Wan7com, Inc.

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# 20 – 500 MHz LOW NOISE AMPLIFIER WEA101[1]

WEA101 LNA is a low noise figure, wideband, and high linearity amplifier with exceptional gain flatness design. The amplifier offers 1.0 dB noise figure, 20.0 dB gain, and 30.0 dBm output $IP_3$ at the frequency range from 20 MHz to 500 MHz of short wave, low VHF, FM, high VHF, and paging bands. WEA101 LNA is most suitable for wireless base stations, wireless data communications, tower top receiver amplifiers, last-mile wireless communication systems, and wireless measurement applications.


WEA101 is designed to meet rugged MIL-STD 202.

## Key Features:

| | |
|---|---|
| Impedance: | 50 Ohm |
| MTBF[2]: | >300,000 hrs (34 Years) |
| Low Noise: | 1.0 dB |
| Output $IP_3$: | 30 dBm |
| Gain: | 20.0 dB |
| $P_{1dB}$: | 16.0 dBm |
| Single power supply: | 40 mA @ +3.0V |
| Frequency Range: | 20 ~ 500 MHz |
| Operating Temperature: | -40 ~ +85 ºC |
| Return Losses: | 16 dB |
| Small size: | SMA Female, 1.23" x 1.10" x 0.41" (31.2 mm x 27.9 mm x 11.4 mm) |
| Built-in Functions: | DC blocks at input and output, temperature compensation circuits, and auto DC biases. |

## Absolute Maximum Ratings[3]:

| Symbol | Parameters | Units | Absolute Maximum |
|---|---|---|---|
| $V_{dd}$ | DC Power Supply Voltage | V | 5.0 |
| $I_{dd}$ | Drain Current | mA | 80 |
| $P_{diss}$ | Total Power Dissipation | mW | 350 |
| $P_{In,Max}$ | RF Input Power | dBm | 10 |
| $T_{ch}$ | Channel Temperature | °C | 150 |
| $T_{STG}$ | Storage Temperature | °C | -65 ~ 150 |
| $T_{O,MAX}$ | Maximum Operating Temperature | °C | -55 ~ 100 |
| $T_{Re,MAX}$ | Maximum Reflow Temperature | °C | 230[4] |
| $R_{th,c}$ | Thermal Resistance | °C/W | 220 |

[1] Specifications are subject to change without notice.
[2] MTBF: Mean Time Between Failure, Per TR-NWT-000332, ISSUE 3, SEPTEMBER, 1990, T=40℃
[3] Operation of this device above any one of these parameters may cause permanent damage.
[4] Refer to WanTcom's AN-109 for correct solder reflow temperature profile.

## Specifications:

**a)** **Table 1** Summary of the electrical specifications WEA101 at room temperature

| Index | Testing Item | Symbol | Test Constraints | Nom (RT) | Min | Max | Unit |
|---|---|---|---|---|---|---|---|
| **1** | Gain | $S_{21}$ | 20 – 500 MHz | 21 | 20 | | dB |
| **2** | Gain Variation | $\Delta G$ | 20 – 500 MHz | +/- 0.8 | | +/- 1.3 | dB |
| **3** | Input Return Loss | $S_{11}$ | 20 – 500 MHz | 20 | 16 | | dB |
| **4** | Output Return Loss | $S_{22}$ | 20 – 500 MHz | 20 | 16 | | dB |
| **5** | Reverse Isolation | $S_{12}$ | 20 – 500 MHz | 25 | 20 | | dB |
| **6** | Noise figure | NF | 50 – 500 MHz | 0.8 | | 1.0 | dB |
| | | | 20 – 30 MHz | 0.90 | | 1.2 | dB |
| **7** | Output Power 1dB compression Point | $P_{1dB}$ | 20 – 500 MHz | 16 | 14 | | dBm |
| **8** | Output-Third-Order Interception point | $IP_3$ | Two-Tone, $P_{out}$ +0 dBm each, 1 MHz separation | 30 | 27 | | dBm |
| **9** | Current Consumption | $I_{dd}$ | $V_{dd}$= +5.0 V | 40 | 35 | 45 | mA |
| **10** | Power Supply Voltage | $V_{dd}$ | | +5.0 | +4.5 | +5.5 | V |
| **11** | Thermal Resistance | $R_{th,c}$ | Junction to case | | | 220 | $^oC/W$ |
| **12** | Operating Temperature | $T_o$ | | | -40 | +85 | $^oC$ |
| **13** | Maximum Average RF Input Power | $P_{IN, MAX}$ | 20 – 500 MHz | | | 10 | dBm |

