# LWA-1 Antenna Position and Cable Data
# Ver. 1

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## Contents



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# 1 Introduction

This memo documents (1) the positions of antennas associated with LWA-1 and (2) the physical lengths and propagation delays of the associated cables. Although this information already exists in various LWA engineering memos, it is currently difficult and tedious to identify the most recent and authoritative data. The purpose of this document is to assemble the relevant information into a single document for the mutual convenience of developers and users.

# 2 Antenna Positions

LWA antennas are grouped into pairs of orthogonally-polarized antennas, referred to as *stands*. There are $N = 256$ stands in the LWA-1 array, numbered 1 through 256. The exists also a Stand 257, which is not part of the LWA-1 array, but is located inside the station perimeter (near the southwest corner) and is identical to the other stands.

Stand positions reported here were extracted from LWA Engineering Memo ARR0003 [1].[1] These are the "as built" positions, as determined by survey measurements.

Stand positions are reported in Appendix A. The positions are given in a local Cartesian coordinate system, with $+y$ pointing North[2], the $+x$ axis pointing East[3], and the $+z$ axis pointing to Zenith. Relative positions are believed to be accurate to within 2 cm. The location of $x = y = 0$ is marked by a steel center post. $z$-coordinates refer to the plane of the circuit board inside each stand (which can interpreted as the "feedpoints" of the dipole antennas), with Stand 252 arbitrarily chosen to be the $z = 0$ datum. Note that there is a significant elevation change across the LWA-1 array; it is not safe to assume the stands lie in a best-fit plane, or that such a plane is perpendicular to the $z$-axis.

The location of the origin of the local coordinate system is not precisely known. The horizontal value being used currently is Latitude 34.070°N, Longitude 107.628°W. The elevation at the LWA-1 site is approximately 7000 ft.

Beyond the 257 stands reported in Appendix A, there is yet another identical stand, located outside the LWA-1 station perimeter fence, referred to variously as the "RTA stand" or the "outrigger". The best known estimate of the position of this stand in the coordinate system described above is $x = +339.61 \pm 0.25$ m, $y = +15.32 \pm 0.25$ m, $z = -0.08 \pm 0.4$ m.

# 3 Cable Data

The cables that connect antenna stands to the shelter are of unequal length. (The rest of the signal path is identical between antennas.) These lengths are reported in LWA Engineering Memo RPD0022 [2], and repeated in Appendix B.

The cables are Kingsignal[4] Part Number KSR200DB, which is advertised to have a velocity factor (speed of propagation relative to the speed of light in free space, $c$) of 0.83. This velocity factor has been confirmed by two of us (Craig and Ellingson) using direct measurement of cables using time-domain reflectometry, and also independently confirmed by one of us (Hartman) using

[1] Specifically, from the spreadsheet `asbuilt.xls`. For those referring back to this file, note that the column headings are wrong; they should be "Stand ID", "x, m", "y, m", and "z, m" respectively.

[2] According to [1]: "directed to the wood post 426.7′ to the north"

[3] According to [1]: "directed 90 degrees to the east of the y-axis".

[4] `http://www.kingsignal.com`

measurement data provided by the supplier as reported in LWA Engineering Memo RPD0026 [3].

When estimating cable propagation delay, it is important to note that coaxial cables are significantly dispersive in the frequency range of interest [4]. The measurements of Craig & Ellingson indicate this additional delay is approximately 3.5 ns in the frequency range of interest. Hartman's fit of the supplier-provided delay measurements (taken at 10 MHz and 80 MHz) to the functional dependence derived in [4] yields the following result for the additional dispersive delay:

$$(2.4 \text{ ns}) \left(\frac{l}{100 \text{ m}}\right) \left(\frac{f}{10 \text{ MHz}}\right)^{-1/2} , \tag{1}$$

where $l$ is cable length and $f$ is frequency. Thus, the analyses agree on the dispersive delay to within roughly 1 ns; i.e., very close agreement relative to what is required for LWA data analysis. However, the latter answer is preferred as it is explicitly in the desired frequency-dependent form.

