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United States Advanced Television Systems Committee

ATSC Standard

GHOST CANCELING REFERENCE SIGNAL FOR NTSC

1. Scope

This document describes a ghost canceling reference (GCR) signal for NTSC television signals.

2. Specification of the GCR Signal

The GCR signal permits detection of ghosts from -3 μsec to +45 μsec. The signal has a flat spectrum and high energy up to 4.1 MHz and has a very low level of energy beyond 4.3 MHz (Figure 1). The normalized GCR signal as a function of time is shown in Figure 2.

The GCR signal shall be placed on line 19* of the vertical blanking interval on a 30 IRE pedestal. The pedestal has a rising transition from 0 IRE to 30 IRE 9.5 μsec after the leading edge of horizontal sync (defined at the 50% point). The falling transition from 30 IRE to 0 IRE is 58.5 μsec after the leading edge of horizontal sync. Both transitions have a 4T transition curve.

The GCR signal has a time duration of 35.5 μsec (measured at 1% of the maximum value) and begins 12.0 μsec after the leading edge of horizontal sync. The first peak (positive or negative) is 16.7 μsec after the leading edge of horizontal sync. The GCR signal varies from -10 to +70 IRE (the pedestal is the average of these extreme values).

Waveforms of the GCR signal on the pedestal are shown in Figure 3 and Figure 4 and represent line A and line B, respectively. Line A and line B have the same 30 IRE pedestal but the GCR polarity is inverted from line A to line B. The line A and line B signals are contained in an 8-field sequence as follows:

field 1 - line A; field 2 - line B; field 3 - line A; field 4 - line B;
field 5 - line B; field 6 - line A; field 7 - line B; field 8 - line A.

Numerical values of the GCR signal as a function of time are given in Annex I. These values were calculated from (1).

$$f(t) = \frac{A}{2p}\left\{ \int_{0}^{\Omega} \left[\cos\left(bw^2\right) + j\sin\left(bw^2\right)\right] W(w) e^{jwt} dw + \int_{-\Omega}^{0} \left[\cos\left(bw^2\right) - j\sin\left(bw^2\right)\right] W(w) e^{jwt} dw \right\} \quad (1)$$

where A = 9.0, b = 110.0, and $\Omega = \frac{4.3}{7.16}\pi$ radians/second. W(ω) is the window function (2).

$$W(w) = \int_{-\frac{p}{c}}^{\frac{p}{c}} \left[\left(\frac{1}{2} + \frac{1}{2}\cos(ct)\right) \left(\frac{1}{2p} \int_{-\Omega_1}^{\Omega_1} e^{jgt} dg \right) \right] e^{-jwt} dt \quad (2)$$

where c = $\frac{p}{49.0}$ radians/second and $\Omega_1 = \frac{4.15}{7.16}\pi$ radians/second.

* Subject to reservation of line 19 by the FCC exclusively for the optional placement of the GCR signal.