### b) Passband Frequency Response

As shown in **Figure 1**, the typical gain of the WEA101 is 21.0 dB across 20 to 500 MHz. The typical input and output return losses are 20 dB across the frequency of 20 to 500 MHz. The gain variation is less than 0.70 dB (+/- 0.35 dB) from the frequency from 20 to 300 MHz and less than 2.0 dB from 20 to 500 MHz. The amplifier has excellent consistent performance between each unit at the same lot. For instance, at 64 units sampling size at 250 MHz, the amplifiers have the nominal gain of 21.70 dB with the standard deviation of 0.04 dB, the nominal input return loss of 19.10 dB with the standard deviation of 0.36 dB, and the nominal output return loss of 22.13 dB with the standard deviation of 1.28 dB.

**Figure 3** illustrates the measured noise figure performance at full temperature. The noise figure is 0.80 dB across the frequency range of 50 to 500 MHz and less than 1.2 dB from 20 MHz to 30 MHz at room temperature. At 85 $^0$C, WEA101 only has 0.35 dB noise figure increases. At – 40 $^0$C, WEA101 offers approximately 0.25 dB less noise figure than that at room temperature.

**Figure 3** shows the measured $P_{1dB}$ and $IP_3$ of the WEA101. The typical $P_{1dB}$ and $IP_3$ are 16.0 dBm and 30.0 dBm in the frequency range of 20 to 500 MHz, respectively.

**Figure 4** demonstrates the stability factor ***k*** of the amplifier. The amplifier is conditional stable since the stability factor ***k*** is less than 1 at the frequency from 1.0 GHz to 1.7 GHz.

**Figure 5** illustrates the small signal performance at the extended frequency band.

**Figure 6** presents the internal block diagram of the WEA101. It is a WhanTcom's WHM0003AE packaged IC with some external bias components.

**Figure 7** shows the mechanical outline of WEA101. It is the WanTcom standard WP-6 housing with SMA female connector at the RF ports and feed thru at DC power supply port.

