9)=	0.000000	0.000000	0.000000	
real zf(9)=	241.0337	0.9128152	1.000000	241.0337
imag.zf(9)=	0.000000	0.000000	0.000000	
real zo(10)=	235.3207	0.8911797	1.000000	235.3207
imag.zo(10)=	0.000000	0.000000	0.000000	
real zf(10)=	237.3084	0.8987071	1.000000	237.3084
imag.zf(10)=	0.000000	0.000000	0.000000	
real zo(11)=	233.2779	0.8834434	1.000000	233.2779
imag.zo(11)=	0.000000	0.000000	0.000000	
real zf(11)=	233.9151	0.8858564	1.000000	233.9151
imag.zf(11)=	0.000000	0.000000	0.000000	
real zo(12)=	231.3788	0.8762513	1.000000	231.3788
imag.zo(12)=	0.000000	0.000000	0.000000	
real zf(12)=	230.8115	0.8741031	1.000000	230.8115
imag.zf(12)=	0.000000	0.000000	0.000000	
real zo(13)=	229.6093	0.8695500	1.000000	229.6093
imag.zo(13)=	0.000000	0.000000	0.000000	
real zf(13)=	227.9624	0.8633133	1.000000	227.9624
imag.zf(13)=	0.000000	0.000000	0.000000	
real zo(14)=	227.9569	0.8632924	1.000000	227.9569
imag.zo(14)=	0.000000	0.000000	0.000000	
real zf(14)=	225.3381	0.8533745	1.000000	225.3381
imag.zf(14)=	0.000000	0.000000	0.000000	
real zo(15)=	226.4109	0.8574374	1.000000	226.4109
imag.zo(15)=	0.000000	0.000000	0.000000	
real zf(15)=	222.9132	0.8441913	1.000000	222.9132
imag.zf(15)=	0.000000	0.000000	0.000000	
real zo(16)=	224.9616	0.8519487	1.000000	224.9616
imag.zo(16)=	0.000000	0.000000	0.000000	
real zf(16)=	220.6662	0.8356818	1.000000	220.6662
imag.zf(16)=	0.000000	0.000000	0.000000	
real zo(17)=	223.6006	0.8467944	1.000000	223.6006
imag.zo(17)=	0.000000	0.000000	0.000000	
real zf(17)=	218.5786	0.8277759	1.000000	218.5786
imag.zf(17)=	0.000000	0.000000	0.000000	
real zo(18)=	222.3203	0.8419461	1.000000	222.3203
imag.zo(18)=	0.000000	0.000000	0.000000	
real zf(18)=	216.6344	0.8204129	1.000000	216.6344
imag.zf(18)=	0.000000	0.000000	0.000000	
real zo(19)=	221.1142	0.8373785	1.000000	221.1142
imag.zo(19)=	0.000000	0.000000	0.000000	
real zf(19)=	214.8195	0.8135400	1.000000	214.8195
imag.zf(19)=	0.000000	0.000000	0.000000	

lista de "toes" esperado sem transformador

toe (1- 0.5300000E+10 Hz.) =	1.060	return loss =	30.691 dB
toe (2- 0.5400000E+10 Hz.) =	1.077	return loss =	28.649 dB
toe (3- 0.5500000E+10 Hz.) =	1.092	return loss =	27.166 dB
toe (4- 0.5600000E+10 Hz.) =	1.105	return loss =	26.037 dB
toe (5- 0.5700000E+10 Hz.) =	1.117	return loss =	25.147 dB
toe (6- 0.5800000E+10 Hz.) =	1.128	return loss =	24.425 dB
toe (7- 0.5900000E+10 Hz.) =	1.138	return loss =	23.826 dB
toe (8- 0.6000000E+10 Hz.) =	1.146	return loss =	23.320 dB
toe (9- 0.6100000E+10 Hz.) =	1.155	return loss =	22.887 dB
toe (10- 0.6200000E+10 Hz.) =	1.162	return loss =	22.511 dB
toe (11- 0.6300000E+10 Hz.) =	1.169	return loss =	22.182 dB
toe (12- 0.6400000E+10 Hz.) =	1.175	return loss =	21.890 dB
toe (13- 0.6500000E+10 Hz.) =	1.181	return loss =	21.630 dB
toe (14- 0.6600000E+10 Hz.) =	1.186	return loss =	21.397 dB
toe (15- 0.6700000E+10 Hz.) =	1.191	return loss =	21.186 dB
toe (16- 0.6800000E+10 Hz.) =	1.196	return loss =	20.994 dB
toe (17- 0.6900000E+10 Hz.) =	1.200	return loss =	20.819 dB
toe (18- 0.7000000E+10 Hz.) =	1.204	return loss =	20.659 dB
toe (19- 0.7100000E+10 Hz.) =	1.208	return loss =	20.511 dB

**** numero de seccoos do transformador ns = 2 ****

constantes dieletricas relativas das seccoos do transformador

=====

constante dieletrica da seccao (1) = 1.000
constante dieletrica da seccao (2) = 1.000

dimensoes iniciais do transformador

=====

as impedancias sao fornecidas p/ a frequencia = 0.6200000E+10 Hz

dimensao a(1) = 0.3894019E-01 metros
dimensao b(1) = 0.1909450E-01 metros
dimensao c(1) = 0.000000 metros
impedancia da seccao(1) = 235.8161

dimensao a(2) = 0.3616812E-01 metros
dimensao b(2) = 0.1689750E-01 metros
dimensao c(2) = 0.000000 metros
impedancia da seccao(2) = 236.8099

lista de comprimentos iniciais das seccoos do transformador

=====

comprimento da seccao(1) = 0.1542060E-01 metros
comprimento da seccao(2) = 0.1625329E-01 metros

trafo ab binomial sem otim

lista de impedancias esperadas com transformador

=====

nao normalz.	norm a z0(f1)	norm a z0(fn)	z0(fn)
--------------	---------------	---------------	--------

impedancia de normalizacao z0(f1) = 264.0553

real zin(1)=	264.6937	1.002418	1.002418	264.0553
---------------	----------	----------	----------	----------

imag.zin(1)=	3.232093	0.1224021E-01	0.1224021E-01	
real zin(2)=	260.9597	0.9882765	1.005575	259.5128
imag.zin(2)=	2.659906	0.1007329E-01	0.1024961E-01	
real zin(3)=	257.2169	0.9741025	1.007017	255.4247
imag.zin(3)=	1.983042	0.7509949E-02	0.7763705E-02	
real zin(4)=	253.5322	0.9601481	1.007173	251.7265
imag.zin(4)=	1.338941	0.5070685E-02	0.5319031E-02	
real zin(5)=	249.9706	0.9466600	1.006462	248.3656
imag.zin(5)=	0.8065917	0.3054632E-02	0.3247598E-02	
real zin(6)=	246.5909	0.9338607	1.005269	245.2984
imag.zin(6)=	0.4228045	0.1601197E-02	0.1723633E-02	
real zin(7)=	243.4421	0.9219359	1.003932	242.4885
imag.zin(7)=	0.1943015	0.7358362E-03	0.8012812E-03	
real zin(8)=	240.5617	0.9110276	1.002735	239.9055
imag.zin(8)=	0.1068627	0.4046983E-03	0.4454368E-03	
real zin(9)=	237.9757	0.9012343	1.001903	237.5236
imag.zin(9)=	0.1324090	0.5014442E-03	0.5574562E-03	
real zin(10)=	235.6985	0.8926103	1.001605	235.3207
imag.zin(10)=	0.2341270	0.8866591E-03	0.9949275E-03	
real zin(11)=	233.7339	0.8851705	1.001955	233.2779
imag.zin(11)=	0.3704926	0.1403087E-02	0.1588203E-02	
real zin(12)=	232.0761	0.8788921	1.003014	231.3788
imag.zin(12)=	0.4981453	0.1886519E-02	0.2152943E-02	
real zin(13)=	230.7105	0.8737203	1.004796	229.6093
imag.zin(13)=	0.5739999	0.2173787E-02	0.2499898E-02	
real zin(14)=	229.6143	0.8695691	1.007271	227.9569
imag.zin(14)=	0.5570863	0.2109734E-02	0.2443823E-02	
real zin(15)=	228.7583	0.8663273	1.010368	226.4109
imag.zin(15)=	0.4097185	0.1551639E-02	0.1809624E-02	
real zin(16)=	228.1066	0.8638591	1.013980	224.9616
imag.zin(16)=	0.9878577E-01	0.3741102E-03	0.4391229E-03	
real zin(17)=	227.6181	0.8620094	1.017968	223.6006
imag.zin(17)=	-0.4033344	-0.1527462E-02	-0.1803817E-02	
real zin(18)=	227.2477	0.8606064	1.022163	222.3203
imag.zin(18)=	-1.117884	-0.4233523E-02	-0.5028259E-02	
real zin(19)=	226.9463	0.8594652	1.026376	221.1142
imag.zin(19)=	-2.058689	-0.7796433E-02	-0.9310524E-02	