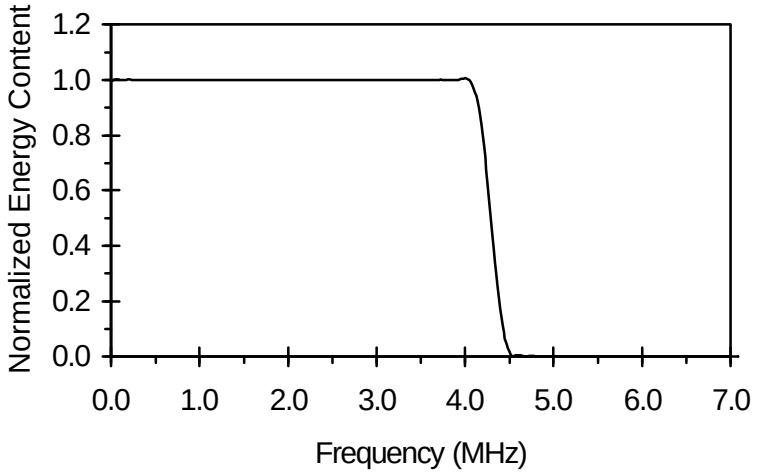

Figure 1. Spectrum of the GCR Signal

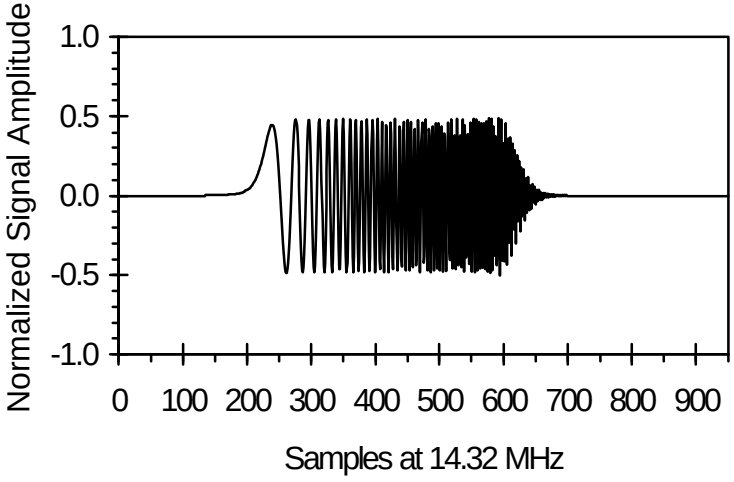

Figure 2. GCR Signal Amplitude as a Function of Time

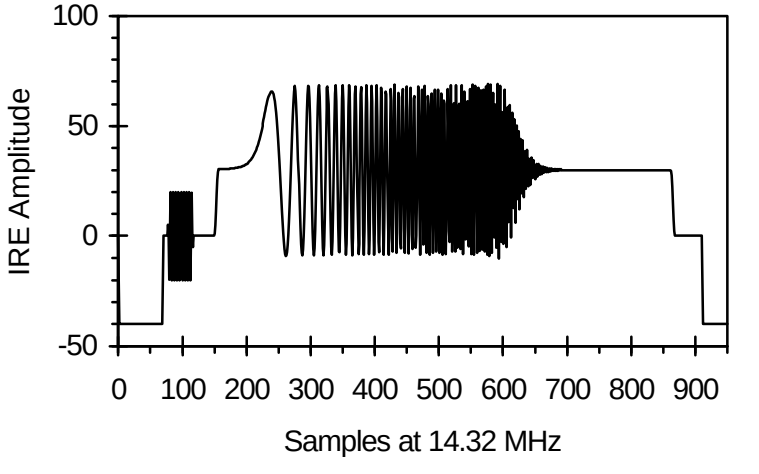

Figure 3. GCR Signal on Line A

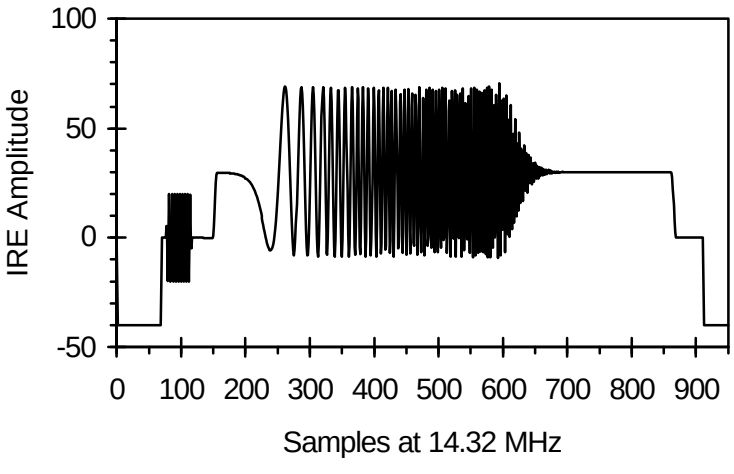

Figure 4. GCR Signal on Line B

Annex I

This Annex contains the GCR signal values. The 910 data values were sampled at 14.3 MHz (4 times color subcarrier) and represent a complete GCR waveform in a full TV line (63.5 μsec). The first sample is coincident with the 50% point of the leading edge of horizontal sync. The data are normalized to 1.0 unit peak to peak and represent the GCR signal with positive polarity. A negative polarity GCR signal can be obtained by multiplying all the data by -1.