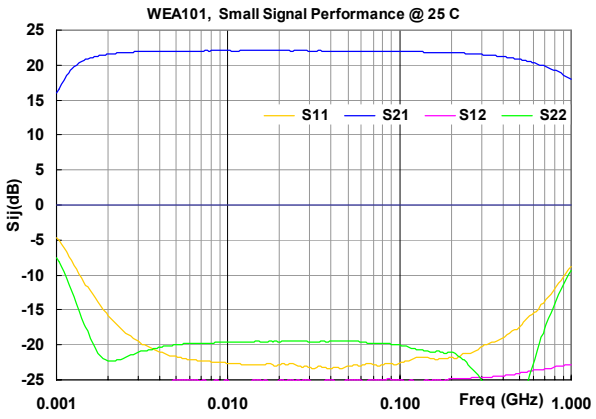


**FIG. 1** Typical small signal performance

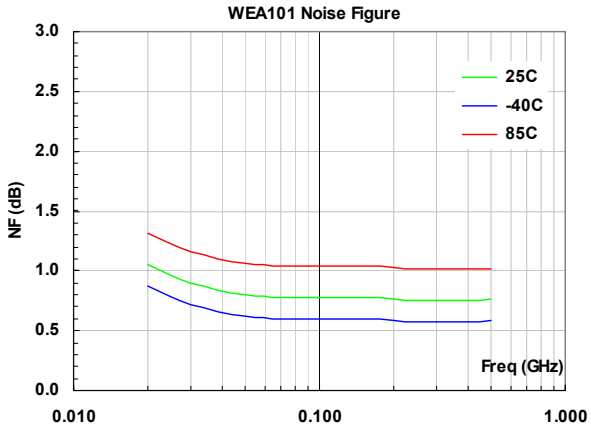


**FIG. 2** Noise figure performance at full temperature

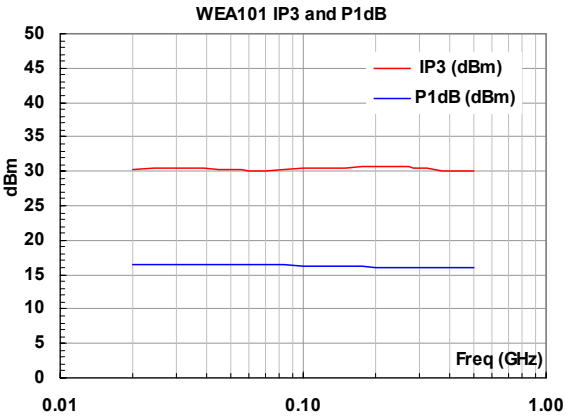


**FIG. 3** Typical $P_{1dB}$ and $IP_3$ at room temperature

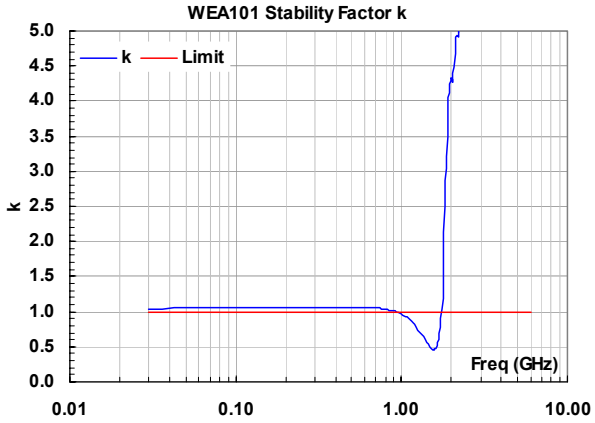


**FIG. 4** The stability factor ***k*** at room temperature

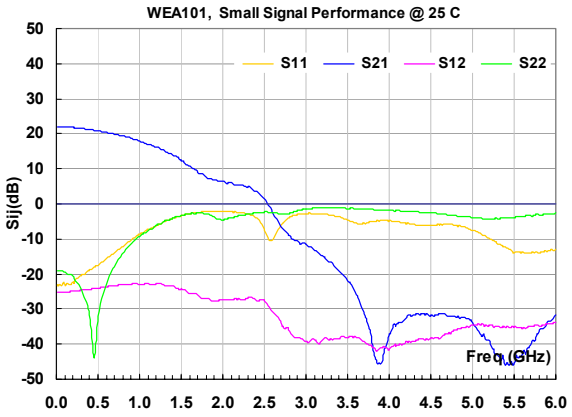


**FIG. 5** Small signal performance at the extended band

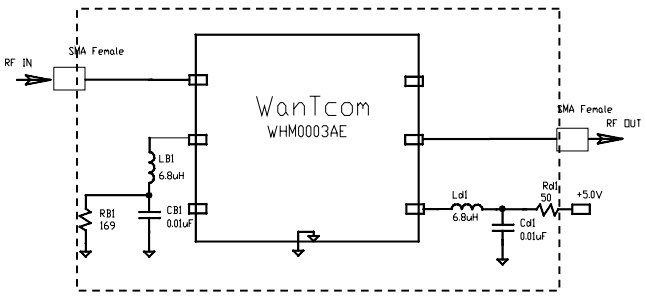


**FIG. 6** Internal block diagram

## WEA101 Mechanical Outline, WP-6:

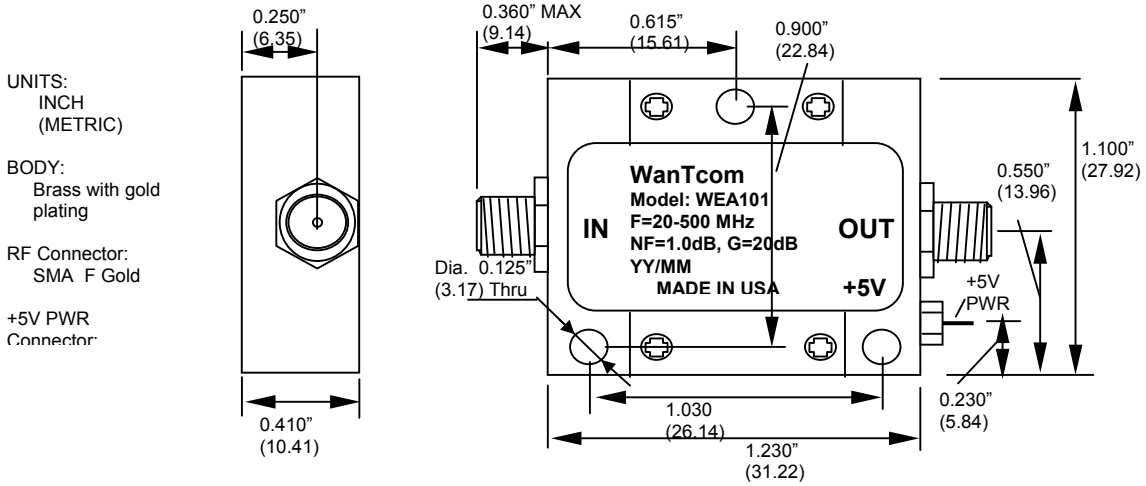


**FIG. 7** WEA101 outline

## Ordering Information

| Model Number | WEA101 |
|---|---|

## Small Signal S-parameters

! WEA101
! Vdd = +5.0 V, Id = 40 mA, Ta = 25 C
# Mhz s ma r 50

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 0 | 0.568 | -20.6 | 4.592 | -150.2 | 0.0200 | 32.5 | 0.567 | -37.1 |
| 10 | 0.073 | 18.6 | 12.657 | -173.4 | 0.056 | 8.3 | 0.107 | -177.9 |
| 20 | 0.073 | 5.2 | 12.671 | -179.8 | 0.055 | 1.0 | 0.102 | 178.3 |
| 30 | 0.069 | -1.9 | 12.656 | 176.8 | 0.055 | 0.8 | 0.107 | 176.4 |
| 40 | 0.068 | -4.0 | 12.646 | 174.2 | 0.056 | 0.0 | 0.108 | 173.1 |
| 50 | 0.070 | -8.1 | 12.629 | 171.6 | 0.056 | -1.6 | 0.107 | 172.5 |
| 60 | 0.069 | -10.6 | 12.603 | 169.5 | 0.055 | -2.5 | 0.105 | 171.0 |
| 70 | 0.072 | -13.3 | 12.593 | 167.3 | 0.056 | -2.4 | 0.106 | 169.1 |
| 80 | 0.072 | -17.6 | 12.559 | 165.1 | 0.055 | -4.9 | 0.102 | 166.5 |
| 90 | 0.074 | -20.2 | 12.563 | 163.1 | 0.055 | -4.7 | 0.102 | 167.1 |
| 100 | 0.072 | -20.9 | 12.530 | 160.9 | 0.057 | -6.1 | 0.100 | 164.1 |
