IEC/PAS 62707-1

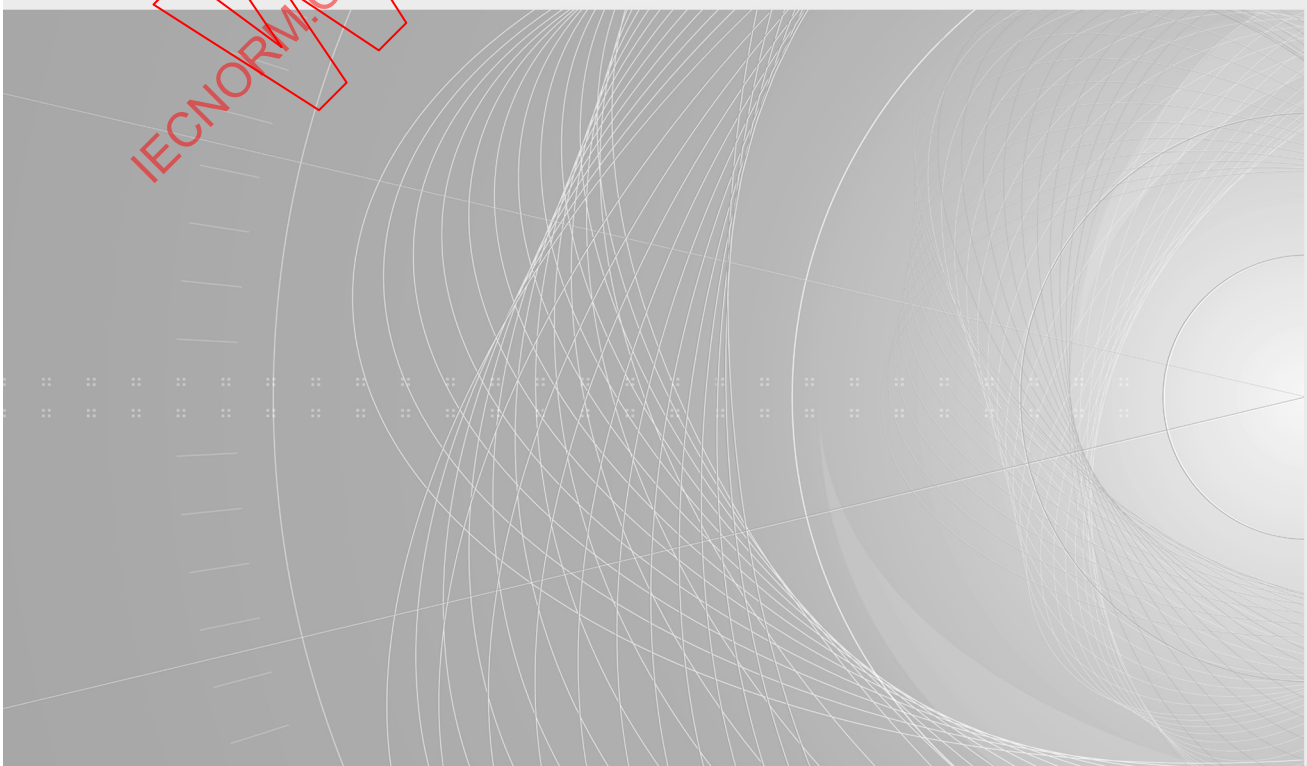
Edition 1.0 2011-03

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

colour inside

LED – Binning – Part 1: General requirements and white grid



IEC/PAS 62707-1:2011(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE Q

ICS 29.140.99

ISBN 978-2-88912-402-2

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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IEC-PAS 62707-1 has been processed by subcommittee 34A: Lamps, of IEC technical committee 34: Lamps and related equipment.

The text of this PAS is based on the following document:

This PAS was approved for publication by the P-members of the committee concerned as indicated in the following document

Draft PAS	Report on voting
34A/1429/PAS	34A/1448/RVD

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

A list of all the parts in the IEC 62707 series, published under the general title *LED – Binning* can be found on the IEC website.

