BBC

ENGINEERING DIVISION

MONOGRAPH

Tables of Horizontal Radiation Patterns of Dipoles Mounted on Cylinders

by

P. KNIGHT, B.A., A.M.I.E.E.

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BRITISH BROADCASTING CORPORATION

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FOREWORD

THIS is one of a series of Engineering Monographs published by the British Broadcasting Corporation. About six are produced every year, each dealing with a technical subject within the field of television and sound broadcasting. Each Monograph describes work that has been done by the Engineering Division of the BBC and includes, where appropriate, a survey of earlier work on the same subject. From time to time the series may include selected reprints of articles by BBC authors that have appeared in technical journals. Papers dealing with general engineering developments in broadcasting may also be included occasionally.

This series should be of interest and value to engineers engaged in the fields of broadcasting and of telecommunications generally.

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CONTENTS

PREVIOUS ISSUES IN THIS SERIES

TABLES OF HORIZONTAL RADIATION PATTERNS OF DIPOLES MOUNTED ON CYLINDERS

SUMMARY

This monograph contains tables of the horizontal radiation pattern (h.r.p.) of a dipole mounted on a cylindrical mast. The tables were calculated on a digital computer and this enabled a comprehensive range of mast sizes and dipole spacings to be covered.

1. Introduction

Aerials used for VHF broadcasting usually consist of tiers of dipoles mounted on a supporting mast. The number of dipoles in each tier and their relative positions and currents are determined by the required shape of the h.r.p. When an omnidirectional pattern is required, satisfactory results are generally obtained by using a number of dipoles uniformly spaced around the mast and fed symmetrically; in these cases it is convenient to calculate the pattern of the complete array, rather than that of an individual dipole. When a directional pattern is required, the procedure used in the theoretical design is to express the h.r.p. of a single dipole in the form of a complex number, the modulus corresponding to the amplitude of the radiated field and the argument to the phase referred to the axis of the mast. The h.r.p. of the arrangement of dipoles which seems most likely to satisfy the requirements is then calculated by adding the contributions from the individual dipoles. The result obtained will not necessarily be the most satisfactory h.r.p.; changes are therefore made to the dipole positions and currents and the calculation repeated until the best approximation to the required h.r.p. is obtained.

The calculation of the basic h.r.p. (that of a single dipole) is rather tedious, as it involves the summation of a complicated series of terms. A digital computer has, therefore, been used to assemble a library of such h.r.p.s, for dipoles having the three orientations shown in Fig. 1. Formulae for the radiation pattern of a doublet (i.e. a Hertzian dipole) mounted on a cylindrical mast have been derived by Carter,[1] and a brief description of his method, with notes on the application of his formulae to $\lambda/2$ dipoles, is contained in another paper.[2] Although cylindrical masts are not generally used by the BBC, the results obtained may be applied with little error to masts of other cross-sections provided their transverse dimensions are not too large.* Carter's formulae were used for the computations described in this monograph, approximations being made where necessary to obtain the result for dipoles rather than for doublets. The formulae and approximations used are described in the following section.

2. Horizontal Radiation Pattern Formulae

The formulae for the h.r.p. of a dipole and cylinder given in this section are normalized both in amplitude and phase to the maximum field radiated if the cylinder were removed

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* Carter's formulae may be used for square- and triangular-section masts having faces not exceeding $0\cdot5\lambda$ and $0\cdot3\lambda$ wide respectively. The radius of the equivalent cylinder for a face of width w is $0\cdot59w$ for masts of square section and $0\cdot42w$ for masts of triangular section.
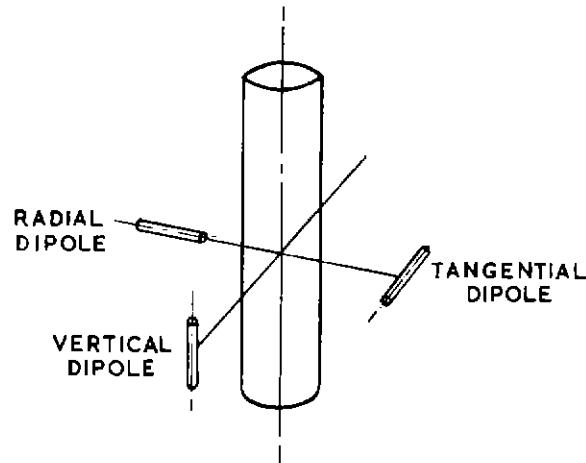
Fig. 1 — Types of dipoles

and the dipole replaced by a similarly oriented dipole, with its centre on the cylinder axis, carrying the same current. The symbols used in the formulae are defined as follows:

A = mast radius in radians

B = distance of dipole from axis of mast in radians

ϕ = azimuth angle, measured relative to the angular position of the centre of the dipole or unipole from the mast axis

$J_n(x)$ = Bessel function of the first kind, of order n and argument x

$Y_n(x)$ = Bessel function of the second kind, of order n and argument x

$H_n^{(2)}(x) = J_n(x) - jY_n(x)$ (Hankel function of the second kind, of order n and argument x)

$J_n'(x)$, $H_n^{(2)'}(x)$ denote the derivatives of $J_n(x)$, $H_n^{(2)}(x)$ with respect to x.

2.1 Vertical Dipoles

In the case of vertical elements, Carter's formula for a doublet is also applicable to a dipole. The series converges most rapidly when the contributions from the dipole and from the mast are calculated separately. The expression for the total field, stated in this form, is

$$E = e^{jB\cos\varphi} + M_o + 2\sum_{n=1}^{\infty} j^n M_n \cos n\phi$$

where $$M_n = -J_n(A)\frac{H_n^{(2)}(B)}{H_n^{(2)'}(A)}$$

2.2 *Tangential Dipoles*

Carter's formula for tangential doublets does not apply to tangential dipoles and some error will result if it is used. The error may be reduced by calculating the field radiated by the dipole directly; the doublet source is assumed only when calculating the contribution re-radiated by the mast. The appropriate formula for the total field is then

$$E = \frac{\cos(\frac{\pi}{2}\sin\phi)}{\cos\phi} e^{jB\cos\phi} - j\left[M_o' + 2\sum_{n=1}^{\infty} j^n M_n' \cos n\phi \right]$$

where
$$M_n' = -J_n'(A)\frac{H_n^{(2)'}(B)}{H_n^{(2)'}(A)}$$

This formula is similar to that used for vertical dipoles but the Bessel and Hankel functions are replaced by their derivatives.

2.3 *Radial Dipoles and Unipoles*

Arrays of radial elements used by the BBC have invariably employed unipoles (or an electrical equivalent) mounted on the surface of the mast. The effective length is generally only $\lambda/4$ and it is therefore permissible to replace them by radial doublets located at the centroid* of the current distribution;[3] this enables Carter's formula to be used with little error. The most rapidly convergent form of the expression is

$$E = \sin\phi\, e^{jB\cos\phi} - j\frac{2}{B}\sum_{n=1}^{\infty} j^n\, n\, Z_n \sin n\phi$$

where $\quad Z_n = -J_n'(A)\dfrac{H_n^{(2)}(B)}{H_n^{(2)'}(A)}$

3. Range of Values Computed

Radiation patterns were computed for cylinder radii in the range 0·25 (0·25) 2·0 (0·5) 6·0 radians; this covers all the sizes of masts likely to be encountered in the foreseeable future. The smallest size of cylinder (radius 0·25 radians) corresponds to a 1 ft 9 in. (0·53 m) diameter pole at 45 Mc/s. Although smaller supporting poles are sometimes used, their effect is easily calculated because only the first term in the series expansion in the formulae quoted in Section 2 is then significant. The upper limit to the mast radius (6·0 radians or 0·96λ) corresponds to a mast diameter of about 10 ft (3·1 m) in Band III and about 3 ft (0·91 m) in Band V. This limit lies well above the range of sizes for which a cylindrical mast may be assumed as equivalent to a square- or triangular-section mast; the tables for the larger values of mast radius can therefore only be

used for masts of circular, or nearly circular, cross-section.

For vertical and tangential dipoles, patterns were computed for dipoles spaced between 0·5 radians (0·08λ) and 4·0 radians (0·64λ) from the surface of the cylinder. For radial unipoles, patterns were computed for a doublet spacing of 0·5 radians only; this spacing corresponds very closely to the position of the current centroid of a $\lambda/4$ unipole. Calculations were made with these spacings for the chosen range of cylinder radii, making a total of 272 tables.

The real and imaginary components of the patterns are tabulated at 15° intervals in the range $0 \leqslant \phi \leqslant 180°$, the columns being headed R and I respectively. Tabulation for the remaining 180° was not necessary as the h.r.p.s are either symmetrical or skew-symmetrical (depending on the dipole orientation) with respect to the centre line. Each table is headed by V, T, or R (vertical, tangential, or radial) followed by the values of A and B.

The computer programme was arranged to work through the whole range of variables without a break, the changes in the parameters A and B being made automatically. As these two parameters between them cover only a small number of radial distances, it was found to be more convenient to feed tabulated Bessel functions into the computer rather than use a time-consuming sub-routine to calculate them. Bessel functions of the first and second kind, of zero and first order only, were stored in the computer; the higher order values were obtained from the recurrence formula, and their derivatives from the difference formula. Numerical values of $\cos\phi$ and $\sin\phi$ were also stored; only seven actual numbers were required, a special sub-routine being used to choose the appropriate value of $\cos\phi$ or $\sin\phi$ and give it the correct sign.

4. Conclusions

The tables of h.r.p.s should satisfy most requirements arising in the design of v.h.f. aerial systems for broadcast transmitters. Although applicable to cylindrical masts, they may be used with little error for masts of square or triangular cross-section provided the widths of the mast faces do not exceed 0·5λ and 0·3λ respectively. The tables are intended not merely to give the pattern of a single dipole but also to simplify the calculation of the patterns of arrangements of more than one dipole spaced around a mast; this is achieved by appropriate addition of the contributions of each dipole and an analogue computer[4] has been developed in the BBC Research Department to facilitate this operation.

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* We have to imagine that the unipole has a mass distributed along its length, the mass per unit length at any point being proportional to the current at that point. Then the centre of gravity (or centroid) of this mass would correspond to the centroid of the current distribution.

5. References

1. Carter, P. S. Antenna Arrays around Cylinders, Proc. I.R.E., Vol. 31, No. 12, p. 671, December 1943.

2. Knight, P. Methods of Calculating the Horizontal Radiation Patterns of Dipole Arrays Around a Support Mast, Proc. I.E.E., Vol. 105, Part B, No. 24, p. 548, December 1958.

3. Medhurst, R. G. Radiation from Short Aerials, Wireless Engineer, Vol. xxv, No. 299, p. 260, August 1948.

4. Page, H., Phillips, G. J., Fox, J. A. S. An Analogue Computer for Aerial Radiation Patterns, E.B.U. Review, Part A, No. 62, p. 146, August 1960.

NOTES ON THE USE OF THE TABLES

There are three sets of tables, for vertical and tangential dipoles and for radial unipoles. Each table is headed by the cylinder radius in radians (A) and the distance of the dipole or unipole from the cylinder axis, also in radians (B). The left-hand column of each table gives the angle ϕ between the direction of the observer and the position of the radiating element. The other columns, headed R and I, give the real and imaginary components of the horizontal radiation pattern, referred in phase to the cylinder axis. Values are not given for ϕ greater than 180° because the patterns are symmetrical about $\phi=0$ for vertical and tangential dipoles and skew-symmetrical (values equal in magnitude but opposite in sign) about $\phi=0$ for radial unipoles.

In order to minimize the possibility of errors, the lists of figures actually printed by the digital computer have been reproduced in these tables. This accounts for the variations in the standard of reproduction of the figures in some of the tables.

VERTICAL DIPOLE   CYLINDER RADIUS 0·25 RADIANS (0·04λ)

V A = 0.25 B = 0.75

	R	I
0	+0.182	+0.944
15	+0.199	+0.929
30	+0.249	+0.880
45	+0.319	+0.797
60	+0.391	+0.677
75	+0.448	+0.527
90	+0.474	+0.359
105	+0.462	+0.191
120	+0.419	+0.041
135	+0.358	-0.079
150	+0.297	-0.162
165	+0.253	-0.211
180	+0.237	-0.226

V A = 0.25 B = 1.25

	R	I
0	+0.060	+1.352
15	+0.102	+1.340
30	+0.219	+1.294
45	+0.391	+1.193
60	+0.577	+1.016
75	+0.724	+0.762
90	+0.787	+0.459
105	+0.747	+0.155
120	+0.621	-0.099
135	+0.454	-0.275
150	+0.296	-0.376
165	+0.187	-0.422
180	+0.149	-0.435

V A = 0.25 B = 1.75

	R	I
0	-0.192	+1.388
15	-0.131	+1.398
30	+0.048	+1.406
45	+0.328	+1.357
60	+0.652	+1.185
75	+0.923	+0.861
90	+1.037	+0.430
105	+0.950	-0.001
120	+0.704	-0.325
135	+0.402	-0.497
150	+0.138	-0.547
165	-0.031	-0.538
180	-0.088	-0.529

V A = 0.25 B = 2.25

	R	I
0	-0.462	+1.094
15	-0.399	+1.139
30	-0.196	+1.245
45	+0.160	+1.316
60	+0.622	+1.216
75	+1.038	+0.866
90	+1.216	+0.316
105	+1.064	-0.234
120	+0.672	-0.587
135	+0.231	-0.684
150	-0.109	-0.614
165	-0.302	-0.509
180	-0.362	-0.463

V A = 0.25 B = 2.75

	R	I
0	-0.654	+0.557
15	-0.612	+0.641
30	-0.449	+0.861
45	-0.083	+1.100
60	+0.485	+1.146
75	+1.057	+0.813
90	+1.310	+0.155
105	+1.078	-0.503
120	+0.525	-0.836
135	-0.026	-0.791
150	-0.379	-0.552
165	-0.535	-0.332
180	-0.573	-0.248

V A = 0.25 B = 3.25

	R	I
0	-0.698	-0.089
15	-0.703	+0.021
30	-0.648	+0.336
45	-0.362	+0.757
60	+0.253	+1.002
75	+0.980	+0.740
90	+1.319	-0.014
105	+0.992	-0.768
120	+0.277	-1.029
135	-0.329	-0.785
150	-0.607	-0.365
165	-0.658	-0.049
180	-0.651	+0.060

V A = 0.25 B = 3.75

	R	I
0	-0.571	-0.689
15	-0.637	-0.581
30	-0.744	-0.229
45	-0.631	+0.342
60	-0.048	+0.818
75	+0.818	+0.680
90	+1.254	-0.155
105	+0.820	-0.990
120	-0.043	-1.128
135	-0.625	-0.653
150	-0.736	-0.083
165	-0.628	+0.270
180	-0.562	+0.378

V A = 0.25 B = 4.25

	R	I
0	-0.295	-1.105
15	-0.420	-1.032
30	-0.708	-0.728
45	-0.843	-0.084
60	-0.381	+0.624
75	+0.596	+0.657
90	+1.139	-0.243
105	+0.589	-1.143
120	-0.594	-1.110
135	-0.861	-0.403
150	-0.730	+0.241
165	-0.444	+0.545
180	-0.320	+0.618

∞

VERTICAL DIPOLE   CYLINDER RADIUS 0·5 RADIANS (0·08λ)

V A = 0.5 B = 1.0

	R	I
0	-0.132	+0.935
15	-0.103	+0.926
30	-0.020	+0.892
45	+0.099	+0.824
60	+0.228	+0.711
75	+0.334	+0.554
90	+0.391	+0.369
105	+0.386	+0.185
120	+0.327	+0.027
135	+0.240	-0.087
150	+0.153	-0.157
165	+0.090	-0.192
180	+0.068	-0.202

V A = 0.5 B = 1.5

	R	I
0	-0.346	+1.344
15	-0.291	+1.345
30	-0.132	+1.332
45	+0.107	+1.269
60	+0.378	+1.112
75	+0.606	+0.849
90	+0.719	+0.513
105	+0.687	+0.176
120	+0.535	-0.089
135	+0.329	-0.248
150	+0.140	-0.314
165	+0.012	-0.328
180	-0.032	-0.328

V A = 0.5 B = 2.0

	R	I
0	-0.574	+1.344
15	-0.506	+1.373
30	-0.298	+1.432
45	+0.044	+1.445
60	+0.462	+1.314
75	+0.831	+0.985
90	+1.008	+0.507
105	+0.924	+0.029
120	+0.641	-0.304
135	+0.297	-0.438
150	+0.013	-0.429
165	-0.160	-0.373
180	-0.215	-0.345

V A = 0.5 B = 2.5

	R	I
0	-0.732	+1.002
15	-0.673	+1.068
30	-0.470	+1.232
45	-0.082	+1.383
60	+0.462	+1.350
75	+0.983	+1.000
90	+1.228	+0.393
105	+1.070	-0.216
120	+0.629	-0.569
135	+0.155	-0.607
150	-0.181	-0.461
165	-0.350	-0.301
180	-0.398	-0.236

V A = 0.5 B = 3.0

	R	I
0	-0.756	+0.429
15	-0.732	+0.527
30	-0.606	+0.796
45	-0.254	+1.120
60	+0.365	+1.250
75	+1.037	+0.935
90	+1.356	+0.213
105	+1.103	-0.511
120	+0.491	-0.831
135	-0.076	-0.706
150	-0.388	-0.387
165	-0.489	-0.122
180	-0.504	-0.026