matriz "s" do transformador (real/imaginario)
 =====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.1244684E-02	-0.6632732	-0.6632733	-0.5911055E-02
	0.6105144E-02	-0.7482296	-0.7482297	-0.1969264E-02
0.5400000E+10	0.2805862E-02	-0.7356025	-0.7356026	-0.5309372E-02
	0.5096227E-02	-0.6772538	-0.6772538	-0.2377717E-02
0.5500000E+10	0.3510922E-02	-0.7989610	-0.7989610	-0.4675397E-02
	0.3854690E-02	-0.6012084	-0.6012085	-0.2307869E-02
0.5600000E+10	0.3580613E-02	-0.8534091	-0.8534091	-0.3983974E-02
	0.2640505E-02	-0.5210478	-0.5210478	-0.1980421E-02
0.5700000E+10	0.3223324E-02	-0.8990343	-0.8990343	-0.3257449E-02
	0.1613328E-02	-0.4376551	-0.4376550	-0.1543671E-02
0.5800000E+10	0.2628418E-02	-0.9359523	-0.9359522	-0.2541769E-02
	0.8573246E-03	-0.3518564	-0.3518564	-0.1088115E-02
0.5900000E+10	0.1962544E-02	-0.9643095	-0.9643096	-0.1891171E-02
	0.3990749E-03	-0.2644253	-0.2644254	-0.6590768E-03

0.6000000E+10	0.1365721E-02	-0.9842804	-0.9842805	-0.1357761E-02
	0.2221112E-03	-0.1760897	-0.1760897	-0.2660946E-03
0.6100000E+10	0.9507303E-03	-0.9960695	-0.9960694	-0.9845265E-03
	0.2781927E-03	-0.8753381E-01	-0.8753379E-01	0.1076517E-03
0.6200000E+10	0.8021705E-03	-0.9999081	-0.9999081	-0.8013927E-03
	0.4966666E-03	0.5974656E-03	0.5974656E-03	0.4976891E-03
0.6300000E+10	0.9770832E-03	-0.9960546	-0.9960546	-0.8232297E-03
	0.7925603E-03	0.8769883E-01	0.8769884E-01	0.9517152E-03
0.6400000E+10	0.1505743E-02	-0.9847922	-0.9847922	-0.1048560E-02
	0.1073233E-02	0.1732008	0.1732008	0.1523738E-02
0.6500000E+10	0.2393807E-02	-0.9664277	-0.9664277	-0.1460628E-02
	0.1243958E-02	0.2565697	0.2565697	0.2269184E-02
0.6600000E+10	0.3623643E-02	-0.9412901	-0.9412900	-0.2027048E-02
	0.1213092E-02	0.3373073	0.3373073	0.3240659E-02
0.6700000E+10	0.5158044E-02	-0.9097288	-0.9097291	-0.2703273E-02
	0.8955448E-03	0.4149496	0.4149497	0.4484734E-02
0.6800000E+10	0.6941578E-02	-0.8721141	-0.8721142	-0.3432979E-02
	0.2165497E-03	0.4890664	0.4890664	0.6038746E-02
0.6900000E+10	0.8904697E-02	-0.8288325	-0.8288325	-0.4151356E-02
	-0.8859074E-03	0.5592622	0.5592622	0.7929075E-02
0.7000000E+10	0.1096627E-01	-0.7802872	-0.7802874	-0.4787804E-02
	-0.2459260E-02	0.6251739	0.6251740	0.1016950E-01
0.7100000E+10	0.1303715E-01	-0.7268975	-0.7268975	-0.5268034E-02
	-0.4534752E-02	0.6864741	0.6864740	0.1276015E-01

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.6230732E-02	0.9998894	0.9998896	0.6230455E-02
	78.47677	-131.5556	-131.5556	-161.5745
0.5400000E+10	0.5817594E-02	0.9998919	0.9998919	0.5817471E-02
	61.16386	-137.3649	-137.3649	-155.8755
0.5500000E+10	0.5213944E-02	0.9998951	0.9998952	0.5213981E-02
	47.67217	-143.0390	-143.0390	-153.7281
0.5600000E+10	0.4448939E-02	0.9998989	0.9998989	0.4449058E-02
	36.40673	-148.5939	-148.5939	-153.5682
0.5700000E+10	0.3604531E-02	0.9999023	0.9999023	0.3604704E-02
	26.58874	-154.0429	-154.0429	-154.6442
0.5800000E+10	0.2764704E-02	0.9999048	0.9999047	0.2764884E-02
	18.06503	-159.3970	-159.3970	-156.8245
0.5900000E+10	0.2002708E-02	0.9999068	0.9999068	0.2002726E-02
	11.49413	-164.6657	-164.6657	-160.7865
0.6000000E+10	0.1383664E-02	0.9999077	0.9999079	0.1383589E-02
	9.237308	-169.8570	-169.8570	-168.9117
0.6100000E+10	0.9905954E-03	0.9999083	0.9999081	0.9903945E-03
	16.30998	-174.9778	-174.9778	173.7599
0.6200000E+10	0.9434804E-03	0.9999083	0.9999083	0.9433582E-03
	31.76386	179.9658	179.9658	148.1585
0.6300000E+10	0.1258111E-02	0.9999080	0.9999080	0.1258360E-02
	39.04721	174.9683	174.9683	130.8597
0.6400000E+10	0.1849078E-02	0.9999071	0.9999071	0.1849664E-02
	35.47975	170.0251	170.0251	124.5338
0.6500000E+10	0.2697730E-02	0.9999052	0.9999052	0.2698635E-02
	27.45895	165.1319	165.1319	122.7686
0.6600000E+10	0.3821306E-02	0.9999016	0.9999015	0.3822407E-02
	18.50907	160.2851	160.2851	122.0262
0.6700000E+10	0.5235210E-02	0.9998949	0.9998951	0.5236461E-02
	9.849566	155.4811	155.4811	121.0804
0.6800000E+10	0.6944955E-02	0.9998845	0.9998845	0.6946352E-02
	1.786822	150.7171	150.7171	119.6179
0.6900000E+10	0.8948658E-02	0.9998688	0.9998688	0.8950083E-02
	-5.681527	145.9901	145.9901	117.6348
0.7000000E+10	0.1123864E-01	0.9998453	0.9998455	0.1124019E-01
	-12.63985	141.2979	141.2979	115.2111
0.7100000E+10	0.1380331E-01	0.9998134	0.9998133	0.1380484E-01
	-19.17936	136.6383	136.6383	112.4333

lista de "toes" esperadas com transformador

=====

toe (1- 0.5300000E+10 Hz.) = 1.013 return loss = 44.109 dB

toe (2- 0.5400000E+10 Hz.) =	1.012	return loss =	44.705 dB
toe (3- 0.5500000E+10 Hz.) =	1.010	return loss =	45.657 dB
toe (4- 0.5600000E+10 Hz.) =	1.009	return loss =	47.035 dB
toe (5- 0.5700000E+10 Hz.) =	1.007	return loss =	48.863 dB
toe (6- 0.5800000E+10 Hz.) =	1.006	return loss =	51.167 dB
toe (7- 0.5900000E+10 Hz.) =	1.004	return loss =	53.968 dB
toe (8- 0.6000000E+10 Hz.) =	1.003	return loss =	57.179 dB
toe (9- 0.6100000E+10 Hz.) =	1.002	return loss =	60.081 dB
toe (10- 0.6200000E+10 Hz.) =	1.002	return loss =	60.505 dB
toe (11- 0.6300000E+10 Hz.) =	1.003	return loss =	58.005 dB
toe (12- 0.6400000E+10 Hz.) =	1.004	return loss =	54.661 dB
toe (13- 0.6500000E+10 Hz.) =	1.005	return loss =	51.380 dB
toe (14- 0.6600000E+10 Hz.) =	1.008	return loss =	48.356 dB
toe (15- 0.6700000E+10 Hz.) =	1.011	return loss =	45.621 dB
toe (16- 0.6800000E+10 Hz.) =	1.014	return loss =	43.167 dB
toe (17- 0.6900000E+10 Hz.) =	1.018	return loss =	40.965 dB
toe (18- 0.7000000E+10 Hz.) =	1.023	return loss =	38.986 dB
toe (19- 0.7100000E+10 Hz.) =	1.028	return loss =	37.200 dB