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LED – BINNING –

Part 1: General requirements and white grid

1 Scope

This PAS specifies general requirements, a grid and a corresponding code for the colour binning of white LEDs emitting incoherent, visible radiation.

Other parts of this series covering chromaticity of coloured LEDs, luminous flux/luminous intensity, colour rendering and forward voltage are in preparation or under consideration.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC/TS 62504,___ *General lighting – LEDs and LED modules – Terms and definitions*[1]

ISO 11664-1 (CIE S 014-1/E), *Colorimetry – Part 1: CIE standard colorimetric observers*

ISO 11664-5 (CIE S 014-5/E), *Colorimetry – Part 5: CIE 1976 L*u*v* Colour space and u', v' uniform chromaticity scale diagram*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC/TS 62504 and the following apply.

3.1
bin
restricted range of LED performance characteristic used to delimit a subset of LEDs near a nominal LED performance as identified by chromaticity, photometric performance and forward voltage

(IEC/TS 62504: ___, 3.5)

3.2
grid
entity specified by a set of grid points

3.3
grid point
colour coordinate in the u', v' colour space according to ISO 11664-5 (CIE S 014-5/E) (or its equivalent in the x, y colour space according to ISO 11664-1 (CIE S 014-1/E)) identified by two discrete indices, the first index p counting steps along the Planckian locus, and its extension beyond the high temperature boundary towards blue colours, and second index j along Judd isothermal lines

[1] To be published

3.4
white colour bin
area inside a quadrilateral defined by four grid points

4 Chromaticity bins for white LEDs

4.1 Grid for white LEDs

The grid shall be aligned parallel along the Planckian locus, and its extension beyond the high temperature boundary towards blue colours, in the first direction (Planck-axis) and along Judd isothermal lines in the second direction (Judd-axis).

The origin of the grid shall be on the Planckian locus at T_∞ (u'/v') = (0,18006/0,39528).

The distance between adjacent grid points along the Planckian locus and its extension beyond the high temperature boundary towards blue colours and along Judd isothermal lines in the u', v' colour space shall be s = 0,00174. Steps along the Planckian locus are counted with a positive index p, steps toward blue with a negative index p. Steps towards the saturated colour line (gamut) along the Judd-axis are counted with a positive index j and with negative index j in the opposite direction.

NOTE 1 = 0,00174 has been chosen as providing for the best alignment with existing chromaticity requirements.

The extension of the Planckian locus beyond T_∞ (towards blue) shall be defined as follows (see Figure 1 for information):

- Quadratic Bézier locus defined by three points:
  - P_1: T_∞ (u'/v') = (0,18006/0,39528)
  - P_2: (u'/v') = (0,14122/0,15593)
  - P_3: (u'/v') = (0,25680/0,01659)
- The Bézier locus is $B(t) = P_1 \times (1-t)^2 + P_2 \times t \times (1-t) + P_3 \times t^2$; $t \in (0;1)$

NOTE 2 P_2 is the intersection of spectral locus of the u', v' colour space and tangent of Planckian locus at T_∞ in direction of blue wavelength.

NOTE 3 P_3 corresponds to a wavelength of 380 nm on the spectral locus of the u', v' colour space.