V A = 0.5 B = 3.5

	R	I
0	-0.619	-0.224
15	-0.652	-0.114
30	-0.667	+0.223
45	-0.449	+0.714
60	+0.173	+1.056
75	+0.984	+0.831
90	+1.384	+0.012
105	+1.018	-0.807
120	+0.238	-1.036
135	-0.356	-0.699
150	-0.554	-0.213
165	-0.525	+0.120
180	-0.488	+0.229

V A = 0.5 B = 4.0

	R	I
0	-0.338	-0.797
15	-0.434	-0.705
30	-0.632	-0.373
45	-0.633	+0.233
60	-0.097	+0.809
75	+0.830	+0.730
90	+1.320	-0.163
105	+0.830	-1.058
120	-0.097	-1.140
135	-0.634	-0.568
150	-0.632	+0.034
165	-0.435	+0.363
180	-0.338	+0.454

V A = 0.5 B = 4.5

	R	I
0	+0.030	-1.154
15	-0.118	-1.114
30	-0.493	-0.876
45	-0.772	-0.247
60	-0.411	+0.551
75	+0.600	+0.666
90	+1.190	-0.281
105	+0.570	-1.228
120	-0.469	-1.114
135	-0.854	-0.320
150	-0.594	+0.307
165	-0.231	+0.544
180	-0.086	+0.583

6

10

V A = 0·75 B = 1·25

	R	I
0	-0.403	+0.841
15	-0.365	+0.842
30	-0.255	+0.835
45	-0.090	+0.799
60	+0.095	+0.708
75	+0.256	+0.555
90	+0.349	+0.359
105	+0.354	+0.162
120	+0.285	+0.003
135	+0.178	-0.095
150	+0.074	-0.139
165	+0.002	-0.150
180	-0.024	-0.151

V A = 0·75 B = 1·75

	R	I
0	-0.726	+1.211
15	-0.662	+1.231
30	-0.472	+1.267
45	-0.172	+1.263
60	+0.184	+1.148
75	+0.500	+0.889
90	+0.673	+0.525
105	+0.655	+0.157
120	+0.483	-0.112
135	+0.251	-0.240
150	+0.046	-0.259
165	-0.085	-0.233
180	-0.128	-0.217

V A = 0·75 B = 2·25

	R	I
0	-0.939	+1.184
15	-0.670	+1.236
30	-0.648	+1.357
45	-0.259	+1.452
60	+0.249	+1.384
75	+0.725	+1.062
90	+0.974	+0.540
105	+0.900	+0.013
120	+0.587	-0.323
135	+0.218	-0.412
150	-0.064	-0.337
165	-0.219	-0.230
180	-0.266	-0.184

V A = 0·75 B = 2·75

	R	I
0	-0.988	+0.833
15	-0.939	+0.919
30	-0.755	+1.143
45	-0.353	+1.386
60	+0.263	+1.435
75	+0.894	+1.101
90	+1.215	+0.436
105	+1.054	-0.236
120	+0.571	-0.587
135	+0.082	-0.562
150	-0.222	-0.342
165	-0.346	-0.135
180	-0.373	-0.056

V A = 0·75 B = 3·25

	R	I
0	-0.844	+0.278
15	-0.843	+0.386
30	-0.769	+0.695
45	-0.454	+1.104
60	+0.201	+1.330
75	+0.975	+1.043
90	+1.366	+0.254
105	+1.091	-0.541
120	+0.425	-0.846
135	-0.138	-0.645
150	-0.383	-0.260
165	-0.413	+0.031
180	-0.399	+0.132

V A = 0·75 B = 3·75

	R	I
0	-0.526	-0.327
15	-0.588	-0.223
30	-0.684	+0.116
45	-0.552	+0.664
60	+0.055	+1.108
75	+0.948	+0.928
90	+1.411	+0.043
105	+1.003	-0.849
120	+0.161	-1.044
135	-0.403	-0.622
150	-0.502	-0.096
165	-0.387	+0.228
180	-0.318	+0.326

V A = 0·75 B = 4·25

	R	I
0	-0.096	-0.828
15	-0.219	-0.761
30	-0.504	-0.472
45	-0.633	+0.145
60	-0.167	+0.816
75	+0.814	+0.802
90	+1.357	-0.151
105	+0.803	-1.108
120	-0.186	-1.133
135	-0.662	-0.478
150	-0.541	+0.124
165	-0.261	+0.401
180	-0.139	+0.465

V A = 0·75 B = 4·75

	R	I
0	+0.357	-1.103
15	+0.193	-1.102
30	-0.253	-0.953
45	-0.678	-0.370
60	-0.439	+0.502
75	+0.592	+0.705
90	+1.226	-0.287
105	+0.526	-1.281
120	-0.566	-1.083
135	-0.858	-0.219
150	-0.475	+0.357
165	-0.055	+0.501
180	+0.099	+0.500

V
A = 1.0 B = 1.5

	R	I
0	-0.626	+0.686
15	-0.583	+0.701
30	-0.455	+0.733
45	-0.256	+0.743
60	-0.022	+0.688
75	+0.190	+0.547
90	+0.319	+0.342
105	+0.335	+0.131
120	+0.258	-0.026
135	+0.138	-0.104
150	+0.027	-0.118
165	-0.045	-0.103
180	-0.069	-0.094

V
A = 1.0 B = 2.0

	R	I
0	-1.047	+0.983
15	-0.982	+1.025
30	-0.777	+1.124
45	-0.436	+1.199
60	-0.005	+1.149
75	+0.398	+0.909
90	+0.632	+0.521
105	+0.628	+0.122
120	+0.439	-0.150
135	+0.190	-0.243
150	-0.012	-0.210
165	-0.129	-0.143
180	-0.166	-0.112

V
A = 1.0 B = 2.5

	R	I
0	-1.247	+0.928
15	-1.184	+1.004
30	-0.969	+1.197
45	-0.556	+1.393
60	+0.029	+1.413
75	+0.610	+1.117
90	+0.934	+0.555
105	+0.869	-0.022
120	+0.527	-0.360
135	+0.147	-0.399
150	-0.111	-0.261
165	-0.229	-0.111
180	-0.259	-0.050

V
A = 1.0 B = 3.0

	R	I
0	-1.194	+0.595
15	-1.163	+0.699
30	-1.015	+0.985
45	-0.626	+1.332
60	+0.046	+1.485
75	+0.787	+1.186
90	+1.187	+0.467
105	+1.021	-0.269
120	+0.496	-0.617
135	+0.008	-0.529
150	-0.242	-0.248
165	-0.304	-0.010
180	-0.305	+0.077

V
A = 1.0 B = 3.5

	R	I
0	-0.897	+0.102
15	-0.922	+0.214
30	-0.914	+0.555
45	-0.657	+1.048
60	+0.016	+1.386
75	+0.889	+1.144
90	+1.355	+0.294
105	+1.056	-0.574
120	+0.336	-0.862
135	-0.207	-0.588
150	-0.368	-0.159
165	-0.317	+0.135
180	-0.272	+0.230

V
A = 1.0 B = 4.0

	R	I
0	-0.419	-0.407
15	-0.508	-0.318
30	-0.685	+0.008
45	-0.655	+0.599
60	-0.080	+1.149
75	+0.890	+1.029
90	+1.420	+0.081
105	+0.964	-0.881
120	+0.061	-1.039
135	-0.460	-0.542
150	-0.451	-0.003
165	-0.251	+0.284
180	-0.154	+0.359

V
A = 1.0 B = 4.5

	R	I
0	+0.140	-0.798
15	-0.004	-0.762
30	-0.366	-0.539
45	-0.625	+0.065
60	-0.244	+0.823
75	+0.783	+0.887
90	+1.382	-0.122
105	+0.760	-1.141
120	-0.291	-1.101
135	-0.696	-0.376
150	-0.457	+0.194
165	-0.110	+0.393
180	+0.029	+0.420

V
A = 1.0 B = 5.0

	R	I
0	+0.655	-0.970
15	+0.487	-1.012
30	-0.007	-0.971
45	-0.567	-0.466
60	-0.463	+0.462
75	+0.580	+0.761
90	+1.261	-0.374
105	+0.475	-1.312
120	-0.668	-1.021
135	-0.859	-0.102
150	-0.369	+0.392
165	+0.080	+0.426
180	+0.232	+0.381

11

VERTICAL DIPOLE

CYLINDER RADIUS 1·25 RADIANS (0·20λ)

V
A = 1.25   B = 1.75

	R	I
0	-0.789	+0.486
15	-0.747	+0.517
30	-0.617	+0.594
45	-0.400	+0.662
60	-0.127	+0.657
75	+0.132	+0.538
90	+0.294	+0.326
105	+0.318	+0.101
120	+0.231	-0.057
135	+0.104	-0.114
150	-0.002	-0.097
165	-0.064	-0.059
180	-0.083	-0.042

V
A = 1.25   B = 2.25

	R	I
0	-1.288	+0.677
15	-1.228	+0.745
30	-1.032	+0.915
45	-0.673	+1.088
60	-0.184	+1.124
75	+0.300	+0.920
90	+0.592	+0.514
105	+0.598	+0.082
120	+0.391	-0.191
135	+0.134	-0.249
150	-0.050	-0.169
165	-0.138	-0.067
180	-0.161	-0.025

V
A = 1.25   B = 2.75

	R	I
0	-1.473	+0.592
15	-1.425	+0.694
30	-1.240	+0.963
45	-0.831	+1.276
60	-0.189	+1.408
75	+0.493	+1.160
90	+0.891	+0.566
105	+0.830	-0.061
120	+0.458	-0.399
135	+0.076	-0.389
150	-0.140	-0.198
165	-0.207	-0.018
180	-0.214	+0.050

V
A = 1.25   B = 3.25

	R	I
0	-1.332	+0.300
15	-1.326	+0.420
30	-1.234	+0.763
45	-0.884	+1.221
60	-0.175	+1.502
75	+0.671	+1.260
90	+1.152	+0.496
105	+0.976	-0.303
120	+0.408	-0.642
135	-0.070	-0.495
150	-0.250	-0.170
165	-0.240	+0.077
180	-0.213	+0.161

V
A = 1.25   B = 3.75

	R	I
0	-0.909	-0.093
15	-0.962	+0.018
30	-1.029	+0.376
45	-0.850	+0.949
60	-0.178	+1.413
75	+0.792	+1.239
90	+1.338	+0.335
105	+1.008	-0.601
120	+0.234	-0.866
135	-0.281	-0.526
150	-0.348	-0.076
165	-0.216	+0.193
180	-0.142	+0.271

V
A = 1.25   B = 4.25

	R	I
0	-0.303	-0.466
15	-0.416	-0.397
30	-0.670	-0.106
45	-0.751	+0.511
60	-0.224	+1.171
75	+0.821	+1.129
90	+1.424	+0.126
105	+0.916	-0.904
120	-0.048	-1.015
135	-0.516	-0.450
150	-0.399	+0.072
165	-0.128	+0.295
180	-0.010	+0.339

V
A = 1.25   B = 4.75

	R	I
0	+0.350	-0.712
15	+0.195	-0.714
30	-0.225	-0.576
45	-0.610	-0.014
60	-0.328	+0.822
75	+0.743	+0.975
90	+1.405	-0.085
105	+0.711	-1.159
120	-0.397	-1.046
135	-0.722	-0.261
150	-0.377	+0.249
165	+0.012	+0.350
180	+0.155	+0.334

V
A = 1.25   B = 5.25

	R	I
0	+0.901	-0.763
15	+0.742	-0.851
30	+0.229	-0.933
45	-0.447	-0.539
60	-0.486	+0.424
75	+0.564	+0.821
90	+1.298	-0.253
105	+0.425	-1.327
120	-0.760	-0.934
135	-0.845	+0.025
150	-0.270	+0.416
165	+0.175	+0.332
180	+0.310	+0.244

VERTICAL DIPOLE.   CYLINDER RADIUS 1·5 RADIANS (0·24λ)

V A = 1.5 B = 2.0	R	I		V A = 1.5 B = 2.5	R	I
0	-0.890	+0.253		0	-1.435	+0.318
15	-0.855	+0.302		15	-1.391	+0.410
30	-0.737	+0.427		30	-1.225	+0.653
45	-0.520	+0.562		45	-0.876	+0.936
60	-0.221	+0.617		60	-0.349	+1.077
75	+0.079	+0.528		75	+0.208	+0.926
90	+0.272	+0.314		90	+0.557	+0.508
105	+0.301	+0.074		105	+0.568	+0.045
120	+0.203	-0.084		120	+0.338	-0.227
135	+0.072	-0.121		135	+0.079	-0.251
150	-0.022	-0.080		150	-0.075	-0.132
165	-0.065	-0.023		165	-0.124	-0.009
180	-0.075	+0.000		180	-0.130	+0.039

V A = 1.5 B = 3.0	R	I		V A = 1.5 B = 3.5	R	I
0	-1.602	+0.203		0	-1.393	-0.031
15	-1.578	+0.326		15	-1.415	+0.099
30	-1.447	+0.668		30	-1.397	+0.489
45	-1.072	+1.105		45	-1.114	+1.058
60	-0.397	+1.372		60	-0.393	+1.483
75	+0.379	+1.193		75	+0.554	+1.323
90	+0.851	+0.576		90	+1.119	+0.525
105	+0.789	-0.097		105	+0.928	-0.332
120	+0.382	-0.430		120	+0.313	-0.656
135	+0.004	-0.373		135	-0.147	-0.452
150	-0.158	-0.145		150	-0.250	-0.103
165	-0.165	+0.045		165	-0.168	+0.128
180	-0.148	+0.113		180	-0.113	+0.199

V A = 1.5 B = 4.0	R	I		V A = 1.5 B = 4.5	R	I
0	-0.878	-0.295		0	-0.185	0.500
15	-0.958	-0.193		15	-0.316	-0.459
30	-1.105	+0.168		30	-0.638	-0.220
45	-1.024	+0.808		45	-0.836	+0.401
60	-0.374	+1.408		60	-0.373	+1.169
75	+0.689	+1.322		75	+0.744	+1.221
90	+1.320	+0.376		90	+1.427	+0.170
105	+0.958	-0.623		105	+0.866	-0.919
120	+0.128	-0.854		120	-0.155	-0.972
135	-0.350	-0.451		135	-0.562	-0.346
150	-0.323	-0.005		150	-0.347	+0.136
165	-0.120	+0.213		165	-0.025	+0.274
180	-0.024	+0.264		180	+0.102	+0.279

V A = 1.5 B = 5.0	R	I		V A = 1.5 B = 5.5	R	I
0	+0.522	-0.578		0	+1.079	-0.499
15	+0.367	-0.621		15	+0.942	-0.631
30	-0.089	-0.584		30	+0.443	-0.843
45	-0.590	-0.093		45	-0.325	-0.589
60	-0.416	+0.808		60	-0.510	+0.383
75	+0.696	+1.058		75	+0.542	+0.880
90	+1.428	-0.047		90	+1.336	-0.230
105	+0.663	-1.170		105	+0.379	-1.336
120	-0.495	-0.970		120	-0.836	-0.830
135	-0.732	-0.135		135	-0.808	+0.157
150	-0.300	+0.293		150	-0.176	+0.429
165	+0.101	+0.285		165	+0.230	+0.231
180	+0.234	+0.226		180	+0.334	+0.105

V A = 1·75 B = 2·25

	R	I
0	-0.925	+0.007
15	-0.902	+0.071
30	-0.812	+0.241
45	-0.614	+0.444
60	-0.304	+0.568
75	+0.032	+0.518
90	+0.255	+0.304
105	+0.284	+0.051
120	+0.173	-0.105
135	+0.041	-0.124
150	-0.035	-0.063
165	-0.056	+0.002
180	-0.056	+0.028

V A = 1·75 B = 2·75

	R	I
0	-1.482	-0.068
15	-1.461	+0.045
30	-1.350	+0.355
45	-1.042	+0.749
60	-0.499	+1.009
75	+0.123	+0.926
90	+0.527	+0.503
105	+0.538	+0.013
120	+0.282	-0.255
135	+0.024	-0.244
150	-0.092	-0.099
165	-0.098	+0.030
180	-0.085	+0.077

V A = 1·75 B = 3·25

	R	I
0	-1.625	-0.212
15	-1.633	-0.073
30	-1.579	+0.330
45	-1.274	+0.889
60	-0.591	+1.305
75	+0.270	+1.214
90	+0.817	+0.586
105	+0.749	-0.128
120	+0.303	-0.449
135	-0.065	-0.346
150	-0.168	-0.096
165	-0.116	+0.083
180	-0.076	+0.140

V A = 1·75 B = 3·75

	R	I
0	-1.368	-0.374
15	-1.423	-0.242
30	-1.495	+0.178
45	-1.309	+0.847
60	-0.603	+1.429
75	+0.438	+1.369
90	+1.090	+0.550
105	+0.882	-0.358
120	+0.218	-0.655
135	-0.218	-0.395
150	-0.244	-0.043
165	-0.098	+0.148
180	-0.022	+0.197

V A = 1·75 B = 4·25

	R	I
0	-0.799	-0.490
15	-0.906	-0.403
30	-1.137	-0.061
45	-1.172	+0.630
60	-0.568	+1.369
75	+0.582	+1.391
90	+1.305	+0.413
105	+0.909	-0.641
120	+0.026	-0.825
135	-0.407	-0.363
150	-0.293	+0.057
165	-0.039	+0.205
180	+0.069	+0.221