Combining the above results, the recommended method for computing the total cable propagation time $t_c$ is to use the known length $l$ of the cable from Appendix B in the following expression:

$$t_c = \frac{l}{0.83c} + (2.4 \text{ ns}) \left(\frac{l}{100 \text{ m}}\right) \left(\frac{f}{10 \text{ MHz}}\right)^{-1/2} . \tag{2}$$

# A Table of Stand Positions

Stand positions in the station local coordinate system (see Section 2) are given below. The columns are as follows: Stand ID, $x$ [m], $y$ [m], $z$ [m].

| | | | |
|---|---|---|---|
| 1 | -0.67 | -54.63 | 1.63 |
| 2 | 0.54 | -49.33 | 1.50 |
| 3 | -2.36 | -43.50 | 1.23 |
| 4 | 1.59 | -39.43 | 1.13 |
| 5 | -3.19 | -31.62 | 0.93 |
| 6 | 1.87 | -26.05 | 0.72 |
| 7 | 0.03 | -16.60 | 0.45 |
| 8 | 0.38 | -10.81 | 0.25 |
| 9 | -0.76 | -4.40 | 0.11 |
| 10 | 1.90 | 0.88 | -0.40 |
| 11 | -0.67 | 5.67 | -0.17 |
| 12 | -1.33 | 14.44 | -0.52 |
| 13 | -0.93 | 19.83 | -0.68 |
| 14 | -0.20 | 25.22 | -0.88 |
| 15 | 1.79 | 29.77 | -1.06 |
| 16 | 2.66 | 35.47 | -1.28 |
| 17 | -1.42 | 42.29 | -1.40 |
| 18 | -0.98 | 47.40 | -1.42 |
| 19 | -2.45 | 53.44 | -1.51 |
| 20 | 7.90 | -51.44 | 1.58 |
| 21 | -8.85 | -53.71 | 1.57 |
| 22 | 7.09 | -46.38 | 1.44 |
| 23 | -6.92 | -49.12 | 1.47 |
| 24 | 6.19 | -41.31 | 1.19 |
| 25 | -3.07 | -36.59 | 1.09 |
| 26 | 4.19 | -32.99 | 0.98 |
| 27 | -8.18 | -32.20 | 0.96 |
| 28 | 6.96 | -26.09 | 0.79 |
| 29 | -6.78 | -27.39 | 0.82 |
| 30 | 5.98 | -21.09 | 0.60 |
| 31 | -3.87 | -21.81 | 0.61 |
| 32 | 4.51 | -13.84 | 0.39 |
| 33 | -4.94 | -14.90 | 0.42 |
| 34 | 5.39 | -8.24 | 0.19 |
| 35 | -5.82 | -9.96 | 0.27 |
| 36 | 4.35 | -3.51 | 0.02 |
| 37 | -7.95 | -5.21 | 0.17 |
| 38 | 7.10 | 0.98 | -0.13 |
| 39 | -6.80 | 2.82 | -0.10 |
| 40 | 3.36 | 11.26 | -0.44 |
| 41 | -4.71 | 8.77 | -0.24 |
| 42 | 7.00 | 15.43 | -0.56 |
| 43 | -5.88 | 16.55 | -0.51 |
| 44 | 4.06 | 19.53 | -0.64 |
| 45 | -7.73 | 21.13 | -0.73 |
| 46 | 4.95 | 25.55 | -0.86 |
| 47 | -5.24 | 25.50 | -0.90 |
| 48 | 7.01 | 30.14 | -1.11 |
| 49 | -4.71 | 31.33 | -1.15 |