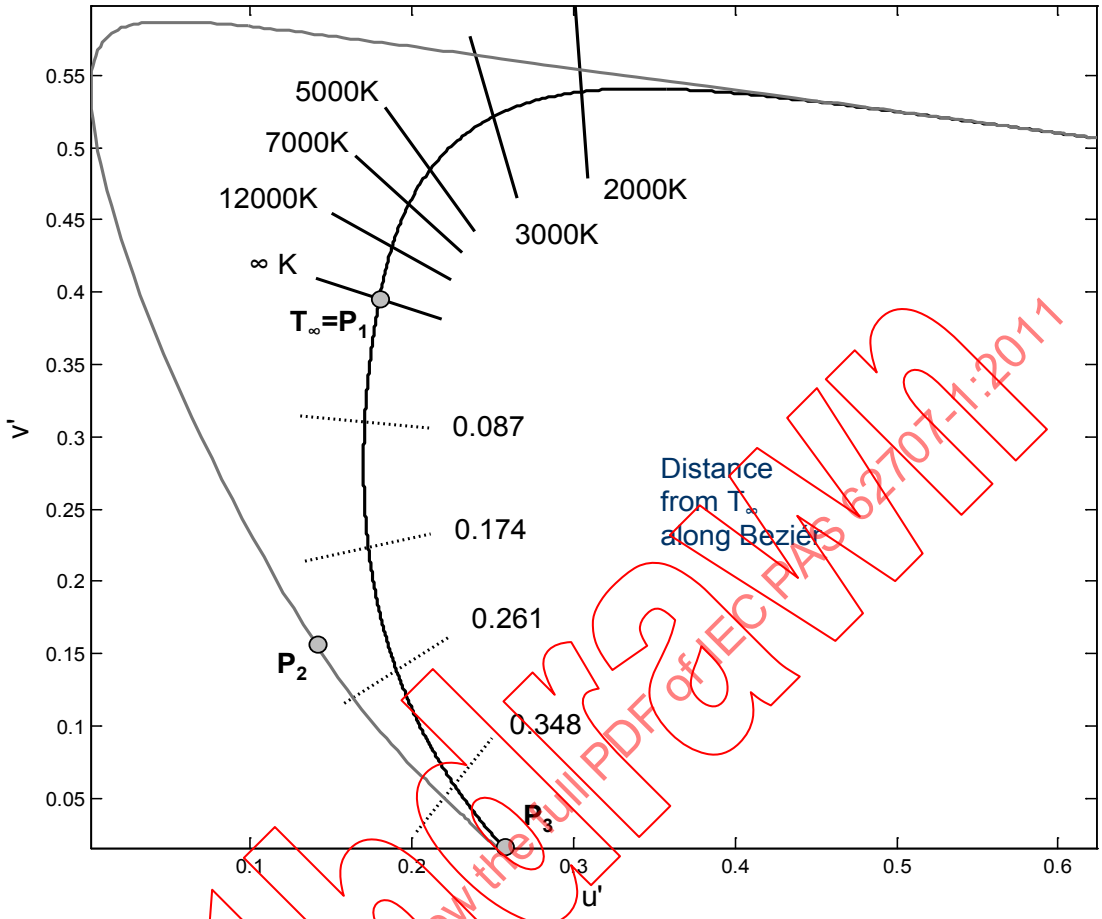

Figure 1 – Extension of the Planckian locus beyond T_∞

The coordinates $u'_{BB}(p)$ and $v'_{BB}(p)$ of the grid points on the Planckian locus (BB = Black Body) are given in Annex A, as well as the unit increments $\Delta u'_{BB}(p)$ and $\Delta v'_{BB}(p)$ of the corresponding Judd isothermal lines.

The u' and v' coordinates of a grid point specified by the indices p and j are given by

$u'(p, j) = u'_{BB}(p) + j \times \Delta u'_{BB}(p)$

$v'(p, j) = v'_{BB}(p) + j \times \Delta v'_{BB}(p)$

or

$u', v' (p, j) = (u'_{BB}(p) + j \times \Delta u'_{BB}(p); v'_{BB}(p) + j \times \Delta v'_{BB}(p))$

The index (p, j) = (0, 0) corresponds to the T_∞ point and the coordinates are (rounded to five digits):

u' (0, 0) = 0,18006, v' (0, 0) = 0,39528 or

u', v' (0, 0) = (0,18006; 0,39528)

Grid points in the u', v' coordinate system can be translated into equivalent grid points in the x, y coordinate system using the following equations:

$x(p, j) = 9u'(p, j)/(6u'(p, j) - 16v'(p, j) + 12)$

$y(p, j) = 4v'(p, j)/(6u'(p, j) - 16v'(p, j) + 12)$

It is recommended to round grid point coordinates to 5 digits after the decimal sign.