000	0.00000000000000E+0000	067	0.00000000000000E+0000	134	0.00000000000000E+0000
001	0.00000000000000E+0000	068	0.00000000000000E+0000	135	1.02260999999970E-0003
002	0.00000000000000E+0000	069	0.00000000000000E+0000	136	1.05892999999924E-0003
003	0.00000000000000E+0000	070	0.00000000000000E+0000	137	1.09718000000036E-0003
004	0.00000000000000E+0000	071	0.00000000000000E+0000	138	1.13701999999982E-0003
005	0.00000000000000E+0000	072	0.00000000000000E+0000	139	1.17906999999917E-0003
006	0.00000000000000E+0000	073	0.00000000000000E+0000	140	1.22286999999943E-0003
007	0.00000000000000E+0000	074	0.00000000000000E+0000	141	1.26910000000002E-0003
008	0.00000000000000E+0000	075	0.00000000000000E+0000	142	1.31748000000087E-0003
009	0.00000000000000E+0000	076	0.00000000000000E+0000	143	1.36846999999918E-0003
010	0.00000000000000E+0000	077	0.00000000000000E+0000	144	1.42190000000042E-0003
011	0.00000000000000E+0000	078	0.00000000000000E+0000	145	1.47821000000015E-0003
012	0.00000000000000E+0000	079	0.00000000000000E+0000	146	1.53740000000013E-0003
013	0.00000000000000E+0000	080	0.00000000000000E+0000	147	1.59988999999960E-0003
014	0.00000000000000E+0000	081	0.00000000000000E+0000	148	1.66547000000072E-0003
015	0.00000000000000E+0000	082	0.00000000000000E+0000	149	1.73485999999912E-0003
016	0.00000000000000E+0000	083	0.00000000000000E+0000	150	1.80787000000038E-0003
017	0.00000000000000E+0000	084	0.00000000000000E+0000	151	1.88510000000086E-0003
018	0.00000000000000E+0000	085	0.00000000000000E+0000	152	1.96657000000044E-0003
019	0.00000000000000E+0000	086	0.00000000000000E+0000	153	2.05283000000023E-0003
020	0.00000000000000E+0000	087	0.00000000000000E+0000	154	2.14390000000009E-0003
021	0.00000000000000E+0000	088	0.00000000000000E+0000	155	2.24045999999944E-0003
022	0.00000000000000E+0000	089	0.00000000000000E+0000	156	2.34250000000102E-0003
023	0.00000000000000E+0000	090	0.00000000000000E+0000	157	2.45085999999972E-0003
024	0.00000000000000E+0000	091	0.00000000000000E+0000	158	2.56557000000157E-0003
025	0.00000000000000E+0000	092	0.00000000000000E+0000	159	2.68752999999933E-0003
026	0.00000000000000E+0000	093	0.00000000000000E+0000	160	2.81685999999937E-0003
027	0.00000000000000E+0000	094	0.00000000000000E+0000	161	2.95447999999965E-0003
028	0.00000000000000E+0000	095	0.00000000000000E+0000	162	3.10071999999906E-0003
029	0.00000000000000E+0000	096	0.00000000000000E+0000	163	3.25656000000052E-0003
030	0.00000000000000E+0000	097	0.00000000000000E+0000	164	3.42231000000126E-0003
031	0.00000000000000E+0000	098	0.00000000000000E+0000	165	3.59925000000061E-0003
032	0.00000000000000E+0000	099	0.00000000000000E+0000	166	3.78781999999944E-0003
033	0.00000000000000E+0000	100	0.00000000000000E+0000	167	3.98931000000147E-0003