V A = 1·75 B = 4·75

	R	I
0	-0.068	-0.509
15	-0.209	-0.499
30	-0.589	-0.330
45	-0.906	+0.271
60	-0.527	+1.140
75	+0.658	+1.300
90	+1.430	+0.211
105	+0.818	-0.931
120	-0.253	-0.913
135	-0.591	-0.231
150	-0.291	+0.189
165	+0.052	+0.231
180	+0.176	+0.194

V A = 1·75 B = 5·25

	R	I
0	+0.648	-0.407
15	+0.504	-0.491
30	+0.038	-0.565
45	-0.564	-0.170
60	-0.510	+0.778
75	+0.637	+1.133
90	+1.450	-0.012
105	+0.617	-1.179
120	-0.578	-0.882
135	-0.718	-0.006
150	-0.221	+0.325
165	+0.158	+0.209
180	+0.267	+0.110

V A = 1·75 B = 5·75

	R	I
0	+1.181	-0.195
15	+1.076	-0.366
30	+0.624	-0.707
45	-0.204	-0.615
60	-0.537	+0.339
75	+0.509	+0.937
90	+1.371	-0.209
105	+0.334	-1.344
120	-0.894	-0.717
135	-0.745	+0.284
150	-0.083	+0.430
165	+0.251	+0.134
180	+0.312	-0.020

VERTICAL DIPOLE   CYLINDER RADIUS 2·0 RADIANS (0·32λ)

V A = 2.0 B = 2.5		V A = 2.0 B = 3.0		V A = 2.0 B = 3.5		V A = 2.0 B = 4.0	
R	I	R	I	R	I	R	I
0		0		0		0	
-0.894	-0.236	-1.425	-0.451	-1.538	-0.622	-1.256	-0.705
15 -0.890	-0.161	15 -1.436	-0.325	15 -1.585	-0.476	15 -1.347	-0.580
30 -0.843	+0.045	30 -1.402	+0.038	30 -1.630	-0.032	30 -1.521	-0.152
45 -0.682	+0.314	45 -1.167	+0.535	45 -1.429	+0.637	45 -1.461	+0.600
60 -0.375	+0.511	60 -0.634	+0.922	60 -0.771	+1.210	60 -0.802	+1.342
75 -0.010	+0.507	75 +0.045	+0.919	75 +0.166	+1.225	75 +0.322	+1.403
90 +0.240	+0.296	90 +0.503	+0.499	90 +0.789	+0.593	90 +1.065	+0.570
105 +0.270	+0.031	105 +0.512	-0.015	105 +0.712	-0.156	105 +0.839	-0.382
120 +0.144	-0.120	120 +0.227	-0.272	120 +0.228	-0.456	120 +0.129	-0.642
135 +0.010	-0.121	135 -0.028	-0.288	135 -0.127	-0.306	135 -0.276	-0.327
150 -0.046	-0.047	150 -0.104	-0.068	150 -0.171	-0.050	150 -0.230	+0.012
165 -0.042	+0.019	165 -0.067	+0.052	165 -0.068	+0.099	165 -0.037	+0.146
180 -0.032	+0.042	180 -0.038	+0.091	180 -0.010	+0.138	180 +0.051	+0.165

V A = 2.0 B = 4.5		V A = 2.0 B = 5.0		V A = 2.0 B = 5.5		V A = 2.0 B = 6.0	
R	I	R	I	R	I	R	I
0 -0.675	-0.665	0 +0.045	-0.493	0 +0.723	-0.212	0 +1.198	+0.124
15 -0.805	-0.601	15 -0.100	-0.518	15 +0.602	-0.334	15 +1.138	-0.077
30 -1.120	-0.297	30 -0.521	-0.433	30 +0.152	-0.522	30 +0.766	-0.534
45 -1.288	+0.421	45 -0.956	+0.125	45 -0.533	-0.243	45 -0.088	-0.618
60 -0.758	+1.299	60 -0.680	+1.086	60 -0.607	+0.734	60 -0.566	+0.294
75 +0.469	+1.446	75 +0.563	+1.368	75 +0.567	+1.201	75 +0.464	+0.991
90 +1.291	+0.444	90 +1.431	+0.246	90 +1.468	+0.019	90 +1.402	-0.189
105 +0.863	-0.659	105 +0.772	-0.944	105 +0.572	-1.189	105 +0.287	-1.353
120 -0.067	-0.785	120 -0.339	-0.844	120 -0.646	-0.787	120 -0.935	-0.603
135 -0.447	-0.265	135 -0.597	-0.113	135 -0.680	+0.119	135 -0.659	+0.397
150 -0.256	+0.112	150 -0.230	+0.233	150 -0.140	+0.346	150 +0.007	+0.418
165 +0.024	+0.177	165 +0.104	+0.176	165 +0.185	+0.133	165 +0.244	+0.049
180 +0.132	+0.156	180 +0.210	+0.101	180 +0.258	+0.003	180 +0.255	-0.118

16

V
A = 2.5   B = 3.0

	R	I
0	-0.656	-0.653
15	-0.698	-0.574
30	-0.772	-0.332
45	-0.740	+0.036
60	-0.489	+0.378
75	-0.035	+0.478
90	+0.220	+0.282
105	+0.247	-0.002
120	+0.090	-0.135
135	-0.039	-0.096
150	-0.054	-0.014
165	-0.013	+0.029
180	+0.010	+0.038

V
A = 2.5   B = 3.5

	R	I
0	-1.028	-1.111
15	-1.116	-0.987
30	-1.286	-0.587
45	-1.283	+0.063
60	-0.854	+0.702
75	-0.099	+0.889
90	+0.466	+0.488
105	+0.468	-0.065
120	+0.128	-0.283
135	-0.108	-0.168
150	-0.108	-0.005
165	-0.012	+0.059
180	+0.035	+0.066

V
A = 2.5   B = 4.0

	R	I
0	-1.064	-1.318
15	-1.196	-1.192
30	-1.482	-0.747
45	-1.532	+0.069
60	-1.076	+0.950
75	-0.035	+1.216
90	+0.742	+0.597
105	+0.649	-0.211
120	+0.094	-0.444
135	-0.214	-0.198
150	-0.153	+0.035
165	+0.007	+0.086
180	+0.075	+0.075

V
A = 2.5   B = 4.5

	R	I
0	-0.793	-1.245
15	-0.953	-1.163
30	-1.349	-0.800
45	-1.615	+0.034
60	-1.153	+1.085
75	+0.088	+1.431
90	+1.020	+0.596
105	+0.760	-0.432
120	-0.024	-0.590
135	-0.341	-0.167
150	-0.176	+0.106
165	+0.044	+0.102
180	+0.122	+0.058

V
A = 2.5   B = 5.0

	R	I
0	-0.312	-0.914
15	-0.472	-0.913
30	-0.932	-0.746
45	-1.398	-0.054
60	-1.104	+1.076
75	+0.231	+1.516
90	+1.259	+0.490
105	+0.773	-0.701
120	-0.222	-0.684
135	-0.461	-0.064
150	-0.158	+0.196
165	+0.093	+0.096
180	+0.161	+0.011

V
A = 2.5   B = 5.5

	R	I
0	+0.239	-0.398
15	+0.116	-0.492
30	-0.329	-0.597
45	-0.981	-0.197
60	-0.970	+0.911
75	+0.348	+1.471
90	+1.423	+0.303
105	+0.675	-0.976
120	-0.474	-0.693
135	-0.538	+0.108
150	-0.091	+0.283
165	+0.141	+0.064
180	+0.176	-0.061

V
A = 2.5   B = 6.0

	R	I
0	+0.711	+0.189
15	+0.663	+0.012
30	+0.331	-0.380
45	-0.443	-0.378
60	-0.795	+0.604
75	+0.395	+1.317
90	+1.487	+0.075
105	+0.470	-1.212
120	-0.743	-0.593
135	-0.537	+0.327
150	+0.025	+0.341
165	+0.175	+0.004
180	+0.152	-0.143

V
A = 2.5   B = 6.5

	R	I
0	+0.984	+0.720
15	+1.036	+0.497
30	+0.911	-0.125
45	+0.123	-0.567
60	-0.624	+0.195
75	+0.347	+1.096
90	+1.444	-0.148
105	+0.180	-1.368
120	-0.980	-0.379
135	-0.434	+0.555
150	+0.174	+0.344
165	+0.179	-0.073
180	+0.086	-0.213

VERTICAL DIPOLE   **CYLINDER RADIUS 3·0 RADIANS (0·48λ)**

V A = 3·0 B = 3·5	R	I	V A = 3·0 B = 4·0	R	I	V A = 3·0 B = 4·5	R	I	V A = 3·0 B = 5·0	R	I
0	-0.246	-0.894	0	-0.354	-1.488	0	-0.298	-1.696	0	-0.111	-1.502
15	-0.336	-0.839	15	-0.515	-1.412	15	-0.502	-1.640	15	-0.316	-1.502
30	-0.546	-0.635	30	-0.908	-1.095	30	-1.031	-1.330	30	-0.903	-1.321
45	-0.695	-0.236	45	-1.217	-0.411	45	-1.512	-0.514	45	-1.547	-0.555
60	-0.562	+0.227	60	-1.003	+0.439	60	-1.294	+0.623	60	-1.416	+0.742
75	-0.150	+0.443	75	-0.230	+0.841	75	-0.224	+1.177	75	-0.142	+1.420
90	+0.205	+0.269	90	+0.436	+0.475	90	+0.701	+0.594	90	+0.975	+0.611
105	+0.226	-0.031	105	+0.427	-0.114	105	+0.586	-0.267	105	+0.678	-0.486
120	+0.044	-0.136	120	+0.045	-0.275	120	-0.016	-0.411	120	-0.149	-0.520
135	-0.066	-0.059	135	-0.146	-0.091	135	-0.241	-0.080	135	-0.334	-0.015
150	-0.047	+0.016	150	-0.083	+0.047	150	-0.101	+0.099	150	-0.088	+0.163
165	+0.006	+0.022	165	+0.020	+0.040	165	+0.043	+0.049	165	+0.072	+0.043
180	+0.028	+0.012	180	+0.057	+0.012	180	+0.084	-0.005	180	+0.100	-0.041

V A = 3·0 B = 5·5	R	I	V A = 3·0 B = 6·0	R	I	V A = 3·0 B = 6·5	R	I	V A = 3·0 B = 7·0	R	I
0	+0.140	-0.972	0	+0.369	-0.240	0	+0.503	+0.518	0	+0.497	+1.123
15	-0.020	-1.048	15	+0.299	-0.387	15	+0.551	+0.329	15	+0.665	+0.945
30	-0.560	-1.087	30	-0.081	-0.685	30	+0.428	-0.194	30	+0.857	+0.294
45	-1.324	-0.552	45	-0.889	-0.525	45	-0.318	-0.491	45	+0.290	-0.458
60	-1.378	+0.760	60	-1.207	+0.654	60	-0.953	+0.419	60	-0.669	+0.077
75	-0.015	+1.543	75	+0.114	+1.535	75	+0.199	+1.405	75	+0.203	+1.186
90	+1.222	+0.525	90	+1.403	+0.353	90	+1.491	+0.131	90	+1.473	-0.099
105	+0.675	-0.746	105	+0.564	-1.007	105	+0.350	-1.227	105	+0.056	-1.365
120	-0.343	-0.571	120	-0.574	-0.536	120	-0.804	-0.399	120	-0.988	-0.161
135	-0.399	+0.106	135	-0.409	+0.270	135	-0.342	+0.450	135	-0.189	+0.610
150	-0.037	+0.226	150	+0.053	+0.267	150	+0.170	+0.265	150	+0.291	+0.205
165	+0.101	+0.020	165	+0.119	-0.030	165	+0.117	-0.072	165	+0.089	-0.125
180	+0.096	-0.088	180	+0.065	-0.137	180	+0.007	-0.172	180	-0.070	-0.177

VERTICAL DIPOLE   CYLINDER RADIUS 3·5 RADIANS (0·56λ)

V
A = 3·5 B = 4·0

	R	I
0	+0.226	−0.900
15	+0.106	−0.898
30	−0.215	−0.807
45	−0.557	−0.469
60	−0.592	+0.068
75	−0.208	+0.404
90	+0.192	+0.258
105	+0.205	−0.058
120	+0.005	−0.130
135	−0.073	−0.021
150	−0.026	+0.035
165	+0.014	+0.011
180	+0.021	−0.011

V
A = 3·5 B = 4·5

	R	I
0	+0.422	−1.434
15	+0.219	−1.499
30	−0.347	−1.387
45	−0.986	−0.824
60	−1.075	+0.154
75	−0.346	+0.780
90	+0.410	+0.463
105	+0.383	−0.158
120	−0.026	−0.254
135	−0.148	−0.019
150	−0.038	+0.077
165	+0.031	+0.016
180	+0.037	−0.028

V
A = 3·5 B = 5·0

	R	I
0	+0.566	−1.651
15	+0.331	−1.705
30	−0.366	−1.662
45	−1.234	−1.032
60	−1.412	+0.254
75	−0.396	+1.114
90	+0.664	+0.591
105	+0.520	−0.318
120	−0.111	−0.363
135	−0.221	+0.021
150	−0.028	+0.124
165	+0.049	+0.011
180	+0.042	−0.053

V
A = 3·5 B = 5·5

	R	I
0	+0.626	−1.397
15	+0.420	−1.503
30	−0.265	−1.605
45	−1.264	−1.086
60	−1.574	+0.340
75	−0.359	+1.375
90	+0.933	+0.624
105	+0.589	−0.533
120	−0.252	−0.435
135	−0.276	+0.102
150	+0.011	+0.167
165	+0.066	−0.005
180	+0.031	−0.082

V
A = 3·5 B = 6·0

	R	I
0	+0.578	−0.811
15	+0.458	−0.962
30	−0.065	−1.247
45	−1.071	−1.001
60	−1.553	+0.377
75	−0.255	+1.529
90	+1.185	+0.556
105	+0.568	−0.780
120	−0.438	−0.445
135	−0.292	+0.220
150	+0.079	+0.192
165	+0.075	−0.032
180	+0.002	−0.107

V
A = 3·5 B = 6·5

	R	I
0	+0.417	−0.051
15	+0.423	−0.221
30	+0.189	−0.672
45	−0.682	−0.814
60	−1.369	+0.331
75	−0.125	+1.556
90	+1.381	+0.400
105	+0.445	−1.024
120	−0.644	−0.369
135	−0.252	+0.358
150	+0.166	+0.184
165	+0.071	−0.066
180	−0.043	−0.118

V
A = 3·5 B = 7·0

	R	I
0	+0.165	+0.692
15	+0.307	+0.544
30	+0.441	−0.000
45	−0.162	−0.571
60	−1.064	+0.183
75	−0.013	+1.456
90	+1.490	+0.185
105	+0.225	−1.223
120	−0.831	−0.200
135	−0.143	+0.488
150	+0.256	+0.132
165	+0.049	−0.100
180	−0.097	−0.106

V
A = 3·5 B = 7·5

	R	I
0	−0.130	+1.238
15	+0.124	+1.156
30	+0.627	+0.638
45	+0.401	−0.314
60	−0.694	−0.062
75	+0.039	+1.249
90	+1.498	−0.048
105	−0.070	−1.341
120	−0.958	+0.056
135	+0.032	+0.577
150	+0.325	+0.032
165	+0.008	−0.126
180	−0.145	−0.066

VERTICAL DIPOLE CYLINDER RADIUS 4.0 RADIANS (0.64λ)

V
A = 4.0   B = 4.5

	R	I
0	+0.639	-0.675
15	+0.521	-0.740
30	+0.154	-0.820
45	-0.349	-0.635
60	-0.581	-0.089
75	-0.257	+0.361
90	+0.182	+0.250
105	+0.182	-0.080
120	-0.030	-0.116
135	-0.066	+0.009
150	-0.001	+0.039
165	+0.014	+0.000
180	+0.004	-0.019

V
A = 4.0   B = 5.0

	R	I
0	+1.098	-1.098
15	+0.907	-1.226
30	+0.284	-1.407
45	-0.623	-1.123
60	-1.069	-0.135
75	-0.448	+0.707
90	+0.389	+0.452
105	+0.339	-0.193
120	-0.087	-0.220
135	-0.126	+0.037
150	+0.011	+0.075
165	+0.028	-0.004
180	+0.002	-0.038

V
A = 4.0   B = 5.5

	R	I
0	+1.306	-1.186
15	+1.103	-1.366
30	+0.382	-1.674
45	-0.786	-1.414
60	-1.427	-0.129
75	-0.551	+1.029
90	+0.633	+0.587
105	+0.453	-0.358
120	-0.188	-0.299
135	-0.173	+0.093
150	+0.041	+0.105
165	+0.038	-0.015
180	-0.010	-0.055

V
A = 4.0   B = 6.0

	R	I
0	+1.232	-0.944
15	+1.082	-1.155
30	+0.443	-1.589
45	-0.805	-1.482
60	-1.617	-0.089
75	-0.560	+1.296
90	+0.898	+0.632
105	+0.501	-0.568
120	-0.332	-0.334
135	-0.193	+0.178
150	+0.090	+0.120
165	+0.043	-0.034
180	-0.033	-0.065

V
A = 4.0   B = 6.5

	R	I
0	+0.898	-0.458
15	+0.854	-0.663
30	+0.464	-1.184
45	-0.665	-1.337
60	-1.619	-0.045
75	-0.487	+1.474
90	+1.152	+0.580
105	+0.462	-0.803
120	-0.503	-0.304
135	-0.171	+0.281
150	+0.152	+0.108
165	+0.038	-0.056
180	-0.064	-0.062