4.2 White colour bins

White colour bins are specified as the area inside a quadrilateral. An origin (p, j) and a positive step size m, n along the Planckian locus (or its extension beyond T_∞) and the Judd lines respectively is given. The quadrilateral is constructed by connecting the four grid points

[u', v' (p, j)], [u', v' (p+m, j)], [u', v' (p, j+n)] and [u', v' (p+m, j+n)]

or

[x, y (p, j)], [x, y (p+m, j)], [x, y (p, j+n)] and [x, y (p+m, j+n)]

It should be noted that white colour bins with step sizes of m or n equal 1 are not considered to be practical in view of measurement accuracy.

4.3 Code for the chromaticity of white LEDs

4.3.1 Optional six digit code for the designation of white colour bins in x, y colour space

This subclause specifies an optional code for white colour bins in the x, y colour space using only six digits. The first four digits are reserved for the identification of the grid point representing the origin of the white colour bin. The last two digits are reserved for the number of steps along the Planckian locus (or its extension beyond T_∞) and the Judd lines respectively.

The first digit is:

"e" for $p \geq 0$ and $j < 0$

"f" for $p \geq 0$ and $j \geq 0$

"g" for $p < 0$ and $j \geq 0$

"h" for $p < 0$ and $j < 0$

The second and third digits represent the absolute value of p starting at "aa". Only the following letters shall be used in the counting for the second and third digit:

a b c d e f g h j k l m n p r s t u v w x y z

The code for |p| is specified in Table 1.

Table 1 – Code for |p|

|p|	0	1	…	7	8	…
code	aa	ab	…	ah	aj	…

The fourth digits represent the absolute value of j starting at "A". Only the following letters shall be used in the counting for the second and third digit:

A B C D E F G H J K L M N P R S T U V W X Y Z

The code for |j| is specified in Table 2.

Table 2 – Code for |j|

|j|	0	1	…	7	8	…
code	A	B	…	H	J	…

The fifth and sixth digits represent the number of steps m and n along the Planckian locus (or its extension beyond T_∞) and the Judd lines respectively. The following characters shall be used in the counting for the fifth and sixth digit:

(1) 2 3 4 5 6 7 8 9 a b c d e f g h j k l m n p r s t u v w x y z

The code for m and n is specified in Table 3.

Table 3 – Code for m and n

m, n	…	8	9	10	11	…
code	…	8	9	a	b	…

Examples for white colour bin codes are given in the following Table 4.

Table 4 – Examples for white colour bin codes

p	**j**	**m**	**n**	**6 digit code**
0	0	2	3	faaA23
9	-3	5	6	eakC56
0	0	10	10	faaAaa

An example of the codes of grid points around the T_∞ point is given in Figure 2.

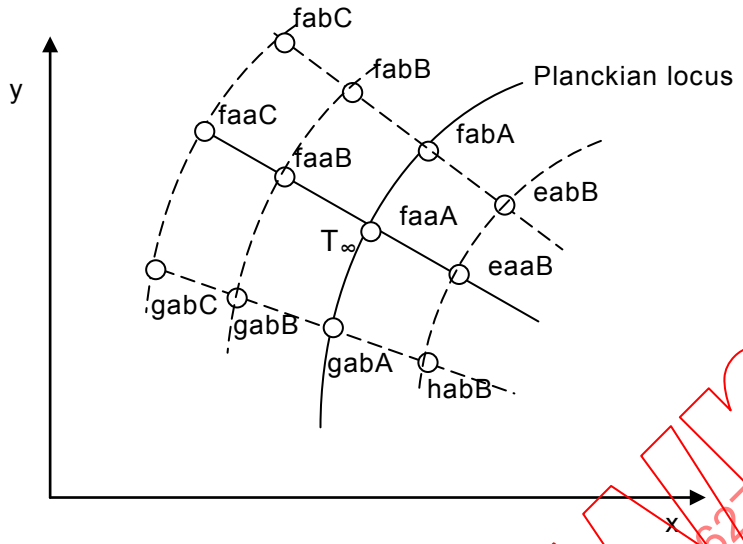

Figure 2 – Example of grid points with short (four digit) designation

An example of the short six digit code of a white colour bin is given in Figure 3.