| | | | |
|---|---|---|---|
| 50 | 7.62 | 37.09 | -1.35 |
| 51 | -5.87 | 38.51 | -1.25 |
| 52 | 6.05 | 41.84 | -1.42 |
| 53 | -6.03 | 44.37 | -1.40 |
| 54 | 5.30 | 54.73 | -1.60 |
| 55 | -7.50 | 53.57 | -1.62 |
| 56 | 13.00 | -52.04 | 1.61 |
| 57 | -12.85 | -50.58 | 1.49 |
| 58 | 12.50 | -46.62 | 1.42 |
| 59 | -9.77 | -45.09 | 1.32 |
| 60 | 10.25 | -38.33 | 1.21 |
| 61 | -10.39 | -39.96 | 1.07 |
| 62 | 9.69 | -30.15 | 0.95 |
| 63 | -14.82 | -30.49 | 0.90 |
| 64 | 11.74 | -24.93 | 0.73 |
| 65 | -10.13 | -23.70 | 0.69 |
| 66 | 12.88 | -18.20 | 0.55 |
| 67 | -10.53 | -18.69 | 0.57 |
| 68 | 9.08 | -11.85 | 0.30 |
| 69 | -11.11 | -13.71 | 0.43 |
| 70 | 10.52 | -7.11 | 0.17 |
| 71 | -11.55 | -8.71 | 0.25 |
| 72 | 11.10 | -2.06 | -0.04 |
| 73 | -12.12 | 1.26 | -0.10 |
| 74 | 6.63 | 6.79 | -0.25 |
| 75 | -9.57 | 6.95 | -0.24 |
| 76 | 9.28 | 10.99 | -0.47 |
| 77 | -9.13 | 12.91 | -0.41 |
| 78 | 11.33 | 17.90 | -0.70 |
| 79 | -11.05 | 17.52 | -0.63 |
| 80 | 10.76 | 23.13 | -0.85 |
| 81 | -12.77 | 24.90 | -0.92 |
| 82 | 12.00 | 30.39 | -1.15 |
| 83 | -10.94 | 29.41 | -1.03 |
| 84 | 13.33 | 36.03 | -1.29 |
| 85 | -8.66 | 34.38 | -1.18 |
| 86 | 12.01 | 44.35 | -1.55 |
| 87 | -10.99 | 41.95 | -1.39 |
| 88 | 13.69 | 51.43 | -1.64 |
| 89 | -15.59 | 52.33 | -1.65 |
| 90 | 18.73 | -46.34 | 1.39 |
| 91 | -16.14 | -46.74 | 1.39 |
| 92 | 14.55 | -42.12 | 1.28 |
| 93 | -17.66 | -40.97 | 1.14 |
| 94 | 14.36 | -33.78 | 1.18 |
| 95 | -16.30 | -36.15 | 1.07 |
| 96 | 16.77 | -27.92 | 0.84 |
| 97 | -17.47 | -26.17 | 0.80 |
| 98 | 17.42 | -20.65 | 0.61 |
| 99 | -14.87 | -21.90 | 0.64 |
| 100 | 16.65 | -14.89 | 0.42 |
| 101 | -15.19 | -16.89 | 0.55 |
| 102 | 13.96 | -10.75 | 0.27 |
| 103 | -16.19 | -11.57 | 0.43 |