V
A = 4.0   B = 7.0

	R	I
0	+0.380	+0.133
15	+0.467	-0.021
30	+0.442	-0.553
45	-0.377	-1.022
60	-1.440	-0.034
75	-0.364	+1.535
90	+1.359	+0.439
105	+0.327	-1.028
120	-0.675	-0.193
135	-0.095	+0.384
150	+0.214	+0.063
165	+0.030	-0.079
180	-0.096	-0.043

V
A = 4.0   B = 7.5

	R	I
0	-0.206	+0.672
15	-0.000	+0.610
30	+0.379	+0.171
45	+0.018	-0.603
60	-1.113	-0.085
75	-0.234	+1.467
90	+1.487	+0.232
105	+0.102	-1.207
120	-0.813	+0.000
135	+0.035	+0.461
150	+0.259	-0.016
165	-0.010	-0.094
180	-0.120	-0.005

V
A = 4.0   B = 8.0

	R	I
0	-0.732	+1.021
15	-0.451	+1.078
30	+0.276	+0.840
45	+0.454	-0.152
60	-0.691	-0.215
75	-0.142	+1.282
90	+1.515	-0.002
105	-0.192	-1.303
120	-0.880	+0.262
135	+0.210	+0.485
150	+0.269	-0.123
165	-0.050	-0.095
180	-0.127	+0.046

19

VERTICAL DIPOLE   CYLINDER RADIUS 4.5 RADIANS (0.72λ)

V
A = 4.5   B = 5.0

	R	I
0	+0.888	-0.278
15	+0.810	-0.406
30	+0.491	-0.673
45	-0.098	-0.714
60	-0.531	-0.235
75	-0.299	+0.314
90	+0.174	+0.242
105	+0.161	-0.097
120	-0.057	-0.095
135	-0.051	+0.032
150	+0.019	+0.028
165	+0.010	-0.007
180	-0.010	-0.013

V
A = 4.5   B = 5.5

	R	I
0	+1.502	-0.430
15	+1.385	-0.657
30	+0.862	-1.154
45	-0.180	-1.272
60	-0.990	-0.407
75	-0.536	+0.623
90	+0.372	+0.442
105	+0.295	-0.223
120	-0.134	-0.173
135	-0.091	+0.076
150	+0.045	+0.049
165	+0.017	-0.017
180	-0.023	-0.022

V
A = 4.5   B = 6.0

	R	I
0	+1.732	-0.414
15	+1.629	-0.698
30	+1.067	-1.363
45	-0.231	-1.609
60	-1.341	-0.499
75	-0.689	+0.925
90	+0.607	+0.581
105	+0.387	-0.391
120	-0.244	-0.221
135	-0.111	+0.138
150	+0.081	+0.057
165	+0.020	-0.030
180	-0.040	-0.024

V
A = 4.5   B = 6.5

	R	I
0	+1.551	-0.247
15	+1.512	-0.530
30	+1.085	-1.268
45	-0.229	-1.687
60	-1.543	-0.513
75	-0.743	+1.190
90	+0.866	+0.637
105	+0.414	-0.596
120	-0.381	-0.221
135	-0.101	+0.216
150	+0.124	+0.045
165	+0.015	-0.045
180	-0.059	-0.016

V
A = 4.5   B = 7.0

	R	I
0	+1.019	+0.012
15	+1.075	-0.208
30	+0.927	-0.900
45	-0.157	-1.509
60	-1.568	-0.471
75	-0.704	+1.384
90	+1.120	+0.599
105	+0.358	-0.817
120	-0.529	-0.157
135	-0.050	+0.296
150	+0.165	+0.009
165	+0.001	-0.059
180	-0.075	+0.004

V
A = 4.5   B = 7.5

	R	I
0	+0.271	+0.279
15	+0.424	+0.177
30	+0.632	-0.339
45	-0.007	-1.114
60	-1.410	-0.410
75	-0.597	+1.474
90	+1.335	+0.471
105	+0.212	-1.024
120	-0.662	-0.020
135	+0.046	+0.360
150	+0.192	-0.052
165	-0.022	-0.067
180	-0.082	+0.034

V
A = 4.5   B = 8.0

	R	I
0	-0.512	+0.472
15	-0.292	+0.520
30	+0.260	+0.294
45	+0.207	-0.579
60	-1.089	-0.368
75	-0.458	+1.441
90	+1.478	+0.273
105	-0.018	-1.181
120	-0.748	+0.185
135	+0.181	+0.386
150	+0.191	-0.132
165	-0.051	-0.065
180	-0.075	+0.070

V
A = 4.5   B = 8.5

	R	I
0	-1.149	+0.532
15	-0.918	+0.732
30	-0.122	+0.866
45	+0.453	+0.005
60	-0.650	-0.373
75	-0.333	+1.285
90	+1.525	+0.041
105	-0.311	-1.256
120	-0.757	+0.439
135	+0.339	+0.354
150	+0.152	-0.218
165	-0.082	-0.048
180	-0.050	+0.104

VERTICAL DIPOLE CYLINDER RADIUS 5.0 RADIANS (0.80λ)

V A = 5.0 B = 5.5

	R	I
0	+0.913	+0.189
15	+0.907	+0.024
30	+0.731	-0.398
45	+0.162	-0.699
60	-0.448	-0.361
75	-0.333	+0.263
90	+0.166	+0.234
105	+0.139	-0.112
120	-0.075	-0.070
135	-0.030	+0.045
150	+0.027	+0.010
165	+0.003	-0.010
180	-0.013	-0.001

V A = 5.0 B = 6.0

	R	I
0	+1.530	+0.354
15	+1.538	+0.071
30	+1.277	-0.678
45	+0.285	-1.252
60	-0.845	-0.647
75	-0.610	+0.532
90	+0.357	+0.433
105	+0.252	-0.247
120	-0.164	-0.130
135	-0.048	+0.097
150	+0.056	+0.013
165	+0.004	-0.021
180	-0.026	+0.002

V A = 5.0 B = 6.5

	R	I
0	+1.731	+0.475
15	+1.780	+0.145
30	+1.556	-0.785
45	+0.358	-1.592
60	-1.162	-0.830
75	-0.807	+0.806
90	+0.583	+0.574
105	+0.321	-0.417
120	-0.274	-0.138
135	-0.044	+0.157
150	+0.086	+0.002
165	-0.001	-0.032
180	-0.037	+0.012

V A = 5.0 B = 7.0

	R	I
0	+1.496	+0.527
15	+1.601	+0.233
30	+1.534	-0.700
45	+0.386	-1.674
60	-1.360	-0.901
75	-0.905	+1.061
90	+0.836	+0.639
105	+0.327	-0.616
120	-0.397	-0.107
135	-0.009	+0.219
150	+0.113	-0.026
165	-0.012	-0.041
180	-0.043	+0.028

V A = 5.0 B = 7.5

	R	I
0	+0.904	+0.490
15	+1.064	+0.306
30	+1.234	-0.440
45	+0.387	-1.489
60	-1.405	-0.871
75	-0.903	+1.264
90	+1.089	+0.613
105	+0.255	-0.824
120	-0.518	-0.017
135	+0.060	+0.271
150	+0.127	-0.070
165	-0.030	-0.044
180	-0.041	+0.049

V A = 5.0 B = 8.0

	R	I
0	+0.115	+0.359
15	+0.303	+0.338
30	+0.724	-0.061
45	+0.381	-1.071
60	-1.278	-0.772
75	-0.815	+1.378
90	+1.310	+0.499
105	+0.097	-1.011
120	-0.610	+0.135
135	+0.163	+0.295
150	+0.120	-0.128
165	-0.051	-0.039
180	-0.028	+0.071

V A = 5.0 B = 8.5

	R	I
0	-0.674	+0.149
15	-0.500	+0.306
30	+0.112	+0.355
45	+0.385	-0.495
60	-0.989	-0.644
75	-0.676	+1.378
90	+1.465	+0.312
105	-0.138	-1.145
120	-0.646	+0.339
135	+0.288	+0.274
150	+0.085	-0.187
165	-0.071	-0.024
180	-0.002	+0.088

V A = 5.0 B = 9.0

	R	I
0	-1.272	-0.101
15	-1.162	+0.205
30	-0.485	+0.717
45	+0.404	+0.144
60	-0.569	-0.528
75	-0.527	+1.255
90	+1.530	+0.084
105	-0.429	-1.196
120	-0.602	+0.574
135	+0.415	+0.196
150	+0.019	-0.235
165	-0.086	+0.004
180	+0.033	+0.094

VERTICAL DIPOLE　　　　CYLINDER RADIUS 5.5 RADIANS (0.88λ)

V
A = 5.5 B = 6.0

	R	I
0	+0.707	+0.609
15	+0.789	+0.448
30	+0.831	-0.048
45	+0.399	-0.593
60	-0.336	-0.460
75	-0.360	+0.211
90	+0.160	+0.228
105	+0.116	-0.124
120	-0.085	-0.043
135	-0.008	+0.049
150	+0.025	-0.006
165	-0.003	-0.009
180	-0.008	+0.008

V
A = 5.5 B = 6.5

	R	I
0	+1.173	+1.054
15	+1.331	+0.787
30	+1.448	-0.070
45	+0.711	-1.069
60	-0.645	-0.839
75	-0.670	+0.434
90	+0.343	+0.424
105	+0.207	-0.266
120	-0.178	-0.066
135	-0.004	+0.100
150	+0.047	-0.017
165	-0.009	-0.017
180	-0.013	+0.018

V
A = 5.5 B = 7.0

	R	I
0	+1.298	+1.258
15	+1.516	+0.966
30	+1.752	-0.051
45	+0.902	-1.367
60	-0.905	-1.102
75	-0.905	+0.674
90	+0.562	+0.568
105	+0.255	-0.436
120	-0.281	-0.057
135	+0.021	+0.149
150	+0.064	-0.039
165	-0.018	-0.023
180	-0.014	+0.030

V
A = 5.5 B = 7.5

	R	I
0	+1.073	+1.187
15	+1.324	+0.956
30	+1.702	+0.012
45	+0.959	-1.440
60	-1.082	-1.227
75	-1.044	+0.913
90	+0.808	+0.640
105	+0.241	-0.627
120	-0.386	-0.001
135	+0.072	+0.190
150	+0.072	-0.071
165	-0.031	-0.024
180	-0.008	+0.043

V
A = 5.5 B = 8.0

	R	I
0	+0.574	+0.864
15	+0.816	+0.764
30	+1.321	+0.115
45	+0.894	-1.275
60	-1.140	-1.216
75	-1.078	+1.116
90	+1.060	+0.626
105	+0.152	-0.820
120	-0.476	+0.107
135	+0.149	+0.211
150	+0.063	-0.111
165	-0.046	-0.018
180	+0.006	+0.055

V
A = 5.5 B = 8.5

	R	I
0	-0.057	+0.362
15	+0.126	+0.431
30	+0.697	+0.237
45	+0.739	-0.892
60	-1.053	-1.090
75	-1.015	+1.249
90	+1.285	+0.524
105	-0.017	-0.986
120	-0.528	+0.265
135	+0.245	+0.197
150	+0.033	-0.151
165	-0.060	-0.003
180	+0.027	+0.060

V
A = 5.5 B = 9.0

	R	I
0	-0.654	-0.207
15	-0.576	+0.024
30	-0.041	+0.352
45	+0.534	-0.353
60	-0.816	-0.891
75	-0.882	+1.280
90	+1.451	+0.348
105	-0.255	-1.096
120	-0.519	+0.460
135	+0.345	+0.137
150	-0.019	-0.181
165	-0.067	+0.020
180	+0.053	+0.055

V
A = 5.5 B = 9.5

	R	I
0	-1.067	-0.716
15	-1.124	-0.376
30	-0.742	+0.428
45	+0.320	+0.254
60	-0.447	-0.667
75	-0.716	+1.192
90	+1.532	+0.125
105	-0.541	-1.122
120	-0.430	+0.667
135	+0.429	+0.028
150	-0.089	-0.189
165	-0.064	+0.048
180	+0.078	+0.037

VERTICAL DIPOLE   CYLINDER RADIUS 6·0 RADIANS (0·96λ)

V A = 6.0 B = 6.5	R	I		V A = 6.0 B = 7.0	R	I
0	+0.324	+0.877		0	+0.520	+1.496
15	+0.487	+0.767		15	+0.810	+1.324
30	+0.772	+0.311		30	+1.343	+0.554
45	+0.581	-0.412		45	+1.043	-0.748
60	-0.206	-0.526		60	-0.405	-0.972
75	-0.379	+0.156		75	-0.714	+0.332
90	+0.154	+0.223		90	+0.331	+0.416
105	+0.094	-0.133		105	+0.163	-0.279
120	-0.088	-0.017		120	-0.178	-0.015
135	+0.012	+0.044		135	+0.035	+0.085
150	+0.015	-0.016		150	+0.027	-0.035
165	-0.008	-0.005		165	-0.017	-0.007
180	+0.001	+0.010		180	+0.004	+0.019

V A = 6.0 B = 7.5	R	I		V A = 6.0 B = 8.0	R	I
0	+0.537	+1.738		0	+0.379	+1.567
15	+0.896	+1.571		15	+0.736	+1.472
30	+1.617	+0.700		30	+1.550	+0.734
45	+1.331	-0.963		45	+1.414	-1.016
60	-0.589	-1.296		60	-0.730	-1.469
75	-0.981	+0.534		75	-1.157	+0.748
90	+0.543	+0.562		90	+0.784	+0.640
105	+0.189	-0.447		105	+0.156	-0.628
120	-0.269	+0.019		120	-0.353	+0.093
135	+0.074	+0.118		135	+0.132	+0.135
150	+0.030	-0.059		150	+0.021	-0.086
165	-0.037	-0.006		165	-0.037	+0.000
180	+0.012	+0.026		180	+0.023	+0.030

V A = 6.0 B = 8.5	R	I		V A = 6.0 B = 9.0	R	I
0	+0.102	+1.040		0	-0.209	+0.290
15	+0.380	+1.062		15	-0.074	+0.439
30	+1.166	+0.662		30	+0.549	+0.504
45	+1.298	-0.891		45	+1.017	-0.594
60	-0.793	-1.479		60	-0.748	-1.341
75	-1.227	+0.946		75	-1.192	+1.091
90	+1.033	+0.636		90	+1.261	+0.545
105	+0.052	-0.804		105	-0.125	-0.949
120	-0.411	+0.212		120	-0.424	+0.368
135	+0.205	+0.125		135	+0.281	+0.081
150	-0.002	-0.112		150	-0.041	-0.130
165	-0.045	+0.013		165	-0.047	+0.031
180	+0.038	+0.028		180	+0.054	+0.019

V A = 6.0 B = 9.5	R	I		V A = 6.0 B = 10.0	R	I
0	-0.462	-0.503		0	-0.585	-1.153
15	-0.508	-0.255		15	-0.813	-0.869
30	-0.172	+0.292		30	-0.847	+0.061
45	+0.632	-0.166		45	+0.212	+0.327
60	-0.578	-1.090		60	-0.288	-0.777
75	-1.071	+1.149		75	-0.897	+1.098
90	+1.436	+0.379		90	+1.531	+0.162
105	-0.364	-1.035		105	-0.643	-1.037
120	-0.375	+0.545		120	-0.249	+0.718
135	+0.347	-0.004		135	+0.382	-0.126
150	-0.094	-0.131		150	-0.152	-0.108
165	-0.040	+0.052		165	-0.023	+0.072
180	+0.066	+0.000		180	+0.071	-0.026

24

T
A = 0.25   B = 0.75

	R	I
0	+0.593	+0.596
15	+0.578	+0.546
30	+0.528	+0.415
45	+0.440	+0.246
60	+0.312	+0.090
75	+0.157	-0.013
90	-0.014	-0.044
105	-0.184	+0.004
120	-0.340	+0.124
135	-0.467	+0.293
150	-0.556	+0.472
165	-0.605	+0.610
180	-0.621	+0.662

T
A = 0.25   B = 1.25

	R	I
0	+0.221	+0.900
15	+0.246	+0.841
30	+0.298	+0.676
45	+0.325	+0.444
60	+0.280	+0.207
75	+0.155	+0.034
90	-0.022	-0.027
105	-0.199	+0.044
120	-0.325	+0.227
135	-0.369	+0.472
150	-0.342	+0.710
165	-0.290	+0.879
180	-0.265	+0.940

T
A = 0.25   B = 1.75

	R	I
0	-0.264	+0.970
15	-0.198	+0.930
30	-0.033	+0.802
45	+0.137	+0.580
60	+0.212	+0.308
75	+0.144	+0.078
90	-0.026	-0.012
105	-0.196	+0.078
120	-0.264	+0.308
135	-0.189	+0.581
150	-0.019	+0.803
165	+0.146	+0.932
180	+0.213	+0.971

T
A = 0.25   B = 2.25

	R	I
0	-0.702	+0.796
15	-0.612	+0.801
30	-0.369	+0.775
45	-0.073	+0.641
60	+0.130	+0.386
75	+0.135	+0.119
90	-0.025	+0.000
105	-0.185	+0.109
120	-0.181	+0.368
135	+0.022	+0.615
150	+0.319	+0.743
165	+0.561	+0.766
180	+0.652	+0.759