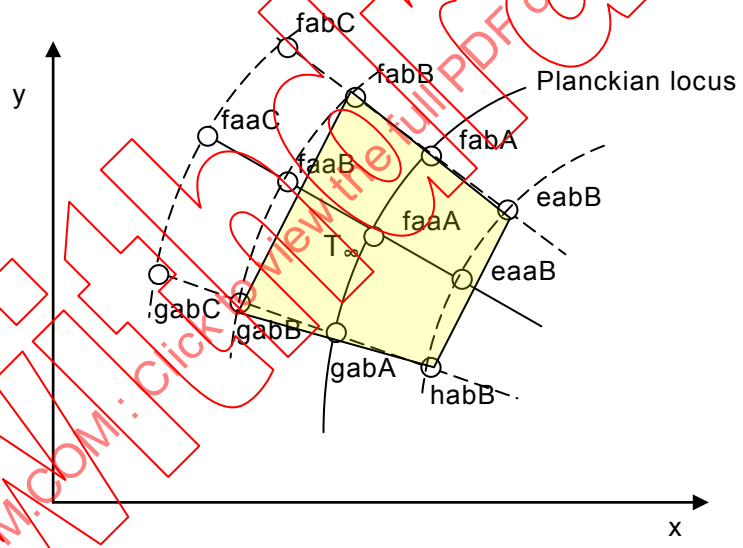

Figure 3 – Example of white colour bin "habB22"

4.3.2 Other codes for the designation of white colour bins

Other codes for the designation of white colour bins may be applicable (e. g. application specific).

5 Bin code

The bin code for LEDs shall consist of sections in the following order (with hyphens as separators, no space allowed):

Luminous flux code–chromaticity code–forward voltage code (optional)–
colour rendering index code (optional)

Annex A
(informative)

White binning grid coordinates

p	u'_{BB}	v'_{BB}	$\Delta u'_{BB}$	$\Delta v'_{BB}$
0	0,180064	0,395282	-0,0016345	0,0005968
1	0,180346	0,396999	-0,0016303	0,0006082
2	0,180634	0,398715	-0,0016257	0,0006203
3	0,180928	0,400430	-0,0016208	0,0006330
4	0,181229	0,402144	-0,0016155	0,0006463
5	0,181537	0,403856	-0,0016099	0,0006601
6	0,181853	0,405567	-0,0016040	0,0006744
7	0,182177	0,407277	-0,0015978	0,0006890
8	0,182508	0,408985	-0,0015912	0,0007041
9	0,182848	0,410691	-0,0015843	0,0007195
10	0,183197	0,412396	-0,0015771	0,0007352
11	0,183554	0,414099	-0,0015695	0,0007512
12	0,183921	0,415800	-0,0015616	0,0007674
13	0,184297	0,417499	-0,0015534	0,0007838
14	0,184682	0,419196	-0,0015449	0,0008005
15	0,185078	0,420890	-0,0015361	0,0008173
16	0,185483	0,422582	-0,0015269	0,0008343
17	0,185899	0,424272	-0,0015174	0,0008515
18	0,186326	0,425959	-0,0015076	0,0008688
19	0,186763	0,427643	-0,0014975	0,0008861
20	0,187211	0,429324	-0,0014870	0,0009036
21	0,187670	0,431002	-0,0014762	0,0009211
22	0,188141	0,432678	-0,0014651	0,0009387
23	0,188623	0,434349	-0,0014536	0,0009563
24	0,189118	0,436018	-0,0014419	0,0009740
25	0,189624	0,437682	-0,0014298	0,0009916
26	0,190143	0,439343	-0,0014174	0,0010092
27	0,190674	0,441000	-0,0014047	0,0010268
28	0,191218	0,442653	-0,0013917	0,0010444
29	0,191775	0,444301	-0,0013784	0,0010619
30	0,192345	0,445945	-0,0013648	0,0010793
31	0,192929	0,447584	-0,0013509	0,0010967
32	0,193527	0,449219	-0,0013367	0,0011139
33	0,194138	0,450848	-0,0013222	0,0011311
34	0,194763	0,452471	-0,0013075	0,0011481
35	0,195403	0,454089	-0,0012925	0,0011650
36	0,196058	0,455702	-0,0012772	0,0011817
37	0,196727	0,457308	-0,0012617	0,0011982
38	0,197411	0,458908	-0,0012459	0,0012146