| | | | |
|---|---|---|---|
| 104 | 15.71 | -5.38 | 0.09 |
| 105 | -14.93 | -5.03 | 0.24 |
| 106 | 13.44 | 2.67 | -0.16 |
| 107 | -16.29 | 4.02 | -0.07 |
| 108 | 13.37 | 7.67 | -0.35 |
| 109 | -13.52 | 10.07 | -0.51 |
| 110 | 13.79 | 13.47 | -0.54 |
| 111 | -16.68 | 15.52 | -0.43 |
| 112 | 15.73 | 22.03 | -0.82 |
| 113 | -16.09 | 20.98 | -0.66 |
| 114 | 16.67 | 28.59 | -1.08 |
| 115 | -16.44 | 29.26 | -1.01 |
| 116 | 17.96 | 33.41 | -1.30 |
| 117 | -13.76 | 33.50 | -1.11 |
| 118 | 15.43 | 40.57 | -1.41 |
| 119 | -15.97 | 38.32 | -1.26 |
| 120 | 17.40 | 47.88 | -1.64 |
| 121 | -18.96 | 44.32 | -1.47 |
| 122 | 23.55 | -44.98 | 1.27 |
| 123 | -25.70 | -43.34 | 1.22 |
| 124 | 18.89 | -37.03 | 1.18 |
| 125 | -22.37 | -36.54 | 1.11 |
| 126 | 20.61 | -32.43 | 0.94 |
| 127 | -19.67 | -32.31 | 0.99 |
| 128 | 23.43 | -25.37 | 0.73 |
| 129 | -21.67 | -21.14 | 0.69 |
| 130 | 22.40 | -19.86 | 0.55 |
| 131 | -19.86 | -14.94 | 0.50 |
| 132 | 21.76 | -14.91 | 0.39 |
| 133 | -22.71 | -10.75 | 0.40 |
| 134 | 21.94 | -7.98 | 0.18 |
| 135 | -22.08 | -5.28 | 0.15 |
| 136 | 19.90 | -2.69 | -0.02 |
| 137 | -19.65 | 0.34 | 0.05 |
| 138 | 19.75 | 3.62 | -0.26 |
| 139 | -22.37 | 6.83 | -0.14 |
| 140 | 19.50 | 9.99 | -0.42 |
| 141 | -20.83 | 11.62 | -0.28 |
| 142 | 18.53 | 15.19 | -0.55 |
| 143 | -20.87 | 18.75 | -0.51 |
| 144 | 20.94 | 25.29 | -0.98 |
| 145 | -21.59 | 26.43 | -0.76 |
| 146 | 22.72 | 29.94 | -1.18 |
| 147 | -21.75 | 31.59 | -0.97 |
| 148 | 22.44 | 35.86 | -1.41 |
| 149 | -20.81 | 36.64 | -1.18 |
| 150 | 24.66 | 46.16 | -1.69 |
| 151 | -25.04 | 47.80 | -1.44 |
| 152 | 29.06 | -38.45 | 1.11 |
| 153 | -28.84 | -37.45 | 1.13 |
| 154 | 26.82 | -33.13 | 1.03 |
| 155 | -27.08 | -30.53 | 0.83 |
| 156 | 28.35 | -28.28 | 0.81 |
| 157 | -22.83 | -26.43 | 0.80 |