"toe" medio = 1.009 +/- 0.031

 traf o ot imiz ado ab b inom ial

dimensoes do transformador apos otimizacao
 =====

opcao a,b,c,l = 1101
 incremento (%) = 0.010
 const. final = 0.2552507E-06
 num. iteracoes = 837
 precisao <= 0.1000000E-05

os dados estao corretos ? (s ou n)

seccao 1
 dimensao a = 0.3857989E-01 metros
 dimensao b = 0.1886050E-01 metros
 dimensao c = 0.000000 metros
 comprimento l = 0.1502154E-01 metros

seccao 2
 dimensao a = 0.3569731E-01 metros
 dimensao b = 0.1666693E-01 metros
 dimensao c = 0.000000 metros
 comprimento l = 0.1595547E-01 metros

lista de impedancias esperadas com transformador
 =====

nao normalz.	norm a z0(f1)	norm a z0(fn)	z0(fn)
--------------	---------------	---------------	--------

impedancia de normalizacao z0(f1) = 264.0553

real zin(1)=	264.0867	1.000119	1.000119	264.0553
imag.zin(1)=	0.9332053E-01	0.3534128E-03	0.3534128E-03	
real zin(2)=	259.8413	0.9840412	1.001266	259.5128
imag.zin(2)=	0.3139364	0.1188904E-02	0.1209715E-02	
real zin(3)=	255.8085	0.9687688	1.001503	255.4247
imag.zin(3)=	0.2843780	0.1076964E-02	0.1113354E-02	

real zin(4)=	251.9872	0.9542971	1.001035	251.7265
imag.zin(4)=	0.1447414	0.5481480E-03	0.5749945E-03	
real zin(5)=	248.3879	0.9406663	1.000090	248.3656
imag.zin(5)=	-0.1617712E-01	-0.6126413E-04	-0.6513429E-04	
real zin(6)=	245.0258	0.9279337	0.9988889	245.2984
imag.zin(6)=	-0.1471166	-0.5571431E-03	-0.5997455E-03	
real zin(7)=	241.9167	0.9161591	0.9976419	242.4885
imag.zin(7)=	-0.2234813	-0.8463429E-03	-0.9216163E-03	
real zin(8)=	239.0738	0.9053928	0.9965330	239.9055
imag.zin(8)=	-0.2400411	-0.9090562E-03	-0.1000565E-02	
real zin(9)=	236.5056	0.8956671	0.9957143	237.5236
imag.zin(9)=	-0.2053454	-0.7776606E-03	-0.8645263E-03	
real zin(10)=	234.2160	0.8869959	0.9953054	235.3207
imag.zin(10)=	-0.1371005	-0.5192113E-03	-0.5826113E-03	
real zin(11)=	232.2024	0.8793705	0.9953898	233.2779
imag.zin(11)=	-0.5898298E-01	-0.2233736E-03	-0.2528443E-03	
real zin(12)=	230.4573	0.8727615	0.9960173	231.3788
imag.zin(12)=	0.1952609E-02	0.7394699E-05	0.8439016E-05	
real zin(13)=	228.9675	0.8671196	0.9972050	229.6093
imag.zin(13)=	0.1719941E-01	0.6513565E-04	0.7490730E-04	
real zin(14)=	227.7146	0.8623747	0.9989370	227.9569
imag.zin(14)=	-0.4160388E-01	-0.1575575E-03	-0.1825076E-03	
real zin(15)=	226.6755	0.8584395	1.001169	226.4109
imag.zin(15)=	-0.2014390	-0.7628668E-03	-0.8897056E-03	
real zin(16)=	225.8228	0.8552104	1.003829	224.9616
imag.zin(16)=	-0.4869452	-0.1844103E-02	-0.2164571E-02	
real zin(17)=	225.1252	0.8525686	1.006819	223.6006
imag.zin(17)=	-0.9193037	-0.3481482E-02	-0.4111366E-02	
real zin(18)=	224.5484	0.8503838	1.010022	222.3203
imag.zin(18)=	-1.515785	-0.5740408E-02	-0.6818024E-02	
real zin(19)=	224.0549	0.8485149	1.013299	221.1142
imag.zin(19)=	-2.288701	-0.8667507E-02	-0.1035076E-01	

matriz "s" do transformador (real/imaginario)
 =====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.5962648E-04	-0.5957846	-0.5957845	-0.1501402E-03
	0.1767102E-03	-0.8030332	-0.8030331	-0.1098243E-03
0.5400000E+10	0.6329464E-03	-0.6735460	-0.6735461	-0.5412638E-03
	0.6041242E-03	-0.7390240	-0.7390242	-0.6881251E-03
0.5500000E+10	0.7510255E-03	-0.7428177	-0.7428176	-0.6291757E-03
	0.5558360E-03	-0.6693602	-0.6693600	-0.6916189E-03
0.5600000E+10	0.5175803E-03	-0.8036255	-0.8036254	-0.4244255E-03
	0.2872579E-03	-0.5949852	-0.5949853	-0.4137077E-03
0.5700000E+10	0.4483793E-04	-0.8560206	-0.8560206	0.8917415E-05
	-0.3260557E-04	-0.5167691	-0.5167691	-0.5741114E-04
0.5800000E+10	-0.5557205E-03	-0.9000789	-0.9000790	0.5808261E-03
	-0.3001955E-03	-0.4355219	-0.4355219	0.2470486E-03
0.5900000E+10	-0.1180194E-02	-0.9359033	-0.9359033	0.1192211E-02
	-0.4618699E-03	-0.3520012	-0.3520011	0.4281620E-03
0.6000000E+10	-0.1736127E-02	-0.9636241	-0.9636240	0.1746872E-02
	-0.5019931E-03	-0.2669209	-0.2669209	0.4610224E-03
0.6100000E+10	-0.2147160E-02	-0.9833990	-0.9833990	0.2160670E-02
	-0.4341176E-03	-0.1809514	-0.1809513	0.3573395E-03
0.6200000E+10	-0.2352771E-02	-0.9954110	-0.9954110	0.2365122E-02
	-0.2926771E-03	-0.9472633E-01	-0.9472633E-01	0.1556208E-03
0.6300000E+10	-0.2310488E-02	-0.9998688	-0.9998692	0.2311701E-02
	-0.1270054E-03	-0.8842842E-02	-0.8842846E-02	-0.8621566E-04

0.6400000E+10	-0.1995330E-02	-0.9970059	-0.9970060	0.1972244E-02
	0.4242176E-05	0.7613603E-01	0.7613603E-01	-0.2982194E-03
0.6500000E+10	-0.1399481E-02	-0.9870775	-0.9870775	0.1339577E-02
	0.3756528E-04	0.1596795	0.1596795	-0.4043714E-03
0.6600000E+10	-0.5317203E-03	-0.9703611	-0.9703612	0.4268953E-03
	-0.9133211E-04	0.2412892	0.2412892	-0.3278631E-03
0.6700000E+10	0.5842571E-03	-0.9471546	-0.9471548	-0.7337668E-03
	-0.4443545E-03	0.3204978	0.3204978	0.4224637E-05
0.6800000E+10	0.1911710E-02	-0.9177755	-0.9177756	-0.2094178E-02
	-0.1078119E-02	0.3968687	0.3968687	0.6574881E-03
0.6900000E+10	0.3402020E-02	-0.8825592	-0.8825591	-0.3591478E-02
	-0.2041727E-02	0.4699949	0.4699949	0.1686763E-02
0.7000000E+10	0.4997332E-02	-0.8418570	-0.8418571	-0.5152023E-02
	-0.3375069E-02	0.5395012	0.5395012	0.3134289E-02
0.7100000E+10	0.6631836E-02	-0.7960378	-0.7960379	-0.6693067E-02
	-0.5107004E-02	0.6050413	0.6050414	0.5027006E-02