p	u'_{BB}	v'_{BB}	$\Delta u'_{BB}$	$\Delta v'_{BB}$
39	0,198110	0,460501	-0,0012299	0,0012308
40	0,198825	0,462087	-0,0012137	0,0012468
41	0,199556	0,463666	-0,0011973	0,0012626
42	0,200302	0,465238	-0,0011806	0,0012782
43	0,201065	0,466802	-0,0011638	0,0012935
44	0,201844	0,468358	-0,0011468	0,0013086
45	0,202639	0,469906	-0,0011296	0,0013235
46	0,203451	0,471445	-0,0011123	0,0013381
47	0,204280	0,472975	-0,0010948	0,0013524
48	0,205126	0,474495	-0,0010771	0,0013665
49	0,205989	0,476006	-0,0010594	0,0013803
50	0,206870	0,477506	-0,0010415	0,0013939
51	0,207768	0,478997	-0,0010235	0,0014071
52	0,208684	0,480476	-0,0010055	0,0014201
53	0,209618	0,481944	-0,0009874	0,0014327
54	0,210570	0,483400	-0,0009692	0,0014451
55	0,211541	0,484845	-0,0009510	0,0014571
56	0,212529	0,486276	-0,0009327	0,0014689
57	0,213536	0,487695	-0,0009144	0,0014803
58	0,214562	0,489101	-0,0008961	0,0014915
59	0,215606	0,490493	-0,0008779	0,0015023
60	0,216668	0,491871	-0,0008596	0,0015128
61	0,217750	0,493234	-0,0008414	0,0015231
62	0,218850	0,494582	-0,0008232	0,0015330
63	0,219969	0,495915	-0,0008051	0,0015426
64	0,221106	0,497231	-0,0007870	0,0015518
65	0,222262	0,498532	-0,0007690	0,0015608
66	0,223437	0,499815	-0,0007512	0,0015695
67	0,224630	0,501082	-0,0007334	0,0015779
68	0,225842	0,502330	-0,0007157	0,0015860
69	0,227072	0,503561	-0,0006982	0,0015938
70	0,228320	0,504773	-0,0006808	0,0016013
71	0,229587	0,505967	-0,0006636	0,0016085
72	0,230871	0,507141	-0,0006465	0,0016154
73	0,232173	0,508295	-0,0006296	0,0016221
74	0,233492	0,509430	-0,0006129	0,0016285
75	0,234828	0,510544	-0,0005963	0,0016346
76	0,236182	0,511637	-0,0005800	0,0016405
77	0,237552	0,512710	-0,0005638	0,0016461
78	0,238938	0,513762	-0,0005479	0,0016515
79	0,240340	0,514792	-0,0005322	0,0016566
80	0,241758	0,515800	-0,0005167	0,0016615
81	0,243192	0,516787	-0,0005014	0,0016662
82	0,244640	0,517751	-0,0004864	0,0016706