| | | | |
|---|---|---|---|
| 158 | 28.13 | -23.07 | 0.63 |
| 159 | -26.45 | -23.01 | 0.76 |
| 160 | 27.10 | -16.73 | 0.45 |
| 161 | -24.48 | -17.03 | 0.52 |
| 162 | 25.52 | -11.57 | 0.28 |
| 163 | -26.55 | -7.50 | 0.28 |
| 164 | 24.92 | -2.79 | -0.02 |
| 165 | -28.14 | -2.66 | 0.13 |
| 166 | 25.46 | 3.75 | -0.22 |
| 167 | -25.56 | 2.87 | 0.00 |
| 168 | 24.28 | 8.60 | -0.39 |
| 169 | -26.03 | 12.47 | -0.19 |
| 170 | 25.16 | 14.43 | -0.59 |
| 171 | -26.50 | 17.41 | -0.42 |
| 172 | 29.13 | 22.24 | -0.82 |
| 173 | -25.15 | 23.01 | -0.66 |
| 174 | 26.93 | 26.74 | -1.09 |
| 175 | -26.49 | 28.30 | -0.83 |
| 176 | 29.11 | 31.18 | -1.26 |
| 177 | -27.75 | 33.70 | -1.03 |
| 178 | 29.34 | 37.97 | -1.55 |
| 179 | -30.18 | 40.32 | -1.25 |
| 180 | 35.19 | -39.46 | 1.12 |
| 181 | -32.85 | -41.84 | 1.18 |
| 182 | 34.39 | -32.19 | 0.91 |
| 183 | -33.83 | -32.41 | 0.91 |
| 184 | 32.64 | -25.66 | 0.70 |
| 185 | -31.41 | -25.41 | 0.74 |
| 186 | 32.00 | -17.77 | 0.51 |
| 187 | -29.42 | -17.67 | 0.57 |
| 188 | 30.67 | -11.47 | 0.28 |
| 189 | -31.55 | -11.58 | 0.47 |
| 190 | 29.10 | -5.39 | 0.04 |
| 191 | -35.01 | -6.97 | 0.24 |
| 192 | 30.91 | -0.68 | -0.03 |
| 193 | -30.60 | 1.82 | 0.01 |
| 194 | 29.71 | 6.43 | -0.33 |
| 195 | -29.19 | 8.48 | -0.10 |
| 196 | 30.87 | 11.31 | -0.49 |
| 197 | -33.49 | 13.13 | -0.25 |
| 198 | 31.95 | 16.22 | -0.63 |
| 199 | -32.46 | 18.06 | -0.36 |
| 200 | 33.04 | 27.10 | -1.08 |
| 201 | -30.60 | 25.65 | -0.69 |
| 202 | 33.35 | 35.02 | -1.38 |
| 203 | -32.62 | 32.47 | -1.00 |
| 204 | 33.92 | 39.96 | -1.57 |
| 205 | -35.12 | 39.41 | -1.22 |
| 206 | -36.68 | -36.47 | 1.09 |
| 207 | 37.33 | -27.26 | 0.72 |
| 208 | -39.72 | -29.82 | 0.88 |
| 209 | 35.81 | -21.04 | 0.52 |
| 210 | -35.52 | -22.66 | 0.71 |
| 211 | 37.04 | -14.43 | 0.36 |

| | | | |
|---|---|---|---|
| 212 | -35.11 | -17.61 | 0.58 |
| 213 | 36.17 | -8.45 | 0.19 |
| 214 | -37.21 | -12.67 | 0.40 |
| 215 | 38.55 | -2.75 | -0.01 |
| 216 | -34.07 | -2.05 | 0.18 |
| 217 | 36.56 | 3.15 | -0.20 |
| 218 | -35.75 | 3.78 | 0.05 |
| 219 | 37.01 | 10.01 | -0.37 |
| 220 | -36.80 | 8.84 | -0.13 |
| 221 | 38.72 | 15.91 | -0.61 |
| 222 | -38.94 | 14.22 | -0.30 |
| 223 | 36.74 | 20.53 | -6.77 |
| 224 | -35.60 | 22.38 | -0.62 |
| 225 | 37.39 | 30.01 | -1.12 |
| 226 | -35.85 | 28.46 | -0.81 |
| 227 | 43.10 | -27.61 | 0.82 |
| 228 | -40.56 | -22.44 | 0.71 |
| 229 | 40.88 | -22.76 | 0.59 |
| 230 | -41.59 | -17.38 | 0.54 |
| 231 | 41.95 | -15.76 | 0.42 |
| 232 | -44.62 | -12.20 | 0.46 |
| 233 | 40.93 | -10.18 | 0.29 |
| 234 | -40.82 | -8.13 | 0.31 |
| 235 | 43.98 | -2.20 | -0.07 |
| 236 | -39.63 | 0.27 | 0.13 |
| 237 | 42.43 | 3.45 | -0.28 |
| 238 | -41.95 | 4.71 | -0.04 |
| 239 | 41.86 | 11.13 | -0.41 |
| 240 | -43.20 | 10.93 | -1.47 |
| 241 | 43.55 | 16.93 | -0.68 |
| 242 | -40.57 | 20.20 | -0.53 |
| 243 | 41.51 | 23.72 | -0.94 |
| 244 | -39.79 | 25.17 | -0.63 |
| 245 | 46.71 | -19.97 | 0.52 |
| 246 | -47.73 | -16.77 | 0.59 |
| 247 | 47.38 | -12.43 | 0.28 |
| 248 | -49.23 | -7.21 | 0.34 |
| 249 | 47.05 | -7.39 | 0.10 |
| 250 | -48.60 | -2.24 | 0.15 |
| 251 | 49.29 | -0.40 | -0.16 |
| 252 | -48.25 | 2.95 | 0.00 |
| 253 | 48.66 | 5.26 | -0.28 |
| 254 | -47.37 | 13.74 | -0.23 |
| 255 | 48.83 | 11.21 | -0.38 |
| 256 | -47.09 | 18.72 | -0.49 |
| 257 | -45.58 | -44.47 | 1.30 |