T
A = 0.25   B = 2.75

	R	I
0	-0.978	+0.425
15	-0.894	+0.486
30	-0.641	+0.601
45	-0.273	+0.618
60	+0.044	+0.437
75	+0.128	+0.154
90	-0.020	+0.011
105	-0.168	+0.137
120	-0.084	+0.404
135	+0.233	+0.571
150	+0.601	+0.544
165	+0.854	+0.422
180	+0.938	+0.359

T
A = 0.25   B = 3.25

	R	I
0	-1.021	-0.051
15	-0.977	+0.058
30	-0.798	+0.314
45	-0.440	+0.515
60	-0.042	+0.455
75	+0.122	+0.182
90	-0.012	+0.017
105	-0.146	+0.161
120	+0.018	+0.414
135	+0.416	+0.457
150	+0.774	+0.244
165	+0.953	-0.021
180	+0.997	-0.133

T
A = 0.25   B = 3.75

	R	I
0	-0.819	-0.513
15	-0.841	-0.382
30	-0.810	-0.033
45	-0.553	+0.343
60	-0.125	+0.438
75	+0.116	+0.200
90	-0.002	+0.019
105	-0.120	+0.179
120	+0.121	+0.398
135	+0.548	+0.286
150	+0.806	-0.102
165	+0.836	-0.460
180	+0.814	-0.593

T
A = 0.25   B = 4.25

	R	I
0	-0.419	-0.847
15	-0.516	-0.734
30	-0.676	-0.375
45	-0.601	+0.125
60	-0.203	+0.388
75	+0.106	+0.209
90	+0.007	+0.017
105	-0.093	+0.193
120	+0.216	+0.356
135	+0.614	+0.080
150	+0.689	-0.430
165	+0.528	-0.795
180	+0.431	-0.910

T
A = 0.5 B = 1.0

	R	I
0	+0.168	+0.616
15	+0.179	+0.563
30	+0.197	+0.419
45	+0.195	+0.230
60	+0.150	+0.049
75	+0.062	-0.073
90	-0.052	-0.107
105	-0.166	-0.043
120	-0.252	+0.108
135	-0.295	+0.313
150	-0.295	+0.521
165	-0.275	+0.676
180	-0.263	+0.734

T
A = 0.5 B = 1.5

	R	I
0	-0.245	+0.900
15	-0.192	+0.848
30	-0.066	+0.695
45	+0.058	+0.462
60	+0.105	+0.205
75	+0.048	+0.004
90	-0.081	-0.071
105	-0.210	+0.008
120	-0.265	+0.212
135	-0.215	+0.472
150	-0.088	+0.707
165	+0.040	+0.861
180	+0.093	+0.914

T
A = 0.5 B = 2.0

	R	I
0	-0.697	+0.930
15	-0.611	+0.909
30	-0.388	+0.821
45	-0.129	+0.629
60	+0.038	+0.352
75	+0.037	+0.090
90	-0.092	-0.026
105	-0.221	+0.060
120	-0.219	+0.293
135	-0.050	+0.546
150	+0.211	+0.720
165	+0.436	+0.795
180	+0.523	+0.812

T
A = 0.5 B = 2.5

	R	I
0	-1.022	+0.718
15	-0.927	+0.749
30	-0.660	+0.784
45	-0.305	+0.707
60	-0.032	+0.467
75	+0.044	+0.169
90	-0.085	+0.016
105	-0.214	+0.110
120	-0.147	+0.352
135	+0.138	+0.545
150	+0.495	+0.584
165	+0.763	+0.526
180	+0.858	+0.488

T
A = 0.5 B = 3.0

	R	I
0	-1.123	+0.328
15	-1.054	+0.412
30	-0.823	+0.591
45	-0.441	+0.683
60	-0.069	+0.537
75	+0.066	+0.231
90	-0.063	+0.048
105	-0.192	+0.154
120	-0.057	+0.388
135	+0.316	+0.473
150	+0.697	+0.334
165	+0.928	+0.125
180	+0.998	+0.031

T
A = 0.5 B = 3.5

	R	I
0	-0.969	-0.141
15	-0.956	-0.020
30	-0.844	+0.282
45	-0.525	+0.558
60	-0.106	+0.552
75	+0.096	+0.268
90	-0.031	+0.067
105	-0.159	+0.189
120	+0.042	+0.399
135	+0.460	+0.343
150	+0.777	+0.018
165	+0.888	-0.314
180	+0.901	-0.445

T
A = 0.5 B = 4.0

	R	I
0	-0.591	-0.568
15	-0.653	-0.444
30	-0.719	-0.085
45	-0.551	+0.348
60	-0.140	+0.510
75	+0.125	+0.279
90	+0.003	+0.069
105	-0.120	+0.214
120	+0.143	+0.384
135	+0.551	+0.170
150	+0.716	-0.304
165	+0.648	-0.688
180	+0.585	-0.821

T
A = 0.5 B = 4.5

	R	I
0	-0.076	-0.847
15	-0.209	-0.760
30	-0.473	-0.439
45	-0.521	+0.084
60	-0.177	+0.419
75	+0.142	+0.266
90	+0.033	+0.056
105	-0.077	+0.226
120	+0.239	+0.341
135	+0.579	-0.026
150	+0.527	-0.574
165	+0.260	-0.911
180	+0.127	-1.003

TANGENTIAL DIPOLE   CYLINDER RADIUS 0·75 RADIANS (0·12λ)

T A = 0.75 B = 1.25	R	I
0	-0.225	+0.641
15	-0.190	+0.592
30	-0.109	+0.452
45	-0.032	+0.255
60	-0.003	+0.052
75	-0.035	-0.098
90	-0.106	-0.153
105	-0.174	-0.096
120	-0.198	+0.055
135	-0.158	+0.259
150	-0.069	+0.457
165	+0.020	+0.597
180	+0.057	+0.647

T A = 0.75 B = 1.75	R	I
0	-0.674	+0.905
15	-0.599	+0.866
30	-0.411	+0.741
45	-0.201	+0.522
60	-0.071	+0.248
75	-0.070	+0.009
90	-0.162	-0.101
105	-0.251	-0.039
120	-0.241	+0.157
135	-0.098	+0.393
150	+0.125	+0.583
165	+0.322	+0.689
180	+0.401	+0.721

T A = 0.75 B = 2.25	R	I
0	-1.051	+0.891
15	-0.954	+0.894
30	-0.694	+0.860
45	-0.369	+0.713
60	-0.127	+0.436
75	-0.074	+0.138
90	-0.179	-0.021
105	-0.281	+0.041
120	-0.220	+0.249
135	+0.032	+0.448
150	+0.367	+0.535
165	+0.634	+0.531
180	+0.734	+0.516

T A = 0.75 B = 2.75	R	I
0	-1.223	+0.639
15	-1.135	+0.696
30	-0.873	+0.799
45	-0.489	+0.793
60	-0.150	+0.579
75	-0.040	+0.253
90	-0.158	+0.056
105	-0.275	+0.123
120	-0.162	+0.328
135	+0.181	+0.438
150	+0.569	+0.363
165	+0.834	+0.209
180	+0.923	+0.135

T A = 0.75 B = 3.25	R	I
0	-1.133	+0.227
15	-1.089	+0.331
30	-0.907	+0.573
45	-0.546	+0.749
60	-0.145	+0.653
75	+0.023	+0.334
90	-0.108	+0.114
105	-0.239	+0.195
120	-0.075	+0.385
135	+0.323	+0.370
150	+0.681	+0.109
165	+0.859	-0.187
180	+0.902	-0.310

T A = 0.75 B = 3.75	R	I
0	-0.793	-0.235
15	-0.817	-0.108
30	-0.791	+0.228
45	-0.542	+0.583
60	-0.127	+0.647
75	+0.097	+0.370
90	-0.041	+0.142
105	-0.182	+0.249
120	+0.033	+0.414
135	+0.438	+0.253
150	+0.675	-0.176
165	+0.693	-0.559
180	+0.665	-0.702

T A = 0.75 B = 4.25	R	I
0	-0.277	-0.627
15	-0.377	-0.516
30	-0.547	-0.165
45	-0.488	+0.320
60	-0.113	+0.564
75	+0.164	+0.360
90	+0.028	+0.137
105	-0.113	+0.279
120	+0.152	+0.407
135	+0.509	+0.099
150	+0.551	-0.437
165	+0.368	-0.819
180	+0.263	-0.940

T A = 0.75 B = 4.75	R	I
0	+0.298	-0.849
15	+0.138	-0.795
30	-0.219	-0.530
4	-0.397	+0.003
60	-0.120	+0.418
75	+0.206	+0.311
90	+0.084	+0.103
105	-0.043	+0.282
120	+0.268	+0.363
135	+0.525	-0.076
150	+0.328	-0.626
165	-0.044	-0.901
180	-0.209	-0.960

CYLINDER RADIUS 1·0 RADIANS (0·16λ)

A = 1.0 B = 1.5

	R	I
0	-0.482	+0.619
15	-0.432	+0.580
30	-0.308	+0.464
45	-0.178	+0.283
60	-0.104	+0.077
75	-0.110	-0.091
90	-0.169	-0.167
105	-0.220	-0.126
120	-0.204	+0.009
135	-0.100	+0.186
150	+0.060	+0.344
165	+0.204	+0.445
180	+0.262	+0.478

A = 1.0 B = 2.0

	R	I
0	-0.953	+0.819
15	-0.867	+0.805
30	-0.644	+0.734
45	-0.379	+0.562
60	-0.195	+0.300
75	-0.164	+0.040
90	-0.251	-0.096
105	-0.329	-0.052
120	-0.277	+0.121
135	-0.063	+0.308
150	+0.232	+0.421
165	+0.478	+0.454
180	+0.572	+0.456

A = 1.0 B = 2.5

	R	I
0	-1.256	+0.736
15	-1.161	+0.770
30	-0.894	+0.815
45	-0.534	+0.748
60	-0.242	+0.511
75	-0.159	+0.203
90	-0.265	+0.020
105	-0.366	+0.065
120	-0.270	+0.244
135	+0.039	+0.368
150	+0.415	+0.347
165	+0.695	+0.246
180	+0.795	+0.193

A = 1.0 B = 3.0

	R	I
0	-1.299	+0.439
15	-1.229	+0.526
30	-0.997	+0.713
45	-0.613	+0.811
60	-0.237	+0.664
75	-0.097	+0.344
90	-0.220	+0.129
105	-0.344	+0.185
120	-0.206	+0.356
135	+0.167	+0.373
150	+0.547	+0.174
165	+0.776	-0.076
180	+0.845	-0.185

A = 1.0 B = 3.5

	R	I
0	-1.062	+0.023
15	-1.048	+0.147
30	-0.934	+0.455
45	-0.613	+0.737
60	-0.194	+0.730
75	+0.005	+0.434
90	-0.132	+0.204
105	-0.275	+0.284
120	-0.095	+0.439
135	+0.298	+0.324
150	+0.593	-0.052
165	+0.688	-0.420
180	+0.695	-0.564

A = 1.0 B = 4.0

	R	I
0	-0.594	-0.394
15	-0.654	-0.267
30	-0.718	+0.097
45	-0.547	+0.536
60	-0.137	+0.699
75	+0.119	+0.460
90	-0.023	+0.231
105	-0.176	+0.345
120	+0.046	+0.478
135	+0.412	+0.223
150	+0.537	-0.287
165	+0.441	-0.695
180	+0.369	-0.837

A = 1.0 B = 4.5

	R	I
0	-0.001	-0.702
15	-0.131	-0.614
30	-0.390	-0.289
45	-0.435	+0.239
60	-0.091	+0.577
75	+0.217	+0.422
90	+0.083	+0.206
105	-0.066	+0.363
120	+0.201	+0.463
135	+0.487	+0.079
150	+0.387	-0.483
165	+0.086	-0.830
180	-0.059	-0.926

A = 1.0 B = 5.0

	R	I
0	+0.582	-0.823
15	+0.408	-0.808
30	-0.013	-0.621
45	-0.300	-0.105
60	-0.079	+0.386
75	+0.274	+0.335
90	+0.162	+0.138
105	+0.035	+0.335
120	+0.345	+0.393
135	+0.509	-0.093
150	+0.164	-0.605
165	-0.299	-0.788
180	-0.488	-0.801

27

TANGENTIAL DIPOLE   CYLINDER RADIUS 1·25 RADIANS (0·20λ)

T
A = 1.25 B = 1.75

	R	I
0	-0.633	+0.486
15	-0.574	+0.469
30	-0.428	+0.405
45	-0.264	+0.275
60	-0.162	+0.098
75	-0.159	-0.064
90	-0.224	-0.144
105	-0.277	-0.110
120	-0.240	+0.008
135	-0.091	+0.143
150	+0.120	+0.238
165	+0.301	+0.280
180	+0.371	+0.289

T
A = 1.25 B = 2.25

	R	I
0	-1.126	+0.580
15	-1.038	+0.600
30	-0.799	+0.614
45	-0.499	+0.535
60	-0.274	+0.331
75	-0.225	+0.088
90	-0.320	-0.048
105	-0.405	-0.006
120	-0.329	+0.146
135	-0.068	+0.268
150	+0.269	+0.280
165	+0.534	+0.220
180	+0.632	+0.185

T
A = 1.25 B = 2.75

	R	I
0	-1.381	+0.424
15	-1.296	+0.497
30	-1.039	+0.644
45	-0.661	+0.700
60	-0.323	+0.550
75	-0.208	+0.374
90	-0.318	+0.097
105	-0.428	+0.146
120	-0.313	+0.302
135	+0.026	+0.342
150	+0.405	+0.197
165	+0.662	-0.008
180	+0.747	-0.101

T
A = 1.25 B = 3.25

	R	I
0	-1.336	+0.114
15	-1.289	+0.232
30	-1.099	+0.513
45	-0.724	+0.743
60	-0.305	+0.704
75	-0.120	+0.427
90	-0.239	+0.224
105	-0.371	+0.291
120	-0.219	+0.438
135	+0.156	+0.362
150	+0.487	+0.039
165	+0.644	-0.302
180	+0.679	-0.441

T
A = 1.25 B = 3.75

	R	I
0	-1.001	-0.247
15	-1.018	-0.110
30	-0.970	+0.257
45	-0.690	+0.653
60	-0.240	+0.760
75	+0.014	+0.515
90	-0.109	+0.299
105	-0.256	+0.395
120	-0.066	+0.527
135	+0.297	+0.320
150	+0.490	-0.154
165	+0.474	-0.571
180	+0.433	-0.726

T
A = 1.25 B = 4.25

	R	I
0	-0.452	-0.552
15	-0.541	-0.435
30	-0.681	-0.067
45	-0.579	+0.443
60	-0.158	+0.710
75	+0.157	+0.523
90	+0.038	+0.305
105	-0.112	+0.440
120	+0.118	+0.551
135	+0.423	+0.218
150	+0.408	-0.342
165	+0.183	-0.741
180	+0.063	-0.868

T
A = 1.25 B = 4.75

	R	I
0	+0.185	-0.714
15	+0.037	-0.659
30	-0.287	-0.391
45	-0.419	+0.144
60	-0.093	+0.562
75	+0.273	+0.455
90	+0.169	+0.245
105	+0.031	+0.422
120	+0.305	+0.501
135	+0.507	+0.062
150	+0.251	-0.486
165	-0.164	-0.761
180	-0.346	-0.818

T
A = 1.25 B = 5.25

	R	I
0	+0.762	-0.689
15	+0.590	-0.723
30	+0.136	-0.646
45	-0.240	-0.191
60	-0.065	+0.343
75	+0.333	+0.333
90	+0.254	+0.134
105	+0.146	+0.351
120	+0.463	+0.383
135	+0.528	-0.127
150	+0.042	-0.558
165	-0.492	-0.617
180	-0.694	-0.576

TANGENTIAL DIPOLE   CYLINDER RADIUS 1·5 RADIANS (0·24λ)

T
A = 1.5   B = 2.0

	R	I
0	−0.736	+0.266
15	−0.673	+0.277
30	−0.510	+0.281
45	−0.317	+0.228
60	−0.187	+0.108
75	−0.173	−0.026
90	−0.246	−0.092
105	−0.308	−0.053
120	−0.265	+0.049
135	−0.095	+0.134
150	+0.136	+0.151
165	+0.328	+0.120
180	+0.401	+0.099

T
A = 1.5   B = 2.5

	R	I
0	−1.252	+0.231
15	−1.167	+0.290
30	−0.923	+0.407
45	−0.591	+0.449
60	−0.317	+0.335
75	−0.237	+0.138
90	−0.335	+0.024
105	−0.432	+0.082
120	−0.349	+0.220
135	−0.072	+0.269
150	+0.263	+0.167
165	+0.508	+0.006
180	+0.594	−0.069

T
A = 1.5   B = 3.0

	R	I
0	−1.476	+0.026
15	−1.405	+0.136
30	−1.169	+0.389
45	−0.773	+0.585
60	−0.376	+0.548
75	−0.209	+0.327
90	−0.310	+0.178
105	−0.427	+0.252
120	−0.305	+0.395
135	+0.030	+0.353
150	+0.362	+0.086
165	+0.552	−0.218
180	+0.606	−0.347

T
A = 1.5   B = 3.5

	R	I
0	−1.368	−0.248
15	−1.345	−0.106
30	−1.202	+0.255
45	−0.836	+0.614
60	−0.360	+0.694
75	−0.105	+0.476
90	−0.200	+0.299
105	−0.329	+0.395
120	−0.170	+0.532
135	+0.175	+0.375
150	+0.409	−0.052
165	+0.455	−0.459
180	+0.442	−0.618