| 110 | 0.078 | -23.1 | 12.495 | 158.8 | 0.055 | -6.3 | 0.099 | 162.6 |
| 120 | 0.079 | -27.9 | 12.494 | 156.6 | 0.056 | -6.2 | 0.094 | 159.0 |
| 130 | 0.080 | -32.5 | 12.429 | 154.7 | 0.057 | -6.9 | 0.094 | 158.4 |
| 140 | 0.083 | -34.6 | 12.360 | 152.4 | 0.056 | -9.1 | 0.090 | 157.7 |
| 150 | 0.082 | -38.2 | 12.269 | 150.6 | 0.057 | -8.2 | 0.090 | 153.0 |
| 160 | 0.077 | -42.9 | 12.182 | 149.0 | 0.055 | -8.0 | 0.093 | 149.4 |
| 170 | 0.078 | -42.7 | 12.201 | 147.5 | 0.057 | -9.7 | 0.090 | 149.0 |
| 180 | 0.079 | -44.2 | 12.239 | 145.7 | 0.057 | -9.6 | 0.088 | 147.2 |
| 190 | 0.077 | -47.2 | 12.267 | 143.8 | 0.057 | -10.7 | 0.089 | 145.9 |
| 200 | 0.081 | -48.4 | 12.212 | 141.8 | 0.057 | -10.4 | 0.088 | 145.2 |
| 210 | 0.081 | -48.2 | 12.184 | 139.7 | 0.057 | -12.0 | 0.087 | 144.2 |
| 220 | 0.081 | -49.3 | 12.172 | 137.8 | 0.057 | -12.8 | 0.082 | 141.4 |
| 230 | 0.084 | -51.8 | 12.149 | 135.9 | 0.058 | -14.6 | 0.080 | 141.5 |
| 240 | 0.087 | -54.8 | 12.102 | 133.8 | 0.057 | -14.4 | 0.077 | 140.6 |
| 250 | 0.086 | -54.0 | 12.079 | 131.9 | 0.058 | -14.7 | 0.073 | 141.0 |
| 260 | 0.087 | -57.7 | 12.075 | 130.0 | 0.057 | -15.2 | 0.071 | 139.7 |
| 270 | 0.089 | -58.4 | 12.016 | 128.0 | 0.057 | -16.6 | 0.067 | 138.7 |
| 280 | 0.089 | -59.0 | 11.971 | 126.0 | 0.057 | -18.0 | 0.062 | 134.8 |
| 290 | 0.090 | -62.7 | 11.967 | 124.2 | 0.058 | -18.6 | 0.062 | 132.3 |
| 300 | 0.095 | -65.0 | 11.919 | 122.2 | 0.059 | -17.5 | 0.058 | 130.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 310 | 0.094 | -67.0 | 11.877 | 120.3 | 0.059 | -18.7 | 0.053 | 127.4 |
| 320 | 0.100 | -70.5 | 11.814 | 118.6 | 0.058 | -21.3 | 0.052 | 126.2 |