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.1864988E-03	0.9999108	0.9999107	0.1860201E-03
	71.35431	-126.5724	-126.5724	-143.8153
0.5400000E+10	0.8749784E-03	0.9999104	0.9999105	0.8754900E-03
	43.66533	-132.3460	-132.3460	-128.1878
0.5500000E+10	0.9343409E-03	0.9999106	0.9999105	0.9349859E-03
	36.50525	-137.9777	-137.9777	-132.2932
0.5600000E+10	0.5919514E-03	0.9999107	0.9999107	0.5926981E-03
	29.03034	-143.4846	-143.4846	-135.7326
0.5700000E+10	0.5543972E-04	0.9999107	0.9999108	0.5809956E-04
	-36.02417	-148.8811	-148.8811	-81.17106
0.5800000E+10	0.6316191E-03	0.9999107	0.9999108	0.6311830E-03
	-151.6225	-154.1790	-154.1790	23.04199
0.5900000E+10	0.1267352E-02	0.9999099	0.9999099	0.1266764E-02
	-158.6271	-159.3883	-159.3883	19.75487
0.6000000E+10	0.1807245E-02	0.9999091	0.9999090	0.1806683E-02
	-163.8730	-164.5174	-164.5174	14.78402
0.6100000E+10	0.2190606E-02	0.9999084	0.9999084	0.2190020E-02
	-168.5699	-169.5739	-169.5739	9.390783
0.6200000E+10	0.2370905E-02	0.9999080	0.9999081	0.2370237E-02
	-172.9090	-174.5639	-174.5639	3.764534
0.6300000E+10	0.2313976E-02	0.9999079	0.9999083	0.2313308E-02
	-176.8537	-179.4933	-179.4933	-2.135875
0.6400000E+10	0.1995334E-02	0.9999087	0.9999088	0.1994664E-02
	179.8782	175.6331	175.6331	-8.598453
0.6500000E+10	0.1399986E-02	0.9999098	0.9999098	0.1399280E-02
	178.4624	170.8109	170.8109	-16.79722
0.6600000E+10	0.5395072E-03	0.9999106	0.9999107	0.5382692E-03
	-170.2536	166.0361	166.0361	-37.52489
0.6700000E+10	0.7340349E-03	0.9999104	0.9999105	0.7337790E-03
	-37.25467	161.3052	161.3052	179.6701
0.6800000E+10	0.2194761E-02	0.9999083	0.9999084	0.2194965E-02
	-29.42107	156.6152	156.6152	162.5698
0.6900000E+10	0.3967668E-02	0.9999030	0.9999028	0.3967857E-02
	-30.97013	151.9631	151.9631	154.8426
0.7000000E+10	0.6030291E-02	0.9998924	0.9998925	0.6030515E-02
	-34.03408	147.3464	147.3464	148.6853
0.7100000E+10	0.8370349E-02	0.9998756	0.9998757	0.8370659E-02
	-37.59893	142.7628	142.7628	143.0907

lista de "toes" esperadas com transformador

=====

toe (1- 0.5300000E+10 Hz.) =	1.000	return loss =	74.588 dB
toe (2- 0.5400000E+10 Hz.) =	1.002	return loss =	61.161 dB
toe (3- 0.5500000E+10 Hz.) =	1.002	return loss =	60.589 dB
toe (4- 0.5600000E+10 Hz.) =	1.001	return loss =	64.555 dB
toe (5- 0.5700000E+10 Hz.) =	1.000	return loss =	85.120 dB
toe (6- 0.5800000E+10 Hz.) =	1.001	return loss =	63.990 dB
toe (7- 0.5900000E+10 Hz.) =	1.003	return loss =	57.942 dB
toe (8- 0.6000000E+10 Hz.) =	1.004	return loss =	54.859 dB
toe (9- 0.6100000E+10 Hz.) =	1.004	return loss =	53.188 dB

toe (10- 0.6200000E+10 Hz.) =	1.005	return loss =	52.502 dB
toe (11- 0.6300000E+10 Hz.) =	1.005	return loss =	52.713 dB
toe (12- 0.6400000E+10 Hz.) =	1.004	return loss =	54.000 dB
toe (13- 0.6500000E+10 Hz.) =	1.003	return loss =	57.078 dB
toe (14- 0.6600000E+10 Hz.) =	1.001	return loss =	65.359 dB
toe (15- 0.6700000E+10 Hz.) =	1.001	return loss =	62.686 dB
toe (16- 0.6800000E+10 Hz.) =	1.004	return loss =	53.172 dB
toe (17- 0.6900000E+10 Hz.) =	1.008	return loss =	48.029 dB
toe (18- 0.7000000E+10 Hz.) =	1.012	return loss =	44.393 dB
toe (19- 0.7100000E+10 Hz.) =	1.017	return loss =	41.545 dB

"toe" medio = 1.004 +/- 0.018

Apêndice 11 – Listagem do caso do transformador binomial, não-homogêneo

A listagem abaixo se refere ao caso apresentado na Seção deste trabalho:

Portas e entrada e saída: WR159 e Seção Quadrada 34,85x34,85mm

Número de seções: 2; Binomial

Modelo utilizado para a síntese: modelo de impedância

Modelo utilizado para análise: modelo modelo de impedância com correção de reatância concentrada

Sem otimização numérica

```
*****
trafo nao homogeneo
*****

dados intrinsecos a estrutura de guia utilizada
=====

transformador em guia retangular

- o programa considera somente modos tel0
- "a" e a dimensao ortogonal ao campo eletrico
- "b" e a dimensao paralela ao campo eletrico
- "c" deve ser ignorado durante a entrada/saida
- impedancia guia=120*pi*b/a/sqrt(1-(lbda/sqrt(epsilon)/2/a)**2)
- as juncoes dos guias sao analizadas de acordo com marcuwitz

perda tipica da estrutura = 0.1000000E-02 dB/mtr.

dados dos guias de entrada e saida
=====

dimensoes do primeiro guia:
dimensao ao = 0.4038600E-01 metros
dimensao bo = 0.2019300E-01 metros
dimensao co = 0.000000 metros

dimensoes do guia final:
dimensao af = 0.3484900E-01 metros
dimensao bf = 0.3484900E-01 metros
dimensao cf = 0.000000 metros

constante dieletrica no guia de entrada = 1.000000
```

constante dieletrica no guia de saida = 1.000000

frequencia de corte na linha de entrada = 0.3711589E+10 Hz
 frequencia de corte na linha de saida = 0.4301307E+10 Hz

modos	frequencias de corte (em Hz.)	
	primeiro guia	ultimo guia
te01	0.7423179E+10	0.4301307E+10
te11	0.8299366E+10	0.6082967E+10
te20	0.7423179E+10	0.8602615E+10
te02	0.1484636E+11	0.8602615E+10
*te12	0.1530328E+11	0.9618015E+10
te21	0.1049796E+11	0.9618015E+10

lista de frequencias

=====

numero de pontos a calcular = 19

frequencia n. 1 =	0.5300000E+10 Hz
frequencia n. 2 =	0.5400000E+10 Hz
frequencia n. 3 =	0.5500000E+10 Hz
frequencia n. 4 =	0.5600000E+10 Hz
frequencia n. 5 =	0.5700000E+10 Hz
frequencia n. 6 =	0.5800000E+10 Hz
frequencia n. 7 =	0.5900000E+10 Hz
frequencia n. 8 =	0.6000000E+10 Hz
frequencia n. 9 =	0.6100000E+10 Hz
frequencia n. 10 =	0.6200000E+10 Hz
frequencia n. 11 =	0.6300000E+10 Hz
frequencia n. 12 =	0.6400000E+10 Hz
frequencia n. 13 =	0.6500000E+10 Hz
frequencia n. 14 =	0.6600000E+10 Hz
frequencia n. 15 =	0.6700000E+10 Hz
frequencia n. 16 =	0.6800000E+10 Hz
frequencia n. 17 =	0.6900000E+10 Hz
frequencia n. 18 =	0.7000000E+10 Hz
frequencia n. 19 =	0.7100000E+10 Hz

lista de impedancias normalizadas de entrada(z0) e saida(zf)