# B Table of Cable Lengths

Cable lengths are given below. The columns are as follows: Stand ID, length [m].

| | |
|---|---|
| 1 | 138 |
| 2 | 133 |
| 3 | 134 |
| 4 | 126 |
| 5 | 117 |
| 6 | 121 |
| 7 | 105 |
| 8 | 100 |
| 9 | 91 |
| 10 | 86 |
| 11 | 96 |
| 12 | 89 |
| 13 | 83 |
| 14 | 81 |
| 15 | 82 |
| 16 | 77 |
| 17 | 76 |
| 18 | 76 |
| 19 | 74 |
| 20 | 132 |
| 21 | 141 |
| 22 | 131 |
| 23 | 137 |
| 24 | 133 |
| 25 | 122 |
| 26 | 124 |
| 27 | 120 |
| 28 | 116 |
| 29 | 119 |
| 30 | 119 |
| 31 | 120 |
| 32 | 105 |
| 33 | 103 |
| 34 | 92 |
| 35 | 99 |
| 36 | 88 |
| 37 | 101 |
| 38 | 83 |
| 39 | 100 |
| 40 | 94 |
| 41 | 93 |
| 42 | 82 |
| 43 | 92 |
| 44 | 79 |
| 45 | 97 |
| 46 | 76 |
| 47 | 91 |
| 48 | 71 |
| 49 | 87 |
| 50 | 76 |

| | |
|---|---|
| 51 | 101 |
| 52 | 71 |
| 53 | 81 |
| 54 | 64 |
| 55 | 78 |
| 56 | 129 |
| 57 | 143 |
| 58 | 126 |
| 59 | 134 |
| 60 | 131 |
| 61 | 130 |
| 62 | 113 |
| 63 | 127 |
| 64 | 113 |
| 65 | 116 |
| 66 | 105 |
| 67 | 113 |
| 68 | 94 |
| 69 | 106 |
| 70 | 91 |
| 71 | 105 |
| 72 | 86 |
| 73 | 114 |
| 74 | 84 |
| 75 | 97 |
| 76 | 74 |
| 77 | 95 |
| 78 | 81 |
| 79 | 106 |
| 80 | 78 |
| 81 | 94 |
| 82 | 66 |
| 83 | 91 |
| 84 | 63 |
| 85 | 89 |
| 86 | 76 |
| 87 | 95 |
| 88 | 57 |
| 89 | 86 |
| 90 | 124 |
| 91 | 137 |
| 92 | 126 |
| 93 | 133 |
| 94 | 110 |
| 95 | 132 |
| 96 | 107 |
| 97 | 123 |
| 98 | 100 |
| 99 | 114 |
| 100 | 91 |
| 101 | 113 |
| 102 | 89 |
| 103 | 111 |
| 104 | 85 |