p	u'_{BB}	v'_{BB}	$\Delta u'_{BB}$	$\Delta v'_{BB}$
83	0,246102	0,518694	-0,0004716	0,0016749
84	0,247579	0,519614	-0,0004571	0,0016789
85	0,249070	0,520511	-0,0004428	0,0016827
86	0,250574	0,521387	-0,0004287	0,0016864
87	0,252090	0,522239	-0,0004149	0,0016898
88	0,253619	0,523069	-0,0004014	0,0016931
89	0,255161	0,523877	-0,0003881	0,0016962
90	0,256713	0,524662	-0,0003751	0,0016991
91	0,258277	0,525425	-0,0003623	0,0017019
92	0,259852	0,526166	-0,0003498	0,0017045
93	0,261436	0,526884	-0,0003376	0,0017069
94	0,263031	0,527581	-0,0003256	0,0017093
95	0,264635	0,528255	-0,0003139	0,0017115
96	0,266248	0,528908	-0,0003024	0,0017135
97	0,267869	0,529540	-0,0002912	0,0017155
98	0,269499	0,530150	-0,0002802	0,0017173
99	0,271136	0,530739	-0,0002695	0,0017190
100	0,272780	0,531307	-0,0002590	0,0017206
101	0,274432	0,531855	-0,0002488	0,0017221
102	0,276090	0,532383	-0,0002388	0,0017235
103	0,277754	0,532891	-0,0002290	0,0017249
104	0,279424	0,533380	-0,0002195	0,0017261
105	0,281100	0,533849	-0,0002102	0,0017273
106	0,282780	0,534299	-0,0002012	0,0017283
107	0,284466	0,534731	-0,0001924	0,0017293
108	0,286156	0,535144	-0,0001838	0,0017303
109	0,287851	0,535539	-0,0001754	0,0017311
110	0,289549	0,535917	-0,0001672	0,0017319
111	0,291251	0,536278	-0,0001592	0,0017327
112	0,292957	0,536622	-0,0001515	0,0017334
113	0,294666	0,536950	-0,0001439	0,0017340
114	0,296378	0,537261	-0,0001366	0,0017346
115	0,298092	0,537557	-0,0001294	0,0017352
116	0,299810	0,537837	-0,0001224	0,0017357
117	0,301529	0,538102	-0,0001156	0,0017362
118	0,303251	0,538353	-0,0001090	0,0017366
119	0,304975	0,538589	-0,0001025	0,0017370
120	0,306701	0,538811	-0,0000963	0,0017373
121	0,308428	0,539020	-0,0000902	0,0017377
122	0,310157	0,539215	-0,0000842	0,0017380
123	0,311888	0,539397	-0,0000784	0,0017382
124	0,313619	0,539566	-0,0000728	0,0017385
125	0,315352	0,539724	-0,0000673	0,0017387
126	0,317086	0,539869	-0,0000620	0,0017389

p	u'_{BB}	v'_{BB}	$\Delta u'_{BB}$	$\Delta v'_{BB}$
127	0,318821	0,540002	-0,0000568	0,0017391
128	0,320557	0,540124	-0,0000518	0,0017392
129	0,322293	0,540235	-0,0000469	0,0017394
130	0,324030	0,540335	-0,0000421	0,0017395
131	0,325768	0,540424	-0,0000375	0,0017396
132	0,327506	0,540503	-0,0000330	0,0017397
133	0,329245	0,540573	-0,0000286	0,0017398
134	0,330984	0,540632	-0,0000243	0,0017398
135	0,332723	0,540682	-0,0000202	0,0017399
136	0,334463	0,540723	-0,0000162	0,0017399
137	0,336202	0,540755	-0,0000122	0,0017400
138	0,337942	0,540778	-0,0000084	0,0017400
139	0,339682	0,540793	-0,0000047	0,0017400
140	0,341422	0,540800	-0,0000011	0,0017400
141	0,343162	0,540798	0,0000024	0,0017400
142	0,344902	0,540789	0,0000058	0,0017400
143	0,346642	0,540772	0,0000091	0,0017400
144	0,348382	0,540748	0,0000123	0,0017400
145	0,350122	0,540717	0,0000154	0,0017399
146	0,351861	0,540679	0,0000185	0,0017399
147	0,353601	0,540634	0,0000214	0,0017399
148	0,355340	0,540583	0,0000243	0,0017398
149	0,357079	0,540525	0,0000271	0,0017398
150	0,358818	0,540461	0,0000298	0,0017397
151	0,360556	0,540391	0,0000324	0,0017397
152	0,362295	0,540315	0,0000350	0,0017396
153	0,364033	0,540234	0,0000374	0,0017396
154	0,365771	0,540147	0,0000399	0,0017395
155	0,367508	0,540055	0,0000422	0,0017395
156	0,369245	0,539957	0,0000445	0,0017394
157	0,370982	0,539855	0,0000467	0,0017394
158	0,372719	0,539747	0,0000488	0,0017393
159	0,374455	0,539635	0,0000509	0,0017393
160	0,376191	0,539519	0,0000530	0,0017392
161	0,377927	0,539398	0,0000549	0,0017391
162	0,379663	0,539272	0,0000568	0,0017391
163	0,381398	0,539142	0,0000587	0,0017390
164	0,383133	0,539009	0,0000605	0,0017389
165	0,384867	0,538871	0,0000623	0,0017389
166	0,386601	0,538729	0,0000640	0,0017388
167	0,388335	0,538584	0,0000656	0,0017388
168	0,390069	0,538435	0,0000672	0,0017387
169	0,391802	0,538282	0,0000688	0,0017386
170	0,393535	0,538126	0,0000703	0,0017386