034	0.00000000000000E+0000	101	0.00000000000000E+0000	168	4.20439999999900E-0003
035	0.00000000000000E+0000	102	0.00000000000000E+0000	169	4.43461999999784E-0003
036	0.00000000000000E+0000	103	0.00000000000000E+0000	170	4.68077000000022E-0003
037	0.00000000000000E+0000	104	0.00000000000000E+0000	171	4.94463999999795E-0003
038	0.00000000000000E+0000	105	0.00000000000000E+0000	172	5.22724000000352E-0003
039	0.00000000000000E+0000	106	0.00000000000000E+0000	173	5.53064000000347E-0003
040	0.00000000000000E+0000	107	0.00000000000000E+0000	174	5.85610000000258E-0003
041	0.00000000000000E+0000	108	0.00000000000000E+0000	175	6.20609999999999E-0003
042	0.00000000000000E+0000	109	0.00000000000000E+0000	176	6.58219999999687E-0003
043	0.00000000000000E+0000	110	0.00000000000000E+0000	177	6.98715000000050E-0003
044	0.00000000000000E+0000	111	0.00000000000000E+0000	178	7.42307000000153E-0003
045	0.00000000000000E+0000	112	0.00000000000000E+0000	179	7.89319000000432E-0003
046	0.00000000000000E+0000	113	0.00000000000000E+0000	180	8.40024000000028E-0003
047	0.00000000000000E+0000	114	0.00000000000000E+0000	181	8.94780000000139E-0003
048	0.00000000000000E+0000	115	0.00000000000000E+0000	182	9.53912999999318E-0003
049	0.00000000000000E+0000	116	0.00000000000000E+0000	183	1.01788000000056E-0002
050	0.00000000000000E+0000	117	0.00000000000000E+0000	184	1.08706000000041E-0002
051	0.00000000000000E+0000	118	0.00000000000000E+0000	185	1.16199999999935E-0002
052	0.00000000000000E+0000	119	0.00000000000000E+0000	186	1.24318000000017E-0002
053	0.00000000000000E+0000	120	0.00000000000000E+0000	187	1.33122999999955E-0002
054	0.00000000000000E+0000	121	0.00000000000000E+0000	188	1.42673999999943E-0002
055	0.00000000000000E+0000	122	0.00000000000000E+0000	189	1.53047000000015E-0002
056	0.00000000000000E+0000	123	0.00000000000000E+0000	190	1.64313999999877E-0002
057	0.00000000000000E+0000	124	0.00000000000000E+0000	191	1.76562000000047E-0002
058	0.00000000000000E+0000	125	0.00000000000000E+0000	192	1.89881000000014E-0002
059	0.00000000000000E+0000	126	0.00000000000000E+0000	193	2.04373999999916E-0002
060	0.00000000000000E+0000	127	0.00000000000000E+0000	194	2.20148999999878E-0002
061	0.00000000000000E+0000	128	0.00000000000000E+0000	195	2.37329999999929E-0002
062	0.00000000000000E+0000	129	0.00000000000000E+0000	196	2.56043999999918E-0002
063	0.00000000000000E+0000	130	0.00000000000000E+0000	197	2.76438999999868E-0002
064	0.00000000000000E+0000	131	0.00000000000000E+0000	198	2.98664999999971E-0002
065	0.00000000000000E+0000	132	0.00000000000000E+0000	199	3.22896999999784E-0002
066	0.00000000000000E+0000	133	0.00000000000000E+0000	200	3.49309999999718E-0002