| 330 | 0.102 | -71.8 | 11.795 | 116.4 | 0.059 | -20.6 | 0.048 | 123.1 |
| 340 | 0.103 | -74.1 | 11.743 | 114.5 | 0.058 | -21.2 | 0.046 | 125.5 |
| 350 | 0.102 | -75.7 | 11.706 | 112.7 | 0.058 | -21.6 | 0.044 | 127.7 |
| 360 | 0.104 | -76.7 | 11.661 | 110.8 | 0.058 | -22.2 | 0.041 | 128.6 |
| 370 | 0.107 | -77.6 | 11.603 | 108.8 | 0.058 | -22.9 | 0.036 | 128.8 |
| 380 | 0.109 | -78.9 | 11.550 | 107.0 | 0.060 | -23.5 | 0.034 | 129.1 |
| 390 | 0.111 | -80.1 | 11.511 | 105.2 | 0.060 | -25.2 | 0.029 | 129.0 |
| 400 | 0.113 | -81.9 | 11.472 | 103.2 | 0.060 | -25.9 | 0.024 | 131.9 |
| 410 | 0.116 | -84.0 | 11.430 | 101.3 | 0.059 | -26.3 | 0.020 | 134.0 |
| 420 | 0.118 | -86.1 | 11.374 | 99.5 | 0.061 | -27.3 | 0.014 | 129.6 |
| 430 | 0.119 | -88.7 | 11.303 | 97.6 | 0.060 | -27.8 | 0.012 | 130.4 |
| 440 | 0.120 | -91.1 | 11.238 | 95.7 | 0.061 | -28.3 | 0.009 | 136.5 |
| 450 | 0.123 | -92.7 | 11.191 | 93.8 | 0.063 | -28.7 | 0.005 | 151.0 |
| 460 | 0.124 | -94.6 | 11.155 | 91.8 | 0.062 | -29.6 | 0.005 | 173.0 |
| 470 | 0.125 | -96.3 | 11.120 | 89.9 | 0.062 | -30.5 | 0.006 | -164.7 |
| 480 | 0.127 | -97.2 | 11.081 | 88.1 | 0.061 | -31.3 | 0.009 | -147.4 |
| 490 | 0.129 | -98.3 | 11.029 | 86.3 | 0.062 | -32.4 | 0.014 | -137.4 |
| 500 | 0.131 | -99.5 | 10.967 | 84.3 | 0.064 | -33.7 | 0.018 | -132.6 |
| 510 | 0.136 | -100.4 | 10.907 | 82.4 | 0.063 | -34.7 | 0.025 | -128.1 |
| 520 | 0.141 | -101.2 | 10.847 | 80.6 | 0.063 | -35.5 | 0.032 | -123.7 |
| 530 | 0.145 | -102.3 | 10.776 | 78.8 | 0.063 | -35.6 | 0.038 | -118.6 |
| 540 | 0.149 | -103.5 | 10.711 | 76.9 | 0.063 | -36.1 | 0.044 | -114.9 |
| 550 | 0.151 | -105.3 | 10.658 | 75.0 | 0.063 | -37.4 | 0.050 | -114.5 |