p	u'_{BB}	v'_{BB}	$\Delta u'_{BB}$	$\Delta v'_{BB}$
171	0,395268	0,537967	0,0000717	0,0017385
172	0,397000	0,537805	0,0000732	0,0017385
173	0,398733	0,537639	0,0000746	0,0017384
174	0,400464	0,537470	0,0000759	0,0017383
175	0,402196	0,537299	0,0000772	0,0017383
176	0,403927	0,537124	0,0000785	0,0017382
177	0,405658	0,536947	0,0000797	0,0017382
178	0,407389	0,536767	0,0000809	0,0017381
179	0,409119	0,536585	0,0000820	0,0017381
180	0,410849	0,536400	0,0000831	0,0017380
181	0,412579	0,536213	0,0000842	0,0017380
182	0,414309	0,536023	0,0000853	0,0017379
183	0,416038	0,535831	0,0000863	0,0017379
184	0,417767	0,535636	0,0000873	0,0017378
185	0,419496	0,535440	0,0000882	0,0017378
186	0,421225	0,535241	0,0000892	0,0017377
187	0,422953	0,535041	0,0000901	0,0017377
188	0,424681	0,534838	0,0000909	0,0017376
189	0,426409	0,534634	0,0000918	0,0017376
190	0,428137	0,534428	0,0000926	0,0017375
191	0,429865	0,534219	0,0000934	0,0017375
192	0,431592	0,534010	0,0000942	0,0017374
193	0,433319	0,533798	0,0000949	0,0017374
194	0,435046	0,533585	0,0000956	0,0017374
195	0,436773	0,533370	0,0000963	0,0017373
196	0,438499	0,533154	0,0000970	0,0017373
197	0,440225	0,532937	0,0000977	0,0017373
198	0,441952	0,532717	0,0000983	0,0017372
199	0,443677	0,532497	0,0000989	0,0017372
200	0,445403	0,532275	0,0000995	0,0017372
201	0,447129	0,532052	0,0001001	0,0017371
202	0,448854	0,531828	0,0001007	0,0017371
203	0,450580	0,531602	0,0001012	0,0017371
204	0,452305	0,531375	0,0001017	0,0017370
205	0,454030	0,531147	0,0001022	0,0017370
206	0,455755	0,530918	0,0001027	0,0017370
207	0,457479	0,530688	0,0001032	0,0017369
208	0,459204	0,530457	0,0001037	0,0017369
209	0,460929	0,530225	0,0001041	0,0017369
210	0,462653	0,529992	0,0001045	0,0017369
211	0,464377	0,529758	0,0001050	0,0017368
212	0,466101	0,529523	0,0001054	0,0017368
213	0,467825	0,529288	0,0001057	0,0017368
214	0,469549	0,529051	0,0001061	0,0017368