201	3.78107999999884E-0002	280	1.84488000000101E-0001	359	3.56715999999778E-0001
202	4.09500000000094E-0002	281	5.59898000000203E-0002	360	4.80940999999802E-0001
203	4.43718999999874E-0002	282	-7.91186000000152E-0002	361	4.16690999999901E-0001
204	4.81004000000098E-0002	283	-2.10235999999895E-0001	362	1.85821000000033E-0001
205	5.21621999999979E-0002	284	-3.26232999999775E-0001	363	-1.21634999999969E-0001
206	5.65846999999735E-0002	285	-4.16419000000133E-0001	364	-3.81190000000061E-0001
207	6.13976000000207E-0002	286	-4.71591999999873E-0001	365	-4.84109999999873E-0001
208	6.66313000000400E-0002	287	-4.85105000000203E-0001	366	-3.84040999999797E-0001
209	7.23186999999825E-0002	288	-4.53794000000016E-0001	367	-1.19752999999946E-0001
210	7.84923999999592E-0002	289	-3.78679999999804E-0001	368	1.97697999999946E-0001
211	8.51879000000508E-0002	290	-2.65297999999802E-0001	369	4.30369000000155E-0001
212	9.24387000000024E-0002	291	-1.23576999999955E-0001	370	4.73501999999826E-0001
213	1.00280999999995E-0001	292	3.28038999999762E-0002	371	3.04200000000037E-0001
214	1.08748999999989E-0001	293	1.87584000000015E-0001	372	-4.45780999999812E-0003
215	1.17876000000024E-0001	294	3.23534999999993E-0001	373	-3.12843000000157E-0001
216	1.27694000000020E-0001	295	4.24414000000070E-0001	374	-4.77105999999822E-0001
217	1.38230999999905E-0001	296	4.77027999999791E-0001	375	-4.17065000000093E-0001
218	1.49511000000075E-0001	297	4.73159000000123E-0001	376	-1.57408999999916E-0001
219	1.61552999999913E-0001	298	4.11086000000068E-0001	377	1.79722999999967E-0001
220	1.74367999999959E-0001	299	2.96408000000156E-0001	378	4.30503999999928E-0001
221	1.87959000000092E-0001	300	1.41969000000017E-0001	379	4.69046000000162E-0001
222	2.02316999999994E-0001	301	-3.32369999999855E-0002	380	2.72319000000152E-0001
223	2.17419999999947E-0001	302	-2.06171999999924E-0001	381	-6.37966000000461E-0002
224	2.33228000000054E-0001	303	-3.52687000000060E-0001	382	-3.68903000000046E-0001
225	2.49684999999999E-0001	304	-4.50949999999921E-0001	383	-4.83776999999918E-0001
226	2.66712000000098E-0001	305	-4.84910000000127E-0001	384	-3.44759999999951E-0001
227	2.84204999999929E-0001	306	-4.47235999999975E-0001	385	-2.16183999999942E-0002
228	3.02032999999938E-0001	307	-3.41190000000097E-0001	386	3.14663999999993E-0001
229	3.20032000000083E-0001	308	-1.80984000000080E-0001	387	4.81103000000076E-0001
230	3.38005000000067E-0001	309	9.63199000000259E-0003	388	3.83209000000079E-0001
231	3.55717999999797E-0001	310	2.00563999999986E-0001	389	7.12525999999798E-0002
232	3.72897000000194E-0001	311	3.59968000000208E-0001	390	-2.82396000000062E-0001
233	3.89230000000225E-0001	312	4.59641999999803E-0001	391	-4.76846999999907E-0001
234	4.04360999999881E-0001	313	4.80308000000150E-0001	392	-3.97513999999774E-0001
235	4.17892999999822E-0001	314	4.15771999999833E-0001	393	-8.63047999999935E-0002
236	4.29389999999785E-0001	315	2.75076999999783E-0001	394	2.77078999999958E-0001
237	4.38381999999820E-0001	316	8.19416000000501E-0002	395	4.77041000000099E-0001
238	4.44367000000057E-0001	317	-1.28693999999996E-0001	396	3.90680999999859E-0001
239	4.46823000000222E-0001	318	-3.16683999999896E-0001	397	6.61678999999822E-0002
240	4.45215000000189E-0001	319	-4.44307000000208E-0001	398	-3.00528000000213E-0001