T
A = 1.5   B = 4.0

	R	I
0	−0.959	−0.494
15	−1.004	−0.356
30	−1.022	+0.040
45	−0.783	+0.526
60	−0.292	+0.742
75	+0.042	+0.550
90	−0.042	+0.352
105	−0.176	+0.478
120	+0.024	+0.601
135	+0.332	+0.324
150	+0.387	−0.211
165	+0.233	−0.639
180	+0.139	−0.788

T
A = 1.5   B = 4.5

	R	I
0	−0.348	−0.633
15	−0.461	−0.541
30	−0.669	−0.207
45	−0.636	+0.332
60	−0.202	+0.682
75	+0.193	+0.537
90	+0.121	+0.326
105	−0.006	+0.485
120	+0.239	+0.585
135	+0.468	+0.202
150	+0.295	−0.358
165	−0.064	−0.702
180	−0.232	−0.796

T
A = 1.5   B = 5.0

	R	I
0	+0.320	−0.615
15	+0.163	−0.605
30	−0.211	−0.433
45	−0.428	+0.061
60	−0.124	+0.524
75	+0.307	+0.446
90	+0.251	+0.227
105	+0.144	+0.420
120	+0.436	+0.483
135	+0.550	+0.020
150	+0.143	−0.461
165	−0.371	−0.619
180	−0.579	−0.623

T
A = 1.5   B = 5.5

	R	I
0	+0.891	−0.436
15	+0.730	−0.526
30	+0.264	−0.587
45	−0.198	−0.242
60	−0.084	+0.297
75	+0.356	+0.303
90	+0.319	+0.082
105	+0.244	+0.304
120	+0.581	+0.312
135	+0.554	−0.195
150	−0.047	−0.498
165	−0.616	−0.401
180	−0.814	−0.297

TANGENTIAL DIPOLE   CYLINDER RADIUS 1·75 RADIANS (0·28λ)

T A = 1.75 B = 2.25			T A = 1.75 B = 2.75			T A = 1.75 B = 3.25			T A = 1.75 B = 3.75		
	R	I		R	I		R	I		R	I
0	-0.806	+0.021	0	-1.330	-0.137	0	-1.517	-0.365	0	-1.348	-0.568
15	-0.744	+0.058	15	-1.255	-0.045	15	-1.468	-0.228	15	-1.356	-0.418
30	-0.573	+0.128	30	-1.022	+0.163	30	-1.271	+0.106	30	-1.280	-0.012
45	-0.355	+0.155	45	-0.667	+0.320	45	-0.876	+0.423	45	-0.948	+0.446
60	-0.189	+0.094	60	-0.337	+0.299	60	-0.419	+0.492	60	-0.425	+0.629
75	-0.152	-0.005	75	-0.210	+0.151	75	-0.184	+0.327	75	-0.087	+0.463
90	-0.226	-0.048	90	-0.298	+0.071	90	-0.257	+0.213	90	-0.137	+0.313
105	-0.298	+0.009	105	-0.403	+0.163	105	-0.369	+0.329	105	-0.245	+0.450
120	-0.260	+0.108	120	-0.321	+0.304	120	-0.242	+0.481	120	-0.070	+0.598
135	-0.092	+0.148	135	-0.056	+0.294	135	+0.064	+0.379	135	+0.229	+0.388
150	+0.126	+0.087	150	+0.231	+0.090	150	+0.306	+0.017	150	+0.333	-0.099
165	+0.296	-0.014	165	+0.413	-0.159	165	+0.388	-0.355	165	+0.240	-0.527
180	+0.358	-0.063	180	+0.470	-0.268	180	+0.395	-0.507	180	+0.171	-0.687

T A = 1.75 B = 4.25			T A = 1.75 B = 4.75			T A = 1.75 B = 5.25			T A = 1.75 B = 5.75		
	R	I		R	I		R	I		R	I
0	-0.878	-0.671	0	-0.224	-0.629	0	+0.456	-0.436	0	+1.001	-0.130
15	-0.954	-0.548	15	-0.359	-0.574	15	+0.294	-0.478	15	+0.858	-0.271
30	-1.054	-0.162	30	-0.642	-0.310	30	-0.127	-0.423	30	+0.392	-0.471
45	-0.883	+0.376	45	-0.703	+0.219	45	-0.447	-0.004	45	-0.161	-0.257
60	-0.370	+0.679	60	-0.283	+0.627	60	-0.197	+0.482	60	-0.138	+0.268
75	+0.049	+0.527	75	+0.185	+0.509	75	+0.285	+0.418	75	+0.322	+0.281
90	+0.021	+0.340	90	+0.173	+0.289	90	+0.282	+0.173	90	+0.323	+0.021
105	-0.077	+0.499	105	+0.092	+0.466	105	+0.224	+0.366	105	+0.292	+0.226
120	+0.150	+0.628	120	+0.372	+0.562	120	+0.554	+0.409	120	+0.664	+0.196
135	+0.398	+0.313	135	+0.533	+0.158	135	+0.597	-0.056	135	+0.567	-0.295
150	+0.302	-0.230	150	+0.210	-0.347	150	+0.069	-0.424	150	-0.103	-0.439
165	+0.005	-0.616	165	-0.265	-0.584	165	-0.504	-0.428	165	-0.654	-0.171
180	-0.145	-0.738	180	-0.470	-0.627	180	-0.721	-0.365	180	-0.827	-0.002

TANGENTIAL DIPOLE   CYLINDER RADIUS 2·0 RADIANS (0·32λ)

T
A = 2.0 B = 2.5

	R	I
0	-0.819	-0.205
15	-0.765	-0.149
30	-0.608	-0.025
45	-0.383	+0.065
60	-0.189	-0.054
75	-0.125	-0.016
90	-0.190	-0.033
105	-0.264	+0.052
120	-0.227	+0.161
135	-0.073	+0.172
150	+0.107	+0.052
165	+0.229	-0.107
180	+0.269	-0.179

T
A = 2.0 B = 3.0

	R	I
0	-1.312	-0.475
15	-1.260	-0.360
30	-1.072	-0.084
45	-0.731	+0.167
60	-0.363	+0.225
75	-0.186	+0.119
90	-0.250	+0.072
105	-0.345	+0.209
120	-0.254	+0.372
135	-0.012	+0.326
150	+0.198	+0.049
165	+0.285	-0.260
180	+0.299	-0.390

T
A = 2.0 B = 3.5

	R	I
0	-1.444	-0.713
15	-1.432	-0.563
30	-1.314	-0.176
45	-0.967	+0.237
60	-0.481	+0.399
75	-0.179	+0.279
90	-0.209	+0.194
105	-0.293	+0.358
120	-0.142	+0.536
135	+0.132	+0.399
150	+0.260	-0.015
165	+0.212	-0.415
180	+0.162	-0.570

T
A = 2.0 B = 4.0

	R	I
0	-1.220	-0.839
15	-1.270	-0.693
30	-1.297	-0.271
45	-1.051	+0.260
60	-0.519	+0.536
75	-0.109	+0.412
90	-0.101	+0.277
105	-0.163	+0.454
120	+0.054	+0.619
135	+0.313	+0.381
150	+0.279	-0.118
165	+0.042	-0.516
180	-0.086	-0.654

T
A = 2.0 B = 4.5

	R	I
0	-0.713	-0.801
15	-0.827	-0.703
30	-1.033	-0.349
45	-0.977	+0.220
60	-0.485	+0.602
75	+0.002	+0.484
90	+0.039	+0.294
105	+0.000	+0.473
120	+0.281	+0.603
135	+0.484	+0.268
150	+0.245	-0.232
165	-0.179	-0.525
180	-0.375	-0.599

T
A = 2.0 B = 5.0

	R	I
0	-0.057	-0.593
15	-0.213	-0.578
30	-0.579	-0.392
45	-0.767	+0.114
60	-0.401	+0.578
75	+0.121	+0.485
90	+0.169	+0.240
105	+0.151	+0.415
120	+0.489	+0.488
135	+0.601	+0.074
150	+0.157	-0.334
165	-0.398	-0.424
180	-0.624	-0.400

T
A = 2.0 B = 5.5

	R	I
0	+0.586	-0.248
15	+0.428	-0.334
30	-0.028	-0.389
45	-0.462	-0.048
60	-0.298	+0.464
75	+0.214	+0.418
90	+0.259	+0.132
105	+0.255	+0.300
120	+0.638	+0.295
135	+0.628	-0.170
150	+0.022	-0.396
165	-0.558	-0.225
180	-0.762	-0.090

T
A = 2.0 B = 6.0

	R	I
0	+1.062	+0.160
15	+0.949	-0.018
30	+0.511	-0.333
45	-0.118	-0.241
60	-0.203	+0.276
75	+0.257	+0.305
90	+0.285	-0.005
105	+0.292	+0.158
120	+0.700	+0.058
135	+0.549	-0.421
150	-0.139	-0.399
165	-0.617	+0.036
180	-0.743	+0.265

32

T
A = 2·5 B = 3·0

	R	I
0	-0.614	-0.587
15	-0.610	-0.505
30	-0.559	-0.304
45	-0.413	-0.106
60	-0.223	-0.032
75	-0.123	-0.065
90	-0.151	-0.058
105	-0.186	+0.072
120	-0.112	+0.213
135	+0.021	+0.200
150	+0.088	+0.024
165	+0.067	-0.176
180	+0.042	-0.260

T
A = 2·5 B = 3·5

	R	I
0	-0.930	-1.058
15	-0.965	-0.918
30	-0.976	-0.549
45	-0.801	-0.130
60	-0.462	+0.080
75	-0.221	+0.035
90	-0.218	+0.012
105	-0.237	+0.207
120	-0.065	+0.408
135	+0.152	+0.329
150	+0.173	+0.011
165	+0.027	-0.294
180	-0.061	-0.411

T
A = 2·5 B = 4·0

	R	I
0	-0.937	-1.320
15	-1.030	-1.165
30	-1.169	-0.714
45	-1.065	-0.125
60	-0.646	+0.234
75	-0.268	+0.193
90	-0.209	+0.115
105	-0.185	+0.319
120	+0.086	+0.511
135	+0.330	+0.338
150	+0.225	-0.056
165	-0.087	-0.354
180	-0.248	-0.450

T
A = 2·5 B = 4·5

	R	I
0	-0.678	-1.311
15	-0.824	-1.189
30	-1.113	-0.769
45	-1.157	-0.101
60	-0.734	+0.389
75	-0.246	+0.355
90	-0.139	+0.200
105	-0.076	+0.378
120	+0.280	+0.515
135	+0.503	+0.236
150	+0.233	-0.156
165	-0.237	-0.338
180	-0.452	-0.366

T
A = 2·5 B = 5·0

	R	I
0	-0.242	-1.029
15	-0.416	-0.981
30	-0.826	-0.707
45	-1.062	-0.079
60	-0.716	+0.503
75	-0.161	+0.480
90	-0.032	+0.240
105	+0.048	+0.375
120	+0.467	+0.421
135	+0.621	+0.043
150	+0.185	-0.262
165	-0.378	-0.240
180	-0.609	-0.168

T
A = 2·5 B = 5·5

	R	I
0	+0.245	-0.531
15	+0.085	-0.583
30	-0.373	-0.544
45	-0.799	-0.079
60	-0.606	+0.540
75	-0.038	+0.541
90	+0.080	+0.224
105	+0.154	+0.314
120	+0.603	+0.248
135	+0.645	-0.208
150	+0.081	-0.348
165	-0.469	-0.075
180	-0.661	+0.105

T
A = 2·5 B = 6·0

	R	I
0	+0.654	+0.072
15	+0.554	-0.076
30	+0.153	-0.310
45	-0.419	-0.115
60	-0.437	+0.481
75	+0.090	+0.526
90	+0.171	+0.157
105	+0.216	+0.217
120	+0.658	+0.031
135	+0.556	-0.466
150	-0.065	-0.387
165	-0.479	+0.128
180	-0.578	+0.393

T
A = 2·5 B = 6·5

	R	I
0	+0.879	+0.646
15	+0.878	+0.434
30	+0.642	-0.047
45	+0.011	-0.185
60	-0.249	+0.327
75	+0.191	+0.442
90	+0.219	+0.058
105	+0.224	+0.110
120	+0.624	-0.191
135	+0.356	-0.678
150	-0.229	-0.357
165	-0.395	+0.326
180	-0.363	+0.625

TANGENTIAL DIPOLE   CYLINDER RADIUS 3.0 RADIANS (0.48λ)

T A = 3.0 B = 3.5			T A = 3.0 B = 4.0			T A = 3.0 B = 4.5			T A = 3.0 B = 5.0		
	R	I		R	I		R	I		R	I
0	-0.232	-0.844	0	-0.295	-1.436	0	-0.205	-1.679	0	-0.012	-1.538
15	-0.283	-0.760	15	-0.414	-1.312	15	-0.380	-1.569	15	-0.212	-1.488
30	-0.368	-0.524	30	-0.647	-0.930	30	-0.761	-1.164	30	-0.697	-1.188
45	-0.356	-0.238	45	-0.710	-0.389	45	-0.955	-0.473	45	-1.043	-0.481
60	-0.231	-0.072	60	-0.491	-0.009	60	-0.701	+0.105	60	-0.811	+0.241
75	-0.141	-0.073	75	-0.265	+0.022	75	-0.336	+0.187	75	-0.329	+0.369
90	-0.164	-0.075	90	-0.256	-0.012	90	-0.271	+0.102	90	-0.315	+0.214
105	-0.162	+0.049	105	-0.219	+0.165	105	-0.190	+0.269	105	-0.108	+0.338
120	-0.021	+0.177	120	+0.062	+0.321	120	+0.201	+0.371	120	+0.352	+0.333
135	+0.122	+0.144	135	+0.296	+0.196	135	+0.454	+0.125	135	+0.557	-0.040
150	+0.096	-0.005	150	+0.180	-0.049	150	+0.214	-0.137	150	+0.188	-0.244
165	-0.053	-0.131	165	-0.131	-0.182	165	-0.227	-0.166	165	-0.309	-0.089
180	-0.135	-0.173	180	-0.289	-0.206	180	-0.429	-0.125	180	-0.512	+0.044

T A = 3.0 B = 5.5			T A = 3.0 B = 6.0			T A = 3.0 B = 6.5			T A = 3.0 B = 7.0		
	R	I		R	I		R	I		R	I
0	+0.211	-1.057	0	+0.390	-0.353	0	+0.466	+0.408	0	+0.410	+1.049
15	+0.033	-1.095	15	+0.283	-0.483	15	+0.467	+0.212	15	+0.533	+0.837
30	-0.471	-1.005	30	-0.132	-0.657	30	+0.247	-0.215	30	+0.585	+0.238
45	-0.955	-0.430	45	-0.703	-0.345	45	-0.332	-0.256	45	+0.093	-0.182
60	-0.803	+0.356	60	-0.688	+0.412	60	-0.496	+0.381	60	-0.270	+0.256
75	-0.244	+0.521	75	-0.103	+0.605	75	+0.057	+0.602	75	+0.196	+0.512
90	-0.105	+0.289	90	+0.031	+0.304	90	+0.160	+0.256	90	+0.253	+0.155
105	-0.004	+0.358	105	+0.097	+0.330	105	+0.172	+0.266	105	+0.209	+0.182
120	+0.475	+0.221	120	+0.543	+0.060	120	+0.541	-0.119	120	+0.471	-0.283
135	+0.571	-0.261	135	+0.478	-0.490	135	+0.282	-0.675	135	+0.010	-0.770
150	+0.099	-0.341	150	-0.041	-0.394	150	-0.210	-0.380	150	-0.373	-0.286
165	-0.351	+0.033	165	-0.334	+0.176	165	-0.249	+0.309	165	-0.107	+0.399
180	-0.500	+0.261	180	-0.378	+0.470	180	-0.157	+0.615	180	+0.122	+0.649

33

TANGENTIAL DIPOLE   CYLINDER RADIUS 3·5 RADIANS (0·56λ)

T	A = 3·5 B = 4·0	
	R	I
0	+0.208	-0.857
15	+0.111	-0.814
30	-0.100	-0.650
45	-0.235	-0.365
60	-0.194	-0.126
75	-0.127	-0.067
90	-0.172	-0.051
105	-0.170	+0.063
120	+0.005	+0.130
135	+0.156	+0.039
150	+0.089	-0.060
165	-0.095	-0.049
180	-0.186	-0.017

T	A = 3·5 B = 4·5	
	R	I
0	+0.431	-1.414
15	+0.246	-1.375
30	-0.188	-1.151
45	-0.513	-0.645
60	-0.450	-0.139
75	-0.250	+0.014
90	-0.265	+0.024
105	-0.233	+0.192
120	+0.092	+0.240
135	+0.315	+0.006
150	+0.148	-0.147
165	-0.164	-0.043
180	-0.303	+0.056

T	A = 3·5 B = 5·0	
	R	I
0	+0.615	-1.585
15	+0.382	-1.590
30	-0.208	-1.420
45	-0.724	-0.822
60	-0.679	-0.094
75	-0.332	+0.162
90	-0.276	+0.147
105	-0.204	+0.312
120	+0.210	+0.271
135	+0.411	-0.114
150	+0.136	-0.250
165	-0.214	+0.008
180	-0.345	+0.191

T	A = 3·5 B = 5·5	
	R	I
0	+0.707	-1.362
15	+0.480	-1.433
30	-0.159	-1.412
45	-0.823	-0.866
60	-0.828	-0.003
75	-0.342	+0.333
90	-0.207	+0.266
105	-0.111	+0.397
120	+0.330	+0.230
135	+0.424	-0.285
150	+0.057	-0.342
165	-0.231	+0.090
180	-0.299	+0.347