=====

lista de impedancias de entrada(z0) e saida(zf)

	nao normaliz.	norm a z0(f1)	n.zguia(fn)	zguia(fn)
impedancia de normalizacao z0(f1) = 264.0553				
real zo(1)=	264.0553	1.000000	1.000000	264.0553
imag.zo(1)=	0.000000	0.000000	0.000000	
real zf(1)=	645.2468	2.443605	1.000000	645.2468
imag.zf(1)=	0.000000	0.000000	0.000000	
real zo(2)=	259.5128	0.9827971	1.000000	259.5128
imag.zo(2)=	0.000000	0.000000	0.000000	
real zf(2)=	623.5505	2.361439	1.000000	623.5505
imag.zf(2)=	0.000000	0.000000	0.000000	
real zo(3)=	255.4247	0.9673152	1.000000	255.4247
imag.zo(3)=	0.000000	0.000000	0.000000	
real zf(3)=	604.9199	2.290884	1.000000	604.9199
imag.zf(3)=	0.000000	0.000000	0.000000	
real zo(4)=	251.7265	0.9533100	1.000000	251.7265
imag.zo(4)=	0.000000	0.000000	0.000000	
real zf(4)=	588.7347	2.229589	1.000000	588.7347
imag.zf(4)=	0.000000	0.000000	0.000000	
real zo(5)=	248.3656	0.9405818	1.000000	248.3656
imag.zo(5)=	0.000000	0.000000	0.000000	

real zf(5)=	574.5349	2.175813	1.000000	574.5349
imag.zf(5)=	0.000000	0.000000	0.000000	
real zo(6)=	245.2984	0.9289659	1.000000	245.2984
imag.zo(6)=	0.000000	0.000000	0.000000	
real zf(6)=	561.9712	2.128233	1.000000	561.9712
imag.zf(6)=	0.000000	0.000000	0.000000	
real zo(7)=	242.4885	0.9183246	1.000000	242.4885
imag.zo(7)=	0.000000	0.000000	0.000000	
real zf(7)=	550.7731	2.085825	1.000000	550.7731
imag.zf(7)=	0.000000	0.000000	0.000000	
real zo(8)=	239.9055	0.9085427	1.000000	239.9055
imag.zo(8)=	0.000000	0.000000	0.000000	
real zf(8)=	540.7279	2.047783	1.000000	540.7279
imag.zf(8)=	0.000000	0.000000	0.000000	
real zo(9)=	237.5236	0.8995222	1.000000	237.5236
imag.zo(9)=	0.000000	0.000000	0.000000	
real zf(9)=	531.6655	2.013463	1.000000	531.6655
imag.zf(9)=	0.000000	0.000000	0.000000	
real zo(10)=	235.3207	0.8911797	1.000000	235.3207
imag.zo(10)=	0.000000	0.000000	0.000000	
real zf(10)=	523.4483	1.982344	1.000000	523.4483
imag.zf(10)=	0.000000	0.000000	0.000000	
real zo(11)=	233.2779	0.8834434	1.000000	233.2779
imag.zo(11)=	0.000000	0.000000	0.000000	
real zf(11)=	515.9634	1.953998	1.000000	515.9634
imag.zf(11)=	0.000000	0.000000	0.000000	
real zo(12)=	231.3788	0.8762513	1.000000	231.3788
imag.zo(12)=	0.000000	0.000000	0.000000	
real zf(12)=	509.1178	1.928073	1.000000	509.1178
imag.zf(12)=	0.000000	0.000000	0.000000	
real zo(13)=	229.6093	0.8695500	1.000000	229.6093
imag.zo(13)=	0.000000	0.000000	0.000000	
real zf(13)=	502.8333	1.904273	1.000000	502.8333
imag.zf(13)=	0.000000	0.000000	0.000000	
real zo(14)=	227.9569	0.8632924	1.000000	227.9569
imag.zo(14)=	0.000000	0.000000	0.000000	
real zf(14)=	497.0446	1.882350	1.000000	497.0446
imag.zf(14)=	0.000000	0.000000	0.000000	
real zo(15)=	226.4109	0.8574374	1.000000	226.4109
imag.zo(15)=	0.000000	0.000000	0.000000	
real zf(15)=	491.6958	1.862094	1.000000	491.6958
imag.zf(15)=	0.000000	0.000000	0.000000	
real zo(16)=	224.9616	0.8519487	1.000000	224.9616
imag.zo(16)=	0.000000	0.000000	0.000000	
real zf(16)=	486.7394	1.843324	1.000000	486.7394
imag.zf(16)=	0.000000	0.000000	0.000000	
real zo(17)=	223.6006	0.8467944	1.000000	223.6006
imag.zo(17)=	0.000000	0.000000	0.000000	
real zf(17)=	482.1347	1.825885	1.000000	482.1347
imag.zf(17)=	0.000000	0.000000	0.000000	
real zo(18)=	222.3203	0.8419461	1.000000	222.3203
imag.zo(18)=	0.000000	0.000000	0.000000	
real zf(18)=	477.8462	1.809644	1.000000	477.8462
imag.zf(18)=	0.000000	0.000000	0.000000	
real zo(19)=	221.1142	0.8373785	1.000000	221.1142
imag.zo(19)=	0.000000	0.000000	0.000000	
real zf(19)=	473.8431	1.794484	1.000000	473.8431
imag.zf(19)=	0.000000	0.000000	0.000000	

lista de "toes" esperado sem transformador

toe (1- 0.5300000E+10 Hz.) =	2.090	return loss =	9.049 dB
toe (2- 0.5400000E+10 Hz.) =	2.058	return loss =	9.221 dB
toe (3- 0.5500000E+10 Hz.) =	2.031	return loss =	9.367 dB
toe (4- 0.5600000E+10 Hz.) =	2.009	return loss =	9.492 dB
toe (5- 0.5700000E+10 Hz.) =	1.990	return loss =	9.599 dB
toe (6- 0.5800000E+10 Hz.) =	1.975	return loss =	9.690 dB
toe (7- 0.5900000E+10 Hz.) =	1.962	return loss =	9.767 dB
toe (8- 0.6000000E+10 Hz.) =	1.952	return loss =	9.832 dB
toe (9- 0.6100000E+10 Hz.) =	1.943	return loss =	9.887 dB
toe (10- 0.6200000E+10 Hz.) =	1.936	return loss =	9.932 dB
toe (11- 0.6300000E+10 Hz.) =	1.930	return loss =	9.968 dB
toe (12- 0.6400000E+10 Hz.) =	1.926	return loss =	9.996 dB
toe (13- 0.6500000E+10 Hz.) =	1.922	return loss =	10.018 dB
toe (14- 0.6600000E+10 Hz.) =	1.920	return loss =	10.032 dB
toe (15- 0.6700000E+10 Hz.) =	1.919	return loss =	10.041 dB
toe (16- 0.6800000E+10 Hz.) =	1.918	return loss =	10.044 dB
toe (17- 0.6900000E+10 Hz.) =	1.918	return loss =	10.042 dB
toe (18- 0.7000000E+10 Hz.) =	1.919	return loss =	10.036 dB
toe (19- 0.7100000E+10 Hz.) =	1.921	return loss =	10.024 dB