241	4.39011999999821E-0001	320	-4.84112000000096E-0001	399	-4.82100000000173E-0001
242	4.27705000000060E-0001	321	-4.25353000000086E-0001	400	-3.61706000000140E-0001
243	4.10821999999825E-0001	322	-2.77427999999873E-0001	401	-1.12785000000031E-0002
244	3.87955000000147E-0001	323	-6.92708000000266E-0002	402	3.47796000000017E-0001
245	3.58785999999782E-0001	324	1.55655000000024E-0001	403	4.82912999999826E-0001
246	3.23113999999805E-0001	325	3.48071999999775E-0001	404	3.02329000000100E-0001
247	2.80886000000010E-0001	326	4.63710999999876E-0001	405	-7.90537999999970E-0002
248	2.32228000000077E-0001	327	4.73907999999938E-0001	406	-4.09227999999985E-0001
249	1.77474000000075E-0001	328	3.73398000000179E-0001	407	-4.64552999999796E-0001
250	1.17197000000033E-0001	329	1.83113999999932E-0001	408	-2.03408999999965E-0001
251	5.22252000000094E-0002	330	-5.32258000000070E-0002	409	1.98789999999917E-0001
252	-1.63339000000065E-0002	331	-2.78533000000152E-0001	410	4.64230000000043E-0001
253	-8.70900999999549E-0002	332	-4.35938999999962E-0001	411	4.04536999999891E-0001
254	-1.58376000000089E-0001	333	-4.83456999999817E-0001	412	5.75837999999749E-0002
255	-2.28262000000086E-0001	334	-4.05898999999863E-0001	413	-3.32002000000102E-0001
256	-2.94597000000067E-0001	335	-2.20585999999912E-0001	414	-4.82986999999866E-0001
257	-3.55059999999867E-0001	336	2.53643000000068E-0002	415	-2.81882000000223E-0001
258	-4.07236000000012E-0001	337	2.66195000000153E-0001	416	1.27741000000015E-0001
259	-4.48710000000119E-0001	338	4.34799999999996E-0001	417	4.43717999999990E-0001
260	-4.77181000000201E-0001	339	4.81733999999960E-0001	418	4.27357000000029E-0001
261	-4.90596000000096E-0001	340	3.90551999999843E-0001	419	8.67075999999543E-0002
262	-4.87282999999934E-0001	341	1.84567999999899E-0001	420	-3.21608000000197E-0001
263	-4.66113999999834E-0001	342	-7.78073999999833E-0002	421	-4.82884000000013E-0001
264	-4.26633000000038E-0001	343	-3.18760000000111E-0001	422	-2.68137000000024E-0001
265	-3.69197999999869E-0001	344	-4.63948000000073E-0001	423	1.58376000000089E-0001
266	-2.95083999999861E-0001	345	-4.65948999999910E-0001	424	4.60480000000189E-0001
267	-2.06552999999985E-0001	346	-3.20834999999988E-0001	425	3.94394999999804E-0001
268	-1.06861999999978E-0001	347	-7.18414000000394E-0002	426	8.97358999999653E-0003
269	-2.26569000000065E-0004	348	2.02201999999943E-0001	427	-3.85126000000128E-0001
270	1.08304999999973E-0001	349	4.11149000000023E-0001	428	-4.63401999999860E-0001
271	2.13048999999955E-0001	350	4.83345000000099E-0001	429	-1.56926999999996E-0001
272	3.07967000000190E-0001	351	3.91160000000127E-0001	430	2.82047000000148E-0001
273	3.87016000000131E-0001	352	1.62923000000092E-0001	431	4.83843999999863E-0001
274	4.44562000000133E-0001	353	-1.24134000000026E-0001	432	2.73432999999841E-0001
275	4.75829999999860E-0001	354	-3.68950000000041E-0001	433	-1.73019000000068E-0001
276	4.77361000000201E-0001	355	-4.82100000000173E-0001	434	-4.70732000000226E-0001
277	4.47440999999799E-0001	356	-4.19299000000137E-0001	435	-3.57265000000098E-0001
278	3.86449999999968E-0001	357	-2.00237999999899E-0001	436	7.19904999999699E-0002
279	2.97098000000005E-0001	358	9.56523999999490E-0002	437	4.38375000000178E-0001