T	A = 3·5 B = 6·0	
	R	I
0	+0.668	-0.820
15	+0.507	-0.959
30	-0.047	-1.139
45	-0.779	-0.783
60	-0.865	+0.102
75	-0.277	+0.482
90	-0.079	+0.341
105	+0.015	+0.428
120	+0.424	+0.132
135	+0.344	-0.465
150	-0.078	-0.390
165	-0.204	+0.182
180	-0.165	+0.481

T	A = 3·5 B = 6·5	
	R	I
0	+0.492	-0.103
15	+0.444	-0.285
30	+0.104	-0.661
45	-0.592	-0.601
60	-0.786	+0.186
75	-0.152	+0.572
90	+0.076	+0.348
105	+0.144	+0.401
120	+0.472	-0.003
135	+0.176	-0.608
150	-0.243	-0.371
165	-0.132	+0.264
180	+0.037	+0.546

T	A = 3·5 B = 7·0	
	R	I
0	+0.205	+0.610
15	+0.293	+0.431
30	+0.263	-0.077
45	-0.286	-0.365
60	-0.610	+0.214
75	-0.001	+0.581
90	+0.222	+0.282
105	+0.248	+0.322
120	+0.464	-0.153
135	-0.057	-0.676
150	-0.401	-0.272
165	-0.023	+0.313
180	+0.269	+0.514

T	A = 3·5 B = 7·5	
	R	I
0	-0.135	+1.148
15	+0.076	+1.024
30	+0.391	+0.497
45	+0.088	-0.121
60	-0.372	+0.167
75	+0.137	+0.504
90	+0.323	+0.154
105	+0.308	+0.212
120	+0.401	-0.290
135	-0.315	-0.642
150	-0.513	-0.099
165	+0.107	+0.310
180	+0.478	+0.373

35

T
A = 4.0　B = 4.5

	R	I
0	+0.617	-0.648
15	+0.494	-0.666
30	+0.185	-0.635
45	-0.100	-0.436
60	-0.158	-0.185
75	-0.102	-0.086
90	-0.146	-0.037
105	-0.152	+0.099
120	+0.011	+0.119
135	+0.116	-0.043
150	+0.036	-0.110
165	-0.079	+0.015
180	-0.120	+0.107

T
A = 4.0　B = 5.0

	R	I
0	+1.091	-1.041
15	+0.881	-1.109
30	+0.314	-1.130
45	-0.272	-0.799
60	-0.408	-0.271
75	-0.226	-0.036
90	-0.226	+0.030
105	-0.193	+0.244
120	+0.105	+0.219
135	+0.223	-0.124
150	+0.037	-0.219
165	-0.118	+0.048
180	-0.149	+0.226

T
A = 4.0　B = 5.5

	R	I
0	+1.335	-1.120
15	+1.100	-1.248
30	+0.404	-1.384
45	-0.418	-1.035
60	-0.650	-0.290
75	-0.331	+0.082
90	-0.232	+0.138
105	-0.141	+0.365
120	+0.224	+0.244
135	+0.254	-0.245
150	-0.030	-0.302
165	-0.128	+0.099
180	-0.096	+0.337

T
A = 4.0　B = 6.0

	R	I
0	+1.297	-0.895
15	+1.105	-1.073
30	+0.440	-1.354
45	-0.502	-1.102
60	-0.830	-0.238
75	-0.379	+0.238
90	-0.168	+0.241
105	-0.028	+0.437
120	+0.343	+0.200
135	+0.206	-0.376
150	-0.150	-0.338
165	-0.106	+0.155
180	+0.026	+0.410

T
A = 4.0　B = 6.5

	R	I
0	+0.985	-0.446
15	+0.896	-0.644
30	+0.423	-1.054
45	-0.494	-0.997
60	-0.907	-0.135
75	-0.356	+0.391
90	-0.052	+0.303
105	+0.113	+0.445
120	+0.436	+0.099
135	+0.086	-0.483
150	-0.295	-0.307
165	-0.053	+0.202
180	+0.192	+0.417

T
A = 4.0　B = 7.0

	R	I
0	+0.466	+0.100
15	+0.513	-0.074
30	+0.360	-0.550
45	-0.377	-0.748
60	-0.860	-0.017
75	-0.267	+0.506
90	+0.086	+0.303
105	+0.247	+0.387
120	+0.483	-0.043
135	-0.088	-0.534
150	-0.430	-0.201
165	+0.024	+0.226
180	+0.364	+0.341

T
A = 4.0　B = 7.5

	R	I
0	-0.145	+0.599
15	+0.037	+0.498
30	+0.262	+0.054
45	-0.162	-0.407
60	-0.696	+0.076
75	-0.135	+0.555
90	+0.213	+0.238
105	+0.345	+0.276
120	+0.473	-0.201
135	-0.287	-0.507
150	-0.518	-0.026
165	+0.113	+0.215
180	+0.498	+0.182

T
A = 4.0　B = 8.0

	R	I
0	-0.713	+0.926
15	-0.436	+0.935
30	+0.145	+0.633
45	+0.120	-0.041
60	-0.443	+0.112
75	+0.007	+0.525
90	+0.298	+0.118
105	+0.384	+0.136
120	+0.402	-0.350
135	-0.474	-0.396
150	-0.525	+0.189
165	+0.197	+0.164
180	+0.557	-0.036

TANGENTIAL DIPOLE   CYLINDER RADIUS 4·5 RADIANS (0·72λ)

T
A = 4·5   B = 5·0

	R	I
0	+0.858	-0.271
15	+0.757	-0.358
30	+0.449	-0.494
45	+0.062	-0.439
60	-0.118	-0.219
75	-0.099	-0.106
90	-0.131	-0.049
105	-0.111	+0.112
120	+0.040	+0.120
135	+0.055	-0.068
150	-0.047	-0.111
165	-0.045	+0.043
180	-0.004	+0.141

T
A = 4·5   B = 5·5

	R	I
0	+1.467	-0.397
15	+1.313	-0.578
30	+0.783	-0.893
45	+0.032	-0.837
60	-0.341	-0.360
75	-0.236	-0.079
90	-0.212	+0.001
105	-0.124	+0.251
120	+0.161	+0.204
135	+0.114	-0.158
150	-0.109	-0.198
165	-0.057	+0.079
180	+0.053	+0.234

T
A = 4·5   B = 6·0

	R	I
0	+1.716	-0.358
15	+1.570	-0.610
30	+0.975	-1.096
45	-0.017	-1.112
60	-0.571	-0.435
75	-0.366	+0.023
90	-0.231	+0.096
105	-0.058	+0.351
120	+0.293	+0.205
135	+0.106	-0.257
150	-0.210	-0.226
165	-0.044	+0.115
180	+0.155	+0.273

T
A = 4·5   B = 6·5

	R	I
0	+1.565	-0.185
15	+1.486	-0.461
30	+0.993	-1.066
45	-0.069	-1.211
60	-0.757	-0.426
75	-0.445	+0.176
90	-0.188	+0.195
105	+0.056	+0.397
120	+0.412	+0.133
135	+0.038	-0.342
150	-0.325	-0.188
165	-0.010	+0.144
180	+0.277	+0.247

T
A = 4·5   B = 7·0

	R	I
0	+1.064	+0.060
15	+1.089	-0.182
30	+0.842	-0.811
45	-0.098	-1.117
60	-0.854	-0.342
75	-0.450	+0.345
90	-0.094	+0.266
105	+0.183	+0.380
120	+0.491	+0.002
135	-0.078	-0.392
150	-0.425	-0.082
165	+0.041	+0.156
180	+0.389	+0.152

T
A = 4·5   B = 7·5

	R	I
0	+0.337	+0.298
15	+0.472	+0.149
30	+0.560	-0.384
45	-0.080	-0.851
60	-0.834	-0.213
75	-0.378	+0.490
90	+0.028	+0.286
105	+0.292	+0.303
120	+0.512	-0.164
135	-0.223	-0.387
150	-0.477	+0.079
165	+0.101	+0.145
180	+0.456	-0.1

T
A = 4·5   B = 8·0

	R	I
0	-0.445	+0.456
15	-0.226	+0.443
30	+0.203	+0.124
45	-0.005	-0.462
60	-0.693	-0.080
75	-0.245	+0.576
90	+0.150	+0.247
105	+0.357	+0.186
120	+0.462	-0.338
135	-0.368	-0.317
150	-0.453	+0.271
165	+0.157	+0.107
180	+0.451	-0.188

T
A = 4·5   B = 8·5

	R	I
0	-1.099	+0.486
15	-0.851	+0.625
30	-0.160	+0.608
45	+0.123	-0.022
60	-0.449	+0.018
75	-0.082	+0.580
90	+0.243	+0.156
105	+0.365	+0.052
120	+0.346	-0.487
135	-0.486	-0.184
150	-0.342	+0.454
165	+0.198	+0.043
180	+0.359	-0.370

TANGENTIAL DIPOLE

CYLINDER RADIUS 5.0 RADIANS (0.80λ)

T A = 5.0 B = 5.5

	R	I
0	+0.887	+0.187
15	+0.841	+0.043
30	+0.621	-0.262
45	+0.220	-0.395
60	-0.056	-0.235
75	-0.091	-0.106
90	-0.137	-0.053
105	-0.086	+0.101
120	+0.079	+0.096
135	+0.018	+0.058
150	-0.109	-0.051
165	-0.015	+0.049
180	+0.088	+0.088

T A = 5.0 B = 6.0

	R	I
0	+1.491	+0.373
15	+1.441	+0.106
30	+1.095	-0.490
45	+0.335	-0.784
60	-0.229	-0.426
75	-0.229	-0.092
90	-0.227	-0.007
105	-0.089	+0.225
120	+0.222	+0.139
135	+0.049	-0.145
150	-0.203	-0.080
165	-0.012	+0.078
180	+0.183	+0.111

T A = 5.0 B = 6.5

	R	I
0	+1.700	+0.521
15	+1.688	+0.193
30	+1.351	-0.601
45	+0.383	-1.067
60	-0.425	-0.559
75	-0.366	-0.005
90	-0.257	+0.090
105	-0.027	+0.310
120	+0.351	+0.100
135	+0.025	-0.225
150	-0.294	-0.046
165	+0.008	+0.099
180	+0.273	+0.074

T A = 5.0 B = 7.0

	R	I
0	+1.490	+0.591
15	+1.546	+0.278
30	+1.349	-0.571
45	+0.364	-1.185
60	-0.603	-0.606
75	-0.459	+0.136
90	-0.225	+0.199
105	+0.071	+0.346
120	+0.445	-0.006
135	-0.045	-0.284
150	-0.360	+0.046
165	+0.042	+0.109
180	+0.336	-0.018

T A = 5.0 B = 7.5

	R	I
0	+0.932	+0.555
15	+1.061	+0.334
30	+1.096	-0.403
45	+0.295	-1.113
60	-0.719	-0.560
75	-0.482	+0.300
90	-0.135	+0.285
105	+0.179	+0.327
120	+0.482	-0.158
135	-0.150	-0.306
150	-0.379	+0.180
165	+0.084	+0.102
180	+0.352	-0.148

T A = 5.0 B = 8.0

	R	I
0	+0.173	+0.404
15	+0.355	+0.336
30	+0.651	-0.131
45	+0.207	-0.858
60	-0.740	-0.441
75	-0.425	+0.450
90	-0.007	+0.324
105	+0.269	+0.261
120	+0.450	-0.327
135	-0.270	-0.277
150	-0.331	+0.331
165	+0.124	+0.076
180	+0.303	-0.289

T A = 5.0 B = 8.5

	R	I
0	-0.598	+0.162
15	-0.408	+0.272
30	+0.106	+0.189
45	+0.130	-0.461
60	-0.648	-0.283
75	-0.301	+0.548
90	+0.130	+0.302
105	+0.322	+0.161
120	+0.345	-0.482
135	-0.381	-0.192
150	-0.211	+0.467
165	+0.155	+0.030
180	+0.186	-0.410

T A = 5.0 B = 9.0

	R	I
0	-1.198	-0.127
15	-1.054	+0.146
30	-0.430	+0.489
45	+0.087	+0.008
60	-0.452	-0.128
75	-0.138	+0.569
90	+0.247	+0.219
105	+0.326	+0.050
120	+0.181	-0.591
135	-0.460	-0.058
150	-0.026	+0.551
165	+0.167	-0.031
180	+0.014	-0.477

TANGENTIAL DIPOLE   CYLINDER RADIUS 5.5 RADIANS (0.88λ)

T A = 5.5 B = 6.0

T	R	I
0	+0.691	+0.595
15	+0.727	+0.437
30	+0.674	+0.031
45	+0.344	-0.297
60	+0.008	-0.249
75	-0.070	-0.110
90	-0.136	-0.041
105	-0.081	+0.100
120	+0.095	+0.050
135	+0.004	-0.050
150	-0.112	+0.033
165	+0.006	+0.046
180	+0.111	-0.003

T A = 5.5 B = 6.5

T	R	I
0	+1.139	+1.048
15	+1.235	+0.774
30	+1.203	+0.027
45	+0.585	-0.623
60	-0.110	-0.482
75	-0.198	-0.115
90	-0.224	+0.010
105	-0.081	+0.221
120	+0.234	+0.046
135	+0.013	-0.140
150	-0.194	+0.064
165	+0.019	+0.069
180	+0.186	-0.049

T A = 5.5 B = 7.0

T	R	I
0	+1.258	+1.273
15	+1.421	+0.963
30	+1.488	+0.035
45	+0.727	-0.872
60	-0.267	-0.667
75	-0.339	-0.056
90	-0.252	+0.109
105	-0.022	+0.306
120	+0.337	-0.025
135	-0.026	-0.213
150	-0.240	+0.137
165	+0.043	+0.081
180	+0.221	-0.130

T A = 5.5 B = 7.5

T	R	I
0	+1.042	+1.225
15	+1.260	+0.964
30	+1.478	+0.058
45	+0.749	-0.990
60	-0.433	-0.762
75	-0.449	+0.060
90	-0.216	+0.218
105	+0.074	+0.345
120	+0.389	-0.145
135	-0.106	-0.256
150	-0.239	+0.237
165	+0.075	+0.078
180	+0.206	-0.238

T A = 5.5 B = 8.0

T	R	I
0	+0.566	+0.915
15	+0.805	+0.779
30	+1.182	+0.099
45	+0.658	-0.946
60	-0.566	-0.751
75	-0.499	+0.208
90	-0.122	+0.305
105	+0.181	+0.333
120	+0.379	-0.288
135	-0.211	-0.256
150	-0.182	+0.343
165	+0.108	+0.059
180	+0.136	-0.322

T A = 5.5 B = 8.5

T	R	I
0	-0.037	+0.413
15	+0.172	+0.445
30	+0.664	+0.152
45	+0.485	-0.735
60	-0.628	-0.640
75	-0.475	+0.357
90	+0.011	+0.342
105	+0.275	+0.273
120	+0.302	-0.427
135	-0.322	-0.203
150	-0.069	+0.429
165	+0.135	+0.023
180	+0.017	-0.385

T A = 5.5 B = 9.0

T	R	I
0	-0.611	-0.172
15	-0.483	+0.029
30	+0.033	+0.208
45	+0.274	-0.388
60	-0.592	-0.457
75	-0.381	+0.470
90	+0.155	+0.315
105	+0.336	+0.178
120	+0.166	-0.533
135	-0.413	-0.098
150	+0.090	+0.467
165	+0.146	-0.027
180	-0.134	-0.394

T A = 5.5 B = 9.5

T	R	I
0	-1.011	-0.707
15	-1.007	-0.383
30	-0.584	+0.249
45	+0.070	+0.040
60	-0.449	-0.243
75	-0.237	+0.518
90	+0.277	+0.224
105	+0.353	+0.068
120	-0.010	-0.582
135	-0.463	+0.051
150	+0.270	+0.436
165	+0.136	-0.085
180	-0.291	-0.334

TANGENTIAL DIPOLE   CYLINDER RADIUS 6·0 RADIANS (0·96λ)

T
A = 6.0   B = 6.5

θ	R	I
0	+0.314	+0.859
15	+0.439	+0.729
30	+0.603	+0.316
45	+0.427	-0.154
60	+0.064	-0.242
75	-0.053	-0.123
90	-0.121	-0.036
105	-0.069	+0.112
120	+0.083	+0.015
135	-0.013	-0.052
150	-0.061	+0.092
165	+0.027	+0.040
180	+0.067	-0.074

T
A = 6.0   B = 7.0

θ	R	I
0	+0.491	+1.478
15	+0.735	+1.268
30	+1.091	+0.535
45	+0.769	-0.374
60	+0.004	-0.494
75	-0.178	-0.151
90	-0.201	+0.009
105	-0.056	+0.239
120	+0.201	-0.030
135	-0.035	-0.144
150	-0.100	+0.155
165	+0.049	+0.056
180	+0.085	-0.152

T
A = 6.0   B = 7.5

θ	R	I
0	+0.493	+1.736
15	+0.818	+1.521
30	+1.352	+0.659
45	+0.993	-0.556
60	-0.102	-0.709
75	-0.326	-0.118
90	-0.227	+0.099
105	+0.015	+0.323
120	+0.273	-0.102
135	-0.099	-0.204
150	-0.094	+0.228
165	+0.077	+0.057
180	+0.057	-0.227