**** numero de seccoos do transformador ns = 2 ****

constantes dieletricas relativas das seccoos do transformador

=====

constante dieletrica da seccao (1) = 1.000
constante dieletrica da seccao (2) = 1.000

dimensoes iniciais do transformador

=====

as impedancias sao fornecidas p/ a frequencia = 0.6200000E+10 Hz

dimensao a(1) = 0.3941728E-01 metros
dimensao b(1) = 0.2385700E-01 metros
dimensao c(1) = 0.000000 metros
impedancia da seccao(1) = 288.8946

dimensao a(2) = 0.3667128E-01 metros
dimensao b(2) = 0.3118500E-01 metros
dimensao c(2) = 0.000000 metros
impedancia da seccao(2) = 426.3777

lista de comprimentos iniciais das seccoos do transformador

=====

comprimento da seccao(1) = 0.1530553E-01 metros
comprimento da seccao(2) = 0.1607729E-01 metros

trafo nh nao otimizado

lista de impedancias esperadas com transformador

=====

nao normalz.	norm a z0(f1)	norm a z0(fn)	z0(fn)
--------------	---------------	---------------	--------

impedancia de normalizacao z0(f1) = 264.0553

real zin(1)=	239.1362	0.9056292	0.9056292	264.0553
---------------	----------	-----------	-----------	----------

imag.zin(1)=	-10.57205	-0.4003727E-01	-0.4003727E-01	
real zin(2)=	240.4041	0.9104310	0.9263672	259.5128
imag.zin(2)=	-4.953051	-0.1875763E-01	-0.1908596E-01	
real zin(3)=	241.6308	0.9150767	0.9459964	255.4247
imag.zin(3)=	-0.8469199	-0.3207358E-02	-0.3315732E-02	
real zin(4)=	242.6714	0.9190172	0.9640276	251.7265
imag.zin(4)=	2.010097	0.7612410E-02	0.7985241E-02	
real zin(5)=	243.4022	0.9217849	0.9800157	248.3656
imag.zin(5)=	3.860810	0.1462122E-01	0.1554487E-01	
real zin(6)=	243.7279	0.9230184	0.9935977	245.2984
imag.zin(6)=	4.935417	0.1869084E-01	0.2012006E-01	
real zin(7)=	243.5856	0.9224793	1.004524	242.4885
imag.zin(7)=	5.454200	0.2065552E-01	0.2249261E-01	
real zin(8)=	242.9474	0.9200626	1.012679	239.9055
imag.zin(8)=	5.625384	0.2130381E-01	0.2344833E-01	
real zin(9)=	241.8205	0.9157948	1.018090	237.5236
imag.zin(9)=	5.641128	0.2136344E-01	0.2374976E-01	
real zin(10)=	240.2436	0.9098231	1.020920	235.3207
imag.zin(10)=	5.672593	0.2148260E-01	0.2410580E-01	
real zin(11)=	238.2826	0.9023966	1.021454	233.2779
imag.zin(11)=	5.865546	0.2221332E-01	0.2514403E-01	
real zin(12)=	236.0238	0.8938423	1.020075	231.3788
imag.zin(12)=	6.337430	0.2400039E-01	0.2738985E-01	
real zin(13)=	233.5668	0.8845376	1.017236	229.6093
imag.zin(13)=	7.176416	0.2717770E-01	0.3125490E-01	
real zin(14)=	231.0178	0.8748842	1.013427	227.9569
imag.zin(14)=	8.442251	0.3197153E-01	0.3703441E-01	
real zin(15)=	228.4836	0.8652870	1.009155	226.4109
imag.zin(15)=	10.16845	0.3850880E-01	0.4491150E-01	
real zin(16)=	226.0675	0.8561369	1.004916	224.9616
imag.zin(16)=	12.36599	0.4683108E-01	0.5496936E-01	
real zin(17)=	223.8659	0.8477992	1.001187	223.6006
imag.zin(17)=	15.02689	0.5690812E-01	0.6720418E-01	
real zin(18)=	221.9665	0.8406061	0.9984084	222.3203
imag.zin(18)=	18.12845	0.6865399E-01	0.8154203E-01	
real zin(19)=	220.4480	0.8348556	0.9969872	221.1142
imag.zin(19)=	21.63630	0.8193851E-01	0.9785123E-01	

matriz "s" do transformador (real/imaginario)
 =====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	-0.4905919E-01	-0.6880429	-0.6880428	0.1953740E-01
	-0.2204092E-01	-0.7236692	-0.7236691	0.5010912E-01
0.5400000E+10	-0.3812188E-01	-0.7599630	-0.7599630	0.1613884E-01
	-0.1028561E-01	-0.6487603	-0.6487603	0.3603655E-01
0.5500000E+10	-0.2774825E-01	-0.8219992	-0.8219990	0.1141738E-01
	-0.1751225E-02	-0.5688032	-0.5688032	0.2535144E-01
0.5600000E+10	-0.1829877E-01	-0.8743495	-0.8743495	0.6177268E-02
	0.4140154E-02	-0.4849265	-0.4849265	0.1771572E-01
0.5700000E+10	-0.1003068E-01	-0.9172369	-0.9172369	0.1057674E-02
	0.7929620E-02	-0.3981276	-0.3981276	0.1274316E-01
0.5800000E+10	-0.3109309E-02	-0.9509011	-0.9509010	-0.3441640E-02
	0.1012367E-01	-0.3093018	-0.3093018	0.1001606E-01
0.5900000E+10	0.2382602E-02	-0.9755960	-0.9755961	-0.6943175E-02
	0.1119419E-01	-0.2192576	-0.2192577	0.9098642E-02

0.6000000E+10	0.6434628E-02	-0.9915867	-0.9915867	-0.9177112E-02
	0.1157533E-01	-0.1287358	-0.1287358	0.9548704E-02
0.6100000E+10	0.9101276E-02	-0.9991485	-0.9991484	-0.9969780E-02
	0.1166132E-01	-0.3841838E-01	-0.3841837E-01	0.1092813E-01
0.6200000E+10	0.1049247E-01	-0.9985672	-0.9985672	-0.9233824E-02
	0.1180297E-01	0.5105908E-01	0.5105909E-01	0.1281162E-01
0.6300000E+10	0.1076621E-01	-0.9901393	-0.9901395	-0.6958956E-02
	0.1230465E-01	0.1391016	0.1391016	0.1479470E-01
0.6400000E+10	0.1011991E-01	-0.9741756	-0.9741756	-0.3204135E-02
	0.1342159E-01	0.2251487	0.2251487	0.1650082E-01
0.6500000E+10	0.8782347E-02	-0.9510011	-0.9510012	0.1911014E-02
	0.1535782E-01	0.3086689	0.3086689	0.1758776E-01
0.6600000E+10	0.7004871E-02	-0.9209588	-0.9209588	0.8214940E-02
	0.1826483E-01	0.3891594	0.3891594	0.1775308E-01
0.6700000E+10	0.5053737E-02	-0.8844115	-0.8844115	0.1549105E-01
	0.2224040E-01	0.4661423	0.4661423	0.1673870E-01
0.6800000E+10	0.3201235E-02	-0.8417447	-0.8417445	0.2348668E-01
	0.2732948E-01	0.5391675	0.5391674	0.1433528E-01
0.6900000E+10	0.1718834E-02	-0.7933667	-0.7933667	0.3192114E-01
	0.3352437E-01	0.6078119	0.6078119	0.1038503E-01
0.7000000E+10	0.8670110E-03	-0.7397113	-0.7397113	0.4049537E-01
	0.4076803E-01	0.6716823	0.6716823	0.4783249E-02
0.7100000E+10	0.8901343E-03	-0.6812377	-0.6812378	0.4889847E-01
	0.4895567E-01	0.7304178	0.7304177	-0.2519664E-02