| 560 | 0.155 | -107.3 | 10.613 | 73.2 | 0.063 | -38.5 | 0.055 | -113.8 |
| 570 | 0.159 | -109.4 | 10.579 | 71.4 | 0.063 | -39.4 | 0.059 | -112.5 |
| 580 | 0.162 | -111.2 | 10.530 | 69.6 | 0.063 | -40.0 | 0.062 | -111.6 |
| 590 | 0.163 | -112.6 | 10.465 | 67.7 | 0.064 | -40.3 | 0.065 | -111.2 |
| 600 | 0.165 | -114.3 | 10.404 | 65.8 | 0.064 | -41.4 | 0.069 | -112.0 |
| 610 | 0.167 | -116.4 | 10.347 | 63.8 | 0.065 | -43.4 | 0.073 | -114.4 |
| 620 | 0.169 | -118.3 | 10.285 | 61.9 | 0.065 | -44.8 | 0.078 | -117.3 |
| 630 | 0.172 | -119.8 | 10.213 | 60.0 | 0.065 | -44.7 | 0.083 | -121.0 |
| 640 | 0.176 | -121.1 | 10.140 | 58.1 | 0.065 | -44.8 | 0.089 | -124.5 |
| 650 | 0.180 | -121.6 | 10.057 | 56.5 | 0.066 | -45.8 | 0.098 | -126.6 |
| 660 | 0.185 | -122.1 | 9.974 | 54.8 | 0.066 | -46.7 | 0.106 | -128.7 |
| 670 | 0.190 | -123.2 | 9.946 | 53.1 | 0.066 | -47.7 | 0.113 | -129.6 |
| 680 | 0.196 | -124.3 | 9.921 | 51.3 | 0.067 | -48.6 | 0.119 | -130.5 |
| 690 | 0.200 | -125.7 | 9.890 | 49.5 | 0.067 | -49.5 | 0.126 | -131.2 |
| 700 | 0.204 | -127.1 | 9.854 | 47.7 | 0.067 | -50.2 | 0.134 | -131.9 |
| 710 | 0.208 | -128.7 | 9.812 | 45.8 | 0.067 | -51.0 | 0.141 | -132.8 |
| 720 | 0.212 | -131.2 | 9.750 | 43.7 | 0.068 | -52.1 | 0.147 | -134.1 |
| 730 | 0.216 | -133.6 | 9.688 | 41.6 | 0.070 | -53.1 | 0.153 | -135.4 |
| 740 | 0.219 | -135.1 | 9.598 | 39.6 | 0.070 | -54.6 | 0.158 | -136.9 |
| 750 | 0.222 | -136.2 | 9.498 | 37.7 | 0.069 | -56.2 | 0.163 | -138.4 |
| 760 | 0.226 | -137.4 | 9.400 | 35.9 | 0.069 | -57.7 | 0.168 | -140.1 |
| 770 | 0.232 | -139.0 | 9.319 | 34.2 | 0.068 | -58.2 | 0.176 | -143.0 |
| 780 | 0.239 | -140.7 | 9.237 | 32.6 | 0.067 | -58.7 | 0.183 | -146.0 |