| | |
|---|---|
| 105 | 113 |
| 106 | 86 |
| 107 | 114 |
| 108 | 73 |
| 109 | 100 |
| 110 | 69 |
| 111 | 105 |
| 112 | 82 |
| 113 | 102 |
| 114 | 66 |
| 115 | 96 |
| 116 | 61 |
| 117 | 94 |
| 118 | 67 |
| 119 | 95 |
| 120 | 62 |
| 121 | 94 |
| 122 | 129 |
| 123 | 142 |
| 124 | 114 |
| 125 | 140 |
| 126 | 110 |
| 127 | 127 |
| 128 | 98 |
| 129 | 119 |
| 130 | 96 |
| 131 | 118 |
| 132 | 90 |
| 133 | 119 |
| 134 | 83 |
| 135 | 115 |
| 136 | 81 |
| 137 | 111 |
| 138 | 77 |
| 139 | 121 |
| 140 | 68 |
| 141 | 110 |
| 142 | 64 |
| 143 | 106 |
| 144 | 70 |
| 145 | 114 |
| 146 | 67 |
| 147 | 108 |
| 148 | 66 |
| 149 | 99 |
| 150 | 69 |
| 151 | 101 |
| 152 | 109 |
| 153 | 136 |
| 154 | 106 |
| 155 | 129 |
| 156 | 102 |
| 157 | 123 |
| 158 | 94 |

| | |
|---|---|
| 159 | 127 |
| 160 | 90 |
| 161 | 123 |
| 162 | 87 |
| 163 | 120 |
| 164 | 83 |
| 165 | 120 |
| 166 | 72 |
| 167 | 122 |
| 168 | 70 |
| 169 | 120 |
| 170 | 65 |
| 171 | 111 |
| 172 | 52 |
| 173 | 115 |
| 174 | 51 |
| 175 | 110 |
| 176 | 47 |
| 177 | 107 |
| 178 | 50 |
| 179 | 113 |
| 180 | 108 |
| 181 | 141 |
| 182 | 101 |
| 183 | 139 |
| 184 | 99 |
| 185 | 132 |
| 186 | 91 |
| 187 | 130 |
| 188 | 83 |
| 189 | 131 |
| 190 | 88 |
| 191 | 136 |
| 192 | 72 |
| 193 | 124 |
| 194 | 67 |
| 195 | 119 |
| 196 | 62 |
| 197 | 131 |
| 198 | 60 |
| 199 | 128 |
| 200 | 46 |
| 201 | 114 |
| 202 | 44 |
| 203 | 111 |
| 204 | 49 |
| 205 | 117 |
| 206 | 141 |
| 207 | 100 |
| 208 | 145 |
| 209 | 92 |
| 210 | 137 |
| 211 | 82 |
| 212 | 133 |

| | |
|---|---|
| 213 | 77 |
| 214 | 135 |
| 215 | 73 |
| 216 | 129 |
| 217 | 71 |
| 218 | 127 |
| 219 | 58 |
| 220 | 126 |
| 221 | 53 |
| 222 | 129 |
| 223 | 57 |
| 224 | 123 |
| 225 | 43 |
| 226 | 116 |
| 227 | 94 |
| 228 | 140 |
| 229 | 89 |
| 230 | 139 |
| 231 | 85 |
| 232 | 144 |
| 233 | 76 |
| 234 | 138 |
| 235 | 71 |
| 236 | 141 |
| 237 | 65 |
| 238 | 146 |
| 239 | 55 |
| 240 | 134 |
| 241 | 52 |
| 242 | 125 |
| 243 | 57 |
| 244 | 125 |
| 245 | 85 |
| 246 | 149 |
| 247 | 81 |
| 248 | 145 |
| 249 | 76 |
| 250 | 145 |
| 251 | 63 |
| 252 | 147 |
| 253 | 59 |
| 254 | 134 |
| 255 | 57 |
| 256 | 131 |

# C Document History

- Version 1 (Aug 18, 2010): First version.

# References


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