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.5378295E-01	0.9985490	0.9985489	0.5378321E-01
	-155.8069	-133.5544	-133.5544	68.69934
0.5400000E+10	0.3948508E-01	0.9992166	0.9992166	0.3948538E-01
	-164.9007	-139.5135	-139.5135	65.87495
0.5500000E+10	0.2780345E-01	0.9996098	0.9996096	0.2780381E-01
	-176.3888	-145.3177	-145.3177	65.75491
0.5600000E+10	0.1876129E-01	0.9998204	0.9998204	0.1876180E-01
	167.2513	-150.9866	-150.9866	70.77692
0.5700000E+10	0.1278646E-01	0.9999146	0.9999146	0.1278697E-01
	141.6723	-156.5367	-156.5367	85.25536
0.5800000E+10	0.1059040E-01	0.9999402	0.9999402	0.1059086E-01
	107.0734	-161.9817	-161.9817	108.9633
0.5900000E+10	0.1144494E-01	0.9999307	0.9999308	0.1144521E-01
	77.98431	-167.3337	-167.3337	127.3473
0.6000000E+10	0.1324359E-01	0.9999085	0.9999085	0.1324376E-01
	60.93069	-172.6028	-172.6028	133.8632
0.6100000E+10	0.1479255E-01	0.9998869	0.9998868	0.1479258E-01
	52.02914	-177.7980	-177.7980	132.3743
0.6200000E+10	0.1579247E-01	0.9998717	0.9998717	0.1579244E-01
	48.36391	177.0729	177.0729	125.7817
0.6300000E+10	0.1634979E-01	0.9998626	0.9998627	0.1634962E-01
	48.81501	172.0030	172.0030	115.1908
0.6400000E+10	0.1680928E-01	0.9998550	0.9998550	0.1680903E-01
	52.98362	166.9865	166.9865	100.9890
0.6500000E+10	0.1769159E-01	0.9998398	0.9998398	0.1769128E-01
	60.23698	162.0180	162.0180	83.79881
0.6600000E+10	0.1956201E-01	0.9998050	0.9998050	0.1956163E-01
	69.01734	157.0931	157.0931	65.16846
0.6700000E+10	0.2280736E-01	0.9997361	0.9997361	0.2280695E-01
	77.19794	152.2079	152.2079	47.21688
0.6800000E+10	0.2751633E-01	0.9996178	0.9996176	0.2751589E-01
	83.31911	147.3590	147.3590	31.39813
0.6900000E+10	0.3356840E-01	0.9994329	0.9994328	0.3356797E-01
	87.06495	142.5437	142.5437	18.02146
0.7000000E+10	0.4077725E-01	0.9991646	0.9991646	0.4077688E-01
	88.78168	137.7595	137.7595	6.736475
0.7100000E+10	0.4896376E-01	0.9987968	0.9987968	0.4896334E-01
	88.95834	133.0047	133.0047	-2.949756

lista de "toes" esperadas com transformador

=====

toe (1- 0.5300000E+10 Hz.) = 1.114 return loss = 25.387 dB

toe (2- 0.5400000E+10 Hz.) =	1.082	return loss =	28.071 dB
toe (3- 0.5500000E+10 Hz.) =	1.057	return loss =	31.118 dB
toe (4- 0.5600000E+10 Hz.) =	1.038	return loss =	34.535 dB
toe (5- 0.5700000E+10 Hz.) =	1.026	return loss =	37.865 dB
toe (6- 0.5800000E+10 Hz.) =	1.021	return loss =	39.502 dB
toe (7- 0.5900000E+10 Hz.) =	1.023	return loss =	38.828 dB
toe (8- 0.6000000E+10 Hz.) =	1.027	return loss =	37.560 dB
toe (9- 0.6100000E+10 Hz.) =	1.030	return loss =	36.599 dB
toe (10- 0.6200000E+10 Hz.) =	1.032	return loss =	36.031 dB
toe (11- 0.6300000E+10 Hz.) =	1.033	return loss =	35.730 dB
toe (12- 0.6400000E+10 Hz.) =	1.034	return loss =	35.489 dB
toe (13- 0.6500000E+10 Hz.) =	1.036	return loss =	35.045 dB
toe (14- 0.6600000E+10 Hz.) =	1.040	return loss =	34.172 dB
toe (15- 0.6700000E+10 Hz.) =	1.047	return loss =	32.838 dB
toe (16- 0.6800000E+10 Hz.) =	1.057	return loss =	31.208 dB
toe (17- 0.6900000E+10 Hz.) =	1.069	return loss =	29.481 dB
toe (18- 0.7000000E+10 Hz.) =	1.085	return loss =	27.792 dB
toe (19- 0.7100000E+10 Hz.) =	1.103	return loss =	26.202 dB

"toe" medio = 1.050 +/- 0.118

 traf o na o-ho moge neo otim izad o

dimensoes do transformador apos otimizacao
 =====

opcao a,b,c,l = 1101
 incremento (%) = 0.010
 const. final = 0.8327834E-06
 num. iteracoes = ***
 precisao <= 0.1000000E-05

os dados estao corretos ? (s ou n)

seccao 1
 dimensao a = 0.3557961E-01 metros
 dimensao b = 0.2272196E-01 metros
 dimensao c = 0.000000 metros
 comprimento l = 0.1104684E-01 metros

seccao 2
 dimensao a = 0.4000352E-01 metros
 dimensao b = 0.3227197E-01 metros
 dimensao c = 0.000000 metros
 comprimento l = 0.1491994E-01 metros

lista de impedancias esperadas com transformador

=====

nao normalz.	norm a z0(f1)	norm a z0(fn)	z0(fn)
--------------	---------------	---------------	--------

impedancia de normalizacao z0(f1) = 264.0553

real zin(1)=	260.7706	0.9875606	0.9875606	264.0553
imag.zin(1)=	-11.41264	-0.4322065E-01	-0.4322065E-01	
real zin(2)=	257.0413	0.9734374	0.9904764	259.5128
imag.zin(2)=	-6.777360	-0.2566644E-01	-0.2611571E-01	
real zin(3)=	254.0001	0.9619203	0.9944228	255.4247
imag.zin(3)=	-3.243086	-0.1228184E-01	-0.1269684E-01	

real zin(4)=	251.4563	0.9522867	0.9989266	251.7265
imag.zin(4)=	-0.6259161	-0.2370398E-02	-0.2486492E-02	
real zin(5)=	249.2518	0.9439378	1.003568	248.3656
imag.zin(5)=	1.220517	0.4622203E-02	0.4914196E-02	
real zin(6)=	247.2553	0.9363769	1.007978	245.2984
imag.zin(6)=	2.419259	0.9161941E-02	0.9862516E-02	
real zin(7)=	245.3575	0.9291897	1.011831	242.4885
imag.zin(7)=	3.079304	0.1166159E-01	0.1269876E-01	
real zin(8)=	243.4682	0.9220350	1.014850	239.9055
imag.zin(8)=	3.300883	0.1250073E-01	0.1375910E-01	
real zin(9)=	241.5153	0.9146391	1.016805	237.5236
imag.zin(9)=	3.178649	0.1203782E-01	0.1338246E-01	
real zin(10)=	239.4429	0.9067907	1.017517	235.3207
imag.zin(10)=	2.803102	0.1061559E-01	0.1191184E-01	
real zin(11)=	237.2115	0.8983402	1.016862	233.2779
imag.zin(11)=	2.261059	0.8562823E-02	0.9692555E-02	
real zin(12)=	234.7963	0.8891938	1.014770	231.3788
imag.zin(12)=	1.634989	0.6191843E-02	0.7066287E-02	
real zin(13)=	232.1871	0.8793125	1.011227	229.6093
imag.zin(13)=	1.002287	0.3795747E-02	0.4365186E-02	
real zin(14)=	229.3864	0.8687060	1.006271	227.9569
imag.zin(14)=	0.4340244	0.1643687E-02	0.1903975E-02	
real zin(15)=	226.4076	0.8574251	0.9999857	226.4109
imag.zin(15)=	-0.6274323E-02	-0.2376140E-04	-0.2771211E-04	
real zin(16)=	223.2741	0.8455582	0.9924990	224.9616
imag.zin(16)=	-0.2634356	-0.9976532E-03	-0.1171025E-02	
real zin(17)=	220.0163	0.8332206	0.9839703	223.6006
imag.zin(17)=	-0.2914474	-0.1103736E-02	-0.1303429E-02	
real zin(18)=	216.6703	0.8205490	0.9745861	222.3203
imag.zin(18)=	-0.5346895E-01	-0.2024915E-03	-0.2405041E-03	
real zin(19)=	213.2755	0.8076927	0.9645492	221.1142
imag.zin(19)=	0.4779775	0.1810142E-02	0.2161677E-02	