| 790 | 0.245 | -142.1 | 9.183 | 30.9 | 0.067 | -59.5 | 0.191 | -148.2 |
| 800 | 0.251 | -143.4 | 9.159 | 29.2 | 0.068 | -60.4 | 0.199 | -149.6 |
| 810 | 0.256 | -144.6 | 9.135 | 27.6 | 0.069 | -61.4 | 0.207 | -151.0 |
| 820 | 0.261 | -146.2 | 9.107 | 25.6 | 0.070 | -62.6 | 0.214 | -152.3 |
| 830 | 0.266 | -147.9 | 9.079 | 23.5 | 0.070 | -63.9 | 0.221 | -153.6 |
| 840 | 0.270 | -149.7 | 9.050 | 21.4 | 0.071 | -65.1 | 0.228 | -154.8 |
| 850 | 0.275 | -151.4 | 8.958 | 19.3 | 0.071 | -66.4 | 0.234 | -156.3 |
| 860 | 0.280 | -153.1 | 8.855 | 17.3 | 0.071 | -67.8 | 0.240 | -157.7 |
| 870 | 0.286 | -154.8 | 8.753 | 15.2 | 0.071 | -69.1 | 0.246 | -159.2 |
| 880 | 0.291 | -156.7 | 8.652 | 13.5 | 0.071 | -69.8 | 0.253 | -161.4 |
| 890 | 0.296 | -158.5 | 8.551 | 11.9 | 0.072 | -70.4 | 0.259 | -163.7 |
| 900 | 0.301 | -160.4 | 8.451 | 10.3 | 0.072 | -71.0 | 0.265 | -165.9 |
| 910 | 0.309 | -161.8 | 8.387 | 8.6 | 0.072 | -72.3 | 0.274 | -168.0 |
| 920 | 0.317 | -163.0 | 8.331 | 6.9 | 0.073 | -73.8 | 0.283 | -170.1 |
| 930 | 0.325 | -164.3 | 8.274 | 5.2 | 0.073 | -75.2 | 0.292 | -172.1 |
| 940 | 0.333 | -165.8 | 8.233 | 3.4 | 0.073 | -76.4 | 0.301 | -173.9 |
| 950 | 0.341 | -167.4 | 8.198 | 1.4 | 0.073 | -77.3 | 0.310 | -175.5 |
| 960 | 0.349 | -169.0 | 8.164 | -0.6 | 0.073 | -78.3 | 0.319 | -177.1 |
| 970 | 0.355 | -170.8 | 8.105 | -2.6 | 0.073 | -79.6 | 0.327 | -178.7 |
| 980 | 0.359 | -172.9 | 8.009 | -4.7 | 0.073 | -81.2 | 0.332 | 179.9 |
| 990 | 0.362 | -174.9 | 7.914 | -6.8 | 0.073 | -82.9 | 0.337 | 178.4 |
| 1000 | 0.365 | -177.0 | 7.818 | -8.9 | 0.073 | -84.5 | 0.342 | 177.0 |

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