T
A = 6.0   B = 8.0

θ	R	I
0	+0.333	+1.590
15	+0.679	+1.444
30	+1.337	+0.669
45	+1.060	-0.661
60	-0.238	-0.841
75	-0.458	-0.024
90	-0.195	+0.198
105	+0.120	+0.357
120	+0.293	-0.214
135	-0.193	-0.231
150	-0.043	+0.296
165	+0.106	+0.041
180	-0.014	-0.281

T
A = 6.0   B = 8.5

θ	R	I
0	+0.070	+1.086
15	+0.364	+1.062
30	+1.050	+0.572
45	+0.963	-0.656
60	-0.368	-0.862
75	-0.539	+0.114
90	-0.110	+0.277
105	+0.234	+0.335
120	+0.255	-0.332
135	-0.299	-0.186
150	+0.049	+0.341
165	+0.129	+0.009
180	-0.118	-0.300

T
A = 6.0   B = 9.0

θ	R	I
0	-0.215	+0.350
15	-0.043	+0.466
30	+0.553	+0.395
45	+0.730	-0.526
60	-0.454	-0.769
75	-0.547	+0.269
90	+0.012	+0.311
105	+0.333	+0.263
120	+0.163	-0.434
135	-0.394	-0.097
150	+0.171	+0.346
165	+0.139	-0.037
180	-0.236	-0.268

T
A = 6.0   B = 9.5

θ	R	I
0	-0.438	-0.445
15	-0.435	-0.212
30	-0.053	+0.175
45	+0.409	-0.282
60	-0.463	-0.582
75	-0.479	+0.405
90	+0.143	+0.287
105	+0.395	+0.153
120	+0.028	-0.406
135	-0.452	+0.041
150	+0.302	+0.297
165	+0.129	-0.090
180	-0.342	-0.180

T
A = 6.0   B = 10.0

θ	R	I
0	-0.536	-1.113
15	-0.715	-0.822
30	-0.642	-0.047
45	+0.064	+0.042
60	-0.376	-0.339
75	-0.348	+0.490
90	+0.255	+0.204
105	+0.407	+0.026
120	-0.130	-0.504
135	-0.452	+0.209
150	+0.417	+0.188
165	+0.095	-0.141
180	-0.410	-0.044

40

R A = 0.25 B = 0.75

R	R	I
0	+0.000	+0.000
15	+0.229	+0.161
30	+0.465	+0.281
45	+0.705	+0.326
60	+0.922	+0.276
75	+1.077	+0.138
90	+1.134	-0.053
105	+1.077	-0.240
120	+0.922	-0.367
135	+0.705	-0.400
150	+0.465	-0.333
165	+0.228	-0.188
180	+0.000	+0.000

R A = 0.5 B = 1.0

R	R	I
0	+0.000	+0.000
15	+0.211	+0.179
30	+0.448	+0.312
45	+0.713	+0.354
60	+0.976	+0.272
75	+1.175	+0.069
90	+1.249	-0.205
105	+1.172	-0.464
120	+0.971	-0.626
135	+0.708	-0.643
150	+0.443	-0.517
165	+0.208	-0.285
180	+0.000	+0.000

R A = 0.75 B = 1.25

R	R	I
0	+0.000	+0.000
15	+0.145	+0.212
30	+0.338	+0.374
45	+0.598	+0.426
60	+0.888	+0.320
75	+1.121	+0.048
90	+1.206	-0.324
105	+1.103	-0.674
120	+0.855	-0.881
135	+0.561	-0.884
150	+0.306	-0.697
165	+0.126	-0.380
180	+0.000	+0.000

R A = 1.0 B = 1.5

R	R	I
0	+0.000	+0.000
15	+0.068	+0.275
30	+0.209	+0.499
45	+0.456	+0.599
60	+0.770	+0.498
75	+1.035	+0.167
90	+1.119	-0.312
105	+0.967	-0.771
120	+0.652	-1.037
135	+0.319	-1.038
150	+0.090	-0.809
165	-0.001	-0.435
180	+0.000	+0.000

R A = 1.25 B = 1.75

R	R	I
0	+0.000	+0.000
15	+0.015	+0.334
30	+0.122	+0.626
45	+0.372	+0.792
60	+0.721	+0.719
75	+1.019	+0.349
90	+1.085	-0.229
105	+0.849	-0.789
120	+0.427	-1.107
135	+0.032	-1.102
150	-0.172	-0.840
165	-0.155	-0.444
180	+0.000	+0.000

R A = 1.5 B = 2.0

R	R	I
0	+0.000	+0.000
15	-0.024	+0.347
30	+0.059	+0.677
45	+0.320	+0.905
60	+0.719	+0.883
75	+1.066	+0.505
90	+1.115	-0.139
105	+0.771	-0.765
120	+0.207	-1.094
135	-0.270	-1.054
150	-0.451	-0.765
165	-0.319	-0.386
180	+0.000	+0.000

R A = 1.75 B = 2.25

R	R	I
0	+0.000	+0.000
15	-0.088	+0.311
30	-0.047	+0.645
45	+0.220	+0.926
60	+0.687	+0.964
75	+1.121	+0.601
90	+1.185	-0.079
105	+0.748	-0.729
120	+0.044	-1.016
135	-0.520	-0.898
150	-0.686	-0.576
165	-0.456	-0.257
180	+0.000	+0.000

R A = 2.0 B = 2.5

R	R	I
0	+0.000	+0.000
15	-0.182	+0.266
30	-0.213	+0.592
45	+0.042	+0.915
60	+0.586	+1.012
75	+1.144	+0.657
90	+1.272	-0.068
105	+0.776	-0.730
120	-0.046	-0.931
135	-0.680	-0.687
150	-0.832	-0.316
165	-0.536	-0.080
180	+0.000	+0.000

A = 2.5 B = 3.0

R	R	I
0	+0.000	+0.000
15	-0.326	+0.197
30	-0.513	+0.516
45	-0.355	+0.927
60	+0.266	+1.130
75	+1.055	+0.740
90	+1.345	-0.167
105	+0.796	-0.898
120	-0.141	-0.871
135	-0.761	-0.271
150	-0.808	+0.260
165	-0.472	+0.323
180	+0.000	+0.000

A = 3.0 B = 3.5

R	R	I
0	+0.000	+0.000
15	-0.352	+0.027
30	-0.646	+0.280
45	-0.637	+0.814
60	-0.043	+1.253
75	+0.890	+0.935
90	+1.268	-0.182
105	+0.625	-1.085
120	-0.321	-0.906
135	-0.673	-0.015
150	-0.430	+0.633
165	-0.124	+0.572
180	+0.000	+0.000

A = 3.5 B = 4.0

R	R	I
0	+0.000	+0.000
15	-0.363	-0.159
30	-0.745	-0.045
45	-0.882	+0.530
60	-0.304	+1.234
75	+0.820	+1.120
90	+1.267	-0.096
105	+0.395	-1.117
120	-0.631	-0.829
135	-0.623	+0.136
150	+0.024	+0.661
165	+0.309	+0.503
180	+0.000	+0.000

A = 4.0 B = 4.5

R	R	I
0	+0.000	+0.000
15	-0.249	-0.284
30	-0.684	-0.326
45	-1.062	+0.196
60	-0.630	+1.095
75	+0.707	+1.191
90	+1.347	-0.076
105	+0.278	-1.075
120	-0.872	-0.555
135	-0.597	+0.337
150	+0.317	+0.448
165	+0.565	+0.146
180	+0.000	+0.000

A = 4.5 B = 5.0

R	R	I
0	+0.000	+0.000
15	-0.082	-0.395
30	-0.476	-0.596
45	-1.077	-0.153
60	-0.926	+0.951
75	+0.507	+1.270
90	+1.364	-0.133
105	+0.206	-1.120
120	-0.923	-0.235
135	-0.451	+0.602
150	+0.404	+0.197
165	+0.496	-0.281
180	+0.000	+0.000

A = 5.0 B = 5.5

R	R	I
0	+0.000	+0.000
15	+0.089	-0.387
30	-0.202	-0.761
45	-0.953	-0.540
60	-1.118	+0.716
75	+0.324	+1.383
90	+1.316	-0.128
105	+0.047	-1.196
120	-0.870	-0.016
135	-0.127	+0.773
150	+0.383	+0.021
165	+0.157	-0.525
180	+0.000	+0.000

A = 5.5 B = 6.0

R	R	I
0	+0.000	+0.000
15	+0.276	-0.300
30	+0.129	-0.774
45	-0.744	-0.852
60	-1.272	+0.396
75	+0.181	+1.431
90	+1.324	-0.076
105	-0.167	-1.181
120	-0.845	+0.146
135	+0.250	+0.720
150	+0.353	-0.110
165	-0.238	-0.462
180	+0.000	+0.000

A = 6.0 B = 6.5

R	R	I
0	+0.000	+0.000
15	+0.380	-0.156
30	+0.454	-0.659
45	-0.405	-1.046
60	-1.370	+0.073
75	-0.015	+1.420
90	+1.372	-0.074
105	-0.316	-1.091
120	-0.827	+0.357
135	+0.502	+0.485
150	+0.300	-0.259
165	-0.460	-0.160
180	+0.000	+0.000

A RECENT BBC DEVELOPMENT

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Modifications have been made to the 'synchro-guide' circuit to overcome certain defects in its performance. Details of the unmodified circuit are shown in Fig. 1. The purpose of the circuit is to provide a regular line time base from an irregular or disturbed television signal.

Referring to Fig. 1, the signal on the grid of valve V_1 consists of positive-going syncs and a sawtooth waveform derived from the blocking oscillator valve V_2. Valve V_1 conducts only during the periods when the syncs overlap the latter portion of the sawtooth waveform since it is biased to 'cut-off' by the anode current through resistor R_1 smoothed by capacitors C_1 and C_2 and the RC network R_4C_3. The current flowing through valve V_1 for this period generates a potential difference across resistor R_3 which controls the repetition frequency of the blocking oscillator valve V_2. The circuit then adjusts itself so that the phase relationship between syncs and the sawtooth waveform is such that the correct current flows through valve V_1 and hence resistor R_3, thereby biasing valve V_2 to give the correct mean repetition frequency. The circuit suffers from a degenerative effect since increasing current through valve V_1 increases its bias, nullifying to some extent the increased conduction period.

To overcome the above defect the improved arrangement shown in Fig. 2 has been devised. In this arrangement the bias for valve V_1 is obtained from the grid current to valve V_2 flowing through resistor R_3, smoothed by the capacitor C_3. Since the mean grid current is nearly constant, an almost constant bias may be obtained for valve V_1 and the current through valve V_1 does not affect this bias and therefore the degenerative effect present in the original circuit is removed.

A simplification of the circuit shown in Fig. 2 may be achieved by removing capacitor C_3 and resistor R_4, under which conditions the circuit for feeding back a sawtooth waveform from the output to the grid of V_1 may no longer be necessary.

The advantages claimed for the modified arrangements are:

1. No degenerative effect takes place in valve V_1 and thus a greater control voltage may be obtained for a given change of phase.

2. A greater locking range may be obtained.

3. The circuit requires fewer components.
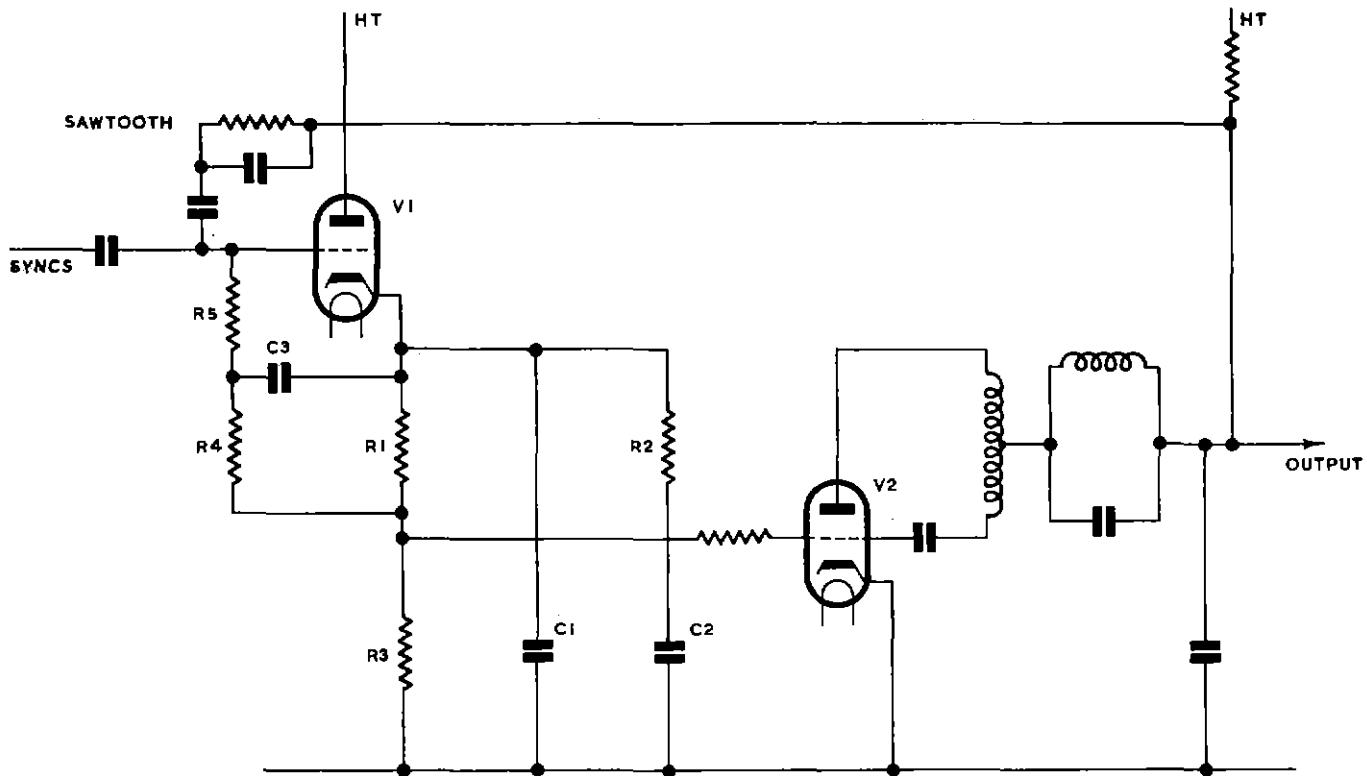
Fig. 1 — Unmodified synchro-guide circuit
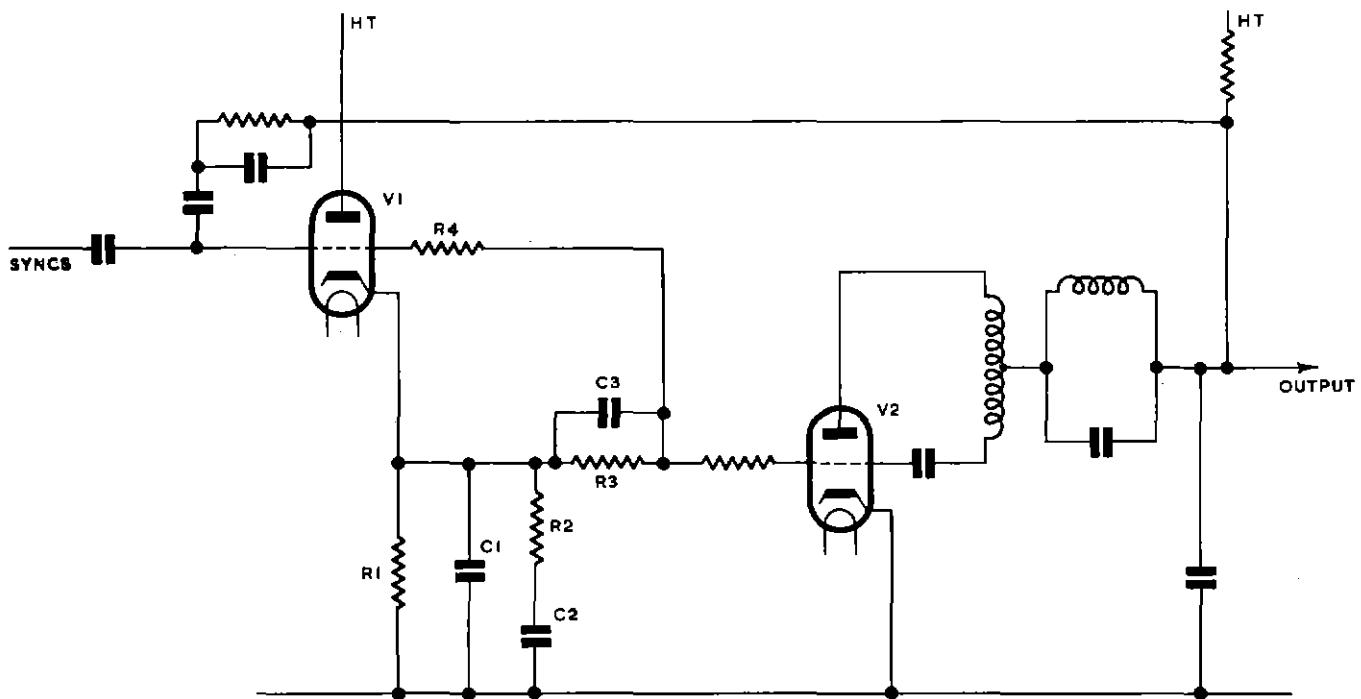
Fig. 2 — Modifications to overcome degenerative effect

43