matriz "s" do transformador (real/imaginario)
 =====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	-0.5782929E-02	-0.3109531	-0.3109531	0.8265196E-02
	-0.2187151E-01	-0.9501526	-0.9501523	0.2105936E-01
0.5400000E+10	-0.4611802E-02	-0.3936984	-0.3936984	0.6358215E-02
	-0.1318095E-01	-0.9191302	-0.9191303	0.1243307E-01
0.5500000E+10	-0.2755760E-02	-0.4712750	-0.4712749	0.3774381E-02
	-0.6383763E-02	-0.8819553	-0.8819553	0.5839634E-02
0.5600000E+10	-0.5355543E-03	-0.5436285	-0.5436284	0.9159330E-03
	-0.1244665E-02	-0.8393213	-0.8393211	0.9984553E-03
0.5700000E+10	0.1786734E-02	-0.6107135	-0.6107135	-0.1914750E-02
	0.2448204E-02	-0.7918419	-0.7918420	-0.2349375E-02
0.5800000E+10	0.3997029E-02	-0.6724913	-0.6724914	-0.4488633E-02
	0.4891906E-02	-0.7400738	-0.7400740	-0.4445061E-02
0.5900000E+10	0.5920373E-02	-0.7289336	-0.7289336	-0.6634366E-02
	0.6274594E-02	-0.6845257	-0.6845257	-0.5514123E-02
0.6000000E+10	0.7416721E-02	-0.7800177	-0.7800177	-0.8226387E-02
	0.6778088E-02	-0.6256719	-0.6256720	-0.5768658E-02
0.6100000E+10	0.8376325E-02	-0.8257316	-0.8257315	-0.9176825E-02
	0.6579900E-02	-0.5639574	-0.5639573	-0.5407770E-02
0.6200000E+10	0.8717074E-02	-0.8660717	-0.8660718	-0.9429169E-02
	0.5852697E-02	-0.4998035	-0.4998035	-0.4618720E-02
0.6300000E+10	0.8383373E-02	-0.9010444	-0.9010443	-0.8954952E-02
	0.4765411E-02	-0.4336127	-0.4336127	-0.3577825E-02

0.6400000E+10	0.7343214E-02	-0.9306661	-0.9306662	-0.7748818E-02
	0.3481524E-02	-0.3657712	-0.3657713	-0.2449539E-02
0.6500000E+10	0.5586870E-02	-0.9549637	-0.9549639	-0.5826537E-02
	0.2158291E-02	-0.2966519	-0.2966520	-0.1386837E-02
0.6600000E+10	0.3126517E-02	-0.9739757	-0.9739758	-0.3223017E-02
	0.9460672E-03	-0.2266155	-0.2266154	-0.5310421E-03
0.6700000E+10	-0.7147224E-05	-0.9877520	-0.9877520	0.1104800E-04
	-0.1384948E-04	-0.1560126	-0.1560126	-0.1079228E-04
0.6800000E+10	-0.3764388E-02	-0.9963549	-0.9963550	0.3809823E-02
	-0.5899735E-03	-0.8518431E-01	-0.8518429E-01	0.5769421E-04
0.6900000E+10	-0.8079174E-02	-0.9998595	-0.9998595	0.8094875E-02
	-0.6622671E-03	-0.1446316E-01	-0.1446313E-01	-0.4282357E-03
0.7000000E+10	-0.1287044E-01	-0.9983544	-0.9983544	0.1277645E-01
	-0.1233539E-03	0.5582773E-01	0.5582768E-01	-0.1557537E-02
0.7100000E+10	-0.1804398E-01	-0.9919420	-0.9919420	0.1775520E-01
	0.1120198E-02	0.1253727	0.1253727	-0.3404560E-02

matriz "s" do transformador. (mod./fase)

=====

freq. (Hz)	s11	s12	s21	s22
0.5300000E+10	0.2262312E-01	0.9997408	0.9997406	0.2262322E-01
	-104.8103	-108.1215	-108.1215	68.57141
0.5400000E+10	0.1396446E-01	0.9998994	0.9998994	0.1396453E-01
	-109.2841	-113.1873	-113.1873	62.91501
0.5500000E+10	0.6953175E-02	0.9999726	0.9999726	0.6953221E-02
	-113.3490	-118.1179	-118.1179	57.12386
0.5600000E+10	0.1354994E-02	0.9999961	0.9999959	0.1354934E-02
	-113.2812	-122.9311	-122.9311	47.46828
0.5700000E+10	0.3030862E-02	0.9999923	0.9999924	0.3030814E-02
	53.87751	-127.6414	-127.6414	-129.1802
0.5800000E+10	0.6317198E-02	0.9999769	0.9999771	0.6317150E-02
	50.74878	-132.2608	-132.2608	-135.2794
0.5900000E+10	0.8626781E-02	0.9999598	0.9999598	0.8626724E-02
	46.66377	-136.7995	-136.7995	-140.2685
0.6000000E+10	0.1004740E-01	0.9999465	0.9999465	0.1004743E-01
	42.42397	-141.2660	-141.2660	-144.9604
0.6100000E+10	0.1065166E-01	0.9999403	0.9999401	0.1065167E-01
	38.15089	-145.6677	-145.6677	-149.4898
0.6200000E+10	0.1049959E-01	0.9999418	0.9999419	0.1049961E-01
	33.87766	-150.0111	-150.0111	-153.9028
0.6300000E+10	0.9643137E-02	0.9999505	0.9999504	0.9643235E-02
	29.61546	-154.3016	-154.3016	-158.2215
0.6400000E+10	0.8126734E-02	0.9999640	0.9999641	0.8126772E-02
	25.36631	-158.5441	-158.5441	-162.4573
0.6500000E+10	0.5989269E-02	0.9999790	0.9999792	0.5989312E-02
	21.12229	-162.7430	-162.7430	-166.6115
0.6600000E+10	0.3266520E-02	0.9999917	0.9999918	0.3266473E-02
	16.83553	-166.9020	-166.9020	-170.6437
0.6700000E+10	0.1558496E-04	0.9999970	0.9999970	0.1544447E-04
	-117.2967	-171.0244	-171.0244	-44.32917
0.6800000E+10	0.3810339E-02	0.9999897	0.9999898	0.3810260E-02
	-171.0928	-175.1133	-175.1133	0.8675946
0.6900000E+10	0.8106273E-02	0.9999641	0.9999641	0.8106194E-02
	-175.3138	-179.1713	-179.1713	-3.028243
0.7000000E+10	0.1287103E-01	0.9999142	0.9999142	0.1287103E-01
	-179.4509	176.7994	176.7994	-6.950456
0.7100000E+10	0.1807872E-01	0.9998336	0.9998336	0.1807866E-01
	176.4476	172.7965	172.7965	-10.85471

lista de "toes" esperadas com transformador

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toe (1- 0.5300000E+10 Hz.) =	1.046	return loss =	32.909 dB
toe (2- 0.5400000E+10 Hz.) =	1.028	return loss =	37.100 dB
toe (3- 0.5500000E+10 Hz.) =	1.014	return loss =	43.156 dB
toe (4- 0.5600000E+10 Hz.) =	1.003	return loss =	57.362 dB
toe (5- 0.5700000E+10 Hz.) =	1.006	return loss =	50.368 dB
toe (6- 0.5800000E+10 Hz.) =	1.013	return loss =	43.989 dB
toe (7- 0.5900000E+10 Hz.) =	1.017	return loss =	41.283 dB
toe (8- 0.6000000E+10 Hz.) =	1.020	return loss =	39.959 dB
toe (9- 0.6100000E+10 Hz.) =	1.022	return loss =	39.452 dB

toe (10- 0.6200000E+10 Hz.) =	1.021	return loss =	39.576 dB
toe (11- 0.6300000E+10 Hz.) =	1.019	return loss =	40.315 dB
toe (12- 0.6400000E+10 Hz.) =	1.016	return loss =	41.802 dB
toe (13- 0.6500000E+10 Hz.) =	1.012	return loss =	44.452 dB
toe (14- 0.6600000E+10 Hz.) =	1.007	return loss =	49.718 dB
toe (15- 0.6700000E+10 Hz.) =	1.000	return loss =	96.139 dB
toe (16- 0.6800000E+10 Hz.) =	1.008	return loss =	48.381 dB
toe (17- 0.6900000E+10 Hz.) =	1.016	return loss =	41.824 dB
toe (18- 0.7000000E+10 Hz.) =	1.026	return loss =	37.808 dB
toe (19- 0.7100000E+10 Hz.) =	1.037	return loss =	34.857 dB

"toe" medio = 1.017 +/- 0.049