438	4.12060999999994E-0001	517	1.61409999999933E-0001	596	4.79287999999997E-0001
439	1.23822000000047E-0002	518	4.80509999999867E-0001	597	-2.06691999999975E-0001
440	-3.99836000000050E-0001	519	4.47993000000224E-0002	598	-4.09948999999870E-0001
441	-4.45055000000139E-0001	520	-4.62160999999924E-0001	599	3.29295000000002E-0001
442	-7.71581999999853E-0002	521	-2.35175999999910E-0001	600	2.97392999999829E-0001
443	3.63976000000093E-0001	522	3.67765999999847E-0001	601	-4.18125000000146E-0001
444	4.62701999999808E-0001	523	3.80204000000049E-0001	602	-1.51035000000093E-0001
445	1.21280999999954E-0001	524	-2.21663999999919E-0001	603	4.57456999999977E-0001
446	-3.37500999999975E-0001	525	-4.63874000000033E-0001	604	-1.21829999999932E-0002
447	-4.71152000000075E-0001	526	5.13983000000167E-0002	605	-4.37680000000000E-0001
448	-1.45841000000019E-0001	527	4.82525999999780E-0001	606	1.69366000000082E-0001
449	3.23628000000099E-0001	528	1.17171999999982E-0001	607	3.58297000000221E-0001
450	4.73699000000124E-0001	529	-4.42914000000201E-0001	608	-2.95907000000170E-0001
451	1.51135999999951E-0001	530	-2.64184000000114E-0001	609	-2.30043000000023E-0001
452	-3.24419000000034E-0001	531	3.57844999999998E-0001	610	3.70323999999982E-0001
453	-4.72220000000107E-0001	532	3.76622000000225E-0001	611	7.37844000000223E-0002
454	-1.37774000000036E-0001	533	-2.43244999999888E-0001	612	-3.79878000000190E-0001
455	3.39309099999978E-0001	534	-4.48910999999953E-0001	613	8.26819999999771E-0002
456	4.65411000000131E-0001	535	1.14519999999970E-0001	614	3.24047000000064E-0001
457	1.04878999999983E-0001	536	4.81073999999808E-0001	615	-2.10759999999937E-0001
458	-3.67131999999856E-0001	537	1.47939000000008E-0002	616	-2.15877000000091E-0001
459	-4.50452000000041E-0001	538	-4.77703000000020E-0001	617	2.87343999999848E-0001
460	-5.20331000000169E-0002	539	-1.34743000000071E-0001	618	7.92186999999558E-0002
461	4.03378999999859E-0001	540	4.45565999999872E-0001	619	-3.00759000000198E-0001
462	4.21691999999894E-0001	541	2.38581000000067E-0001	620	5.63948000000210E-0002
463	-2.14152000000070E-0002	542	-3.92727999999806E-0001	621	2.53298000000086E-0001
464	-4.41976000000068E-0001	543	-3.23120999999901E-0001	622	-1.63127999999915E-0001
465	-3.72757999999976E-0001	544	3.26771999999892E-0001	623	-1.60753000000113E-0001
466	1.13511000000017E-0001	545	3.87517000000116E-0001	624	2.21193999999969E-0001
467	4.72905000000083E-0001	546	-2.54672999999912E-0001	625	4.78082000000200E-0002
468	2.96350999999959E-0001	547	-4.33148000000074E-0001	626	-2.23539999999957E-0001
469	-2.19368000000031E-0001	548	1.81812000000036E-0001	627	5.81391000000053E-0002
470	-4.83674999999948E-0001	549	4.62328000000070E-0001	628	1.76492000000053E-0001
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472	3.27948999999990E-0001	551	-4.78289000000132E-0001	630	-9.74677000000383E-0002
473	4.59028000000217E-0001	552	4.92869999999925E-0002	631	1.66602999999895E-0001
474	4.67350000000124E-0002	553	4.84148000000005E-0001	632	9.46428999999682E-0003
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478	4.78071999999884E-0001	557	4.77914999999939E-0001	636	-1.09595000000013E-0001
479	2.53111999999874E-0001	558	8.96437999999762E-0002	637	-4.21787000000222E-0002
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486	-4.83322999999928E-0001	565	4.55015999999887E-0001	644	-2.79875000000018E-0003
487	-1.93813000000091E-0001	566	1.53954999999996E-0001	645	7.37881000000016E-0002
488	3.48465000000033E-0001	567	-4.54807999999957E-0001	646	-3.52417999999943E-0002
489	4.35011999999915E-0001	568	-1.50088000000096E-0001	647	-4.63371999999822E-0002
490	-5.20594999999844E-0002	569	4.57700999999815E-0001	648	5.46148000000244E-0002
491	-4.70860999999786E-0001	570	1.38134999999920E-0001	649	1.19423999999952E-0002
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493	2.99838999999793E-0001	572	-1.17764999999963E-0001	651	1.78473999999937E-0002
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495	-8.47457000000418E-0003	574	8.81894999999986E-0002	653	-3.52100999999720E-0002
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497	-2.79306999999790E-0001	576	-4.87550000000283E-0002	655	3.75063999999838E-0002
498	2.91294999999991E-0001	577	4.87923000000137E-0001	656	-8.99504000000206E-0003
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