# BB(5) Macro-Layer Table with Tape Ones

## Recurrence definitions (macro variables)

For each macro-layer $i$ with oscillator count $M_i$:

$$X_i = 5M_i + 2, \qquad K_i = \begin{cases} X_i, & X_i \text{ even} \\ X_i - 3, & X_i \text{ odd} \end{cases} \qquad Y_i = \frac{K_i + 2}{3} + 1.5, \qquad M_{i+1} = \lfloor Y_i \rfloor.$$

## Tape-one accounting

Let $W_i$ denote the number of 1's on the tape at the end of macro-layer $i$ (your `ones@layer_end`). Define the number of net new 1's created during layer $i$ as:

$$\Delta W_i = W_i - W_{i-1} \quad (i \geq 1).$$

Empirically (from the verified run) the layer-end tape ones satisfy:

$W_0 = 10, \quad W_1 = 20, \quad W_2 = 38, \quad W_3 = 68, \quad W_4 = 118, \quad W_5 = 200, \quad W_6 = 338, \quad W_7 = 568, \quad W_8 = 950, \quad W$

(So the endgame includes a large deletion phase before halting.)

| $i$ | $M_i$ | $X_i$ | $K_i$ | $(K_i, K_i{+}2)$ | $Y_i$ | $M_{i+1}$ | Gate | $W_i$ | $\Delta W_i$ |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 7 | 4 | (4,6) | 3.500 | 3 | lead02 | 10 | – |
| 1 | 3 | 17 | 14 | (14,16) | 6.833 | 6 | lead02 | 20 | 10 |
| 2 | 6 | 32 | 32 | (32,34) | 12.833 | 12 | lead14 | 38 | 18 |
| 3 | 12 | 62 | 62 | (62,64) | 22.833 | 22 | lead14 | 68 | 30 |
| 4 | 22 | 112 | 112 | (112,114) | 39.500 | 39 | lead14 | 118 | 50 |
| 5 | 39 | 197 | 194 | (194,196) | 66.833 | 66 | lead02 | 200 | 82 |
| 6 | 66 | 332 | 332 | (332,334) | 112.833 | 112 | lead14 | 338 | 138 |
| 7 | 112 | 562 | 562 | (562,564) | 189.500 | 189 | lead14 | 568 | 230 |
| 8 | 189 | 947 | 944 | (944,946) | 316.833 | 316 | lead02 | 950 | 382 |
| 9 | 316 | 1582 | 1582 | (1582,1584) | 529.500 | 529 | lead14 | 1588 | 638 |
| 10 | 529 | 2647 | 2644 | (2644,2646) | 883.500 | 883 | lead02 | 2650 | 1062 |
| 11 | 883 | 4417 | 4414 | (4414,4416) | 1473.500 | 1473 | lead02 | 4420 | 1770 |
| 12 | 1473 | 7367 | 7364 | (7364,7366) | 2456.833 | 2456 | lead02 | 7370 | 2950 |
| 13 | 2456 | 12282 | 12282 | (12282,12284) | 4096.167 | 4095 | lead14 | 12288 | 4918 |
| | | | | | | | **Halting end tape** | 4098 | (deletion phase) |

Table 1: Macro-layer recurrence with tape-one counts. $W_i$ is the number of 1s on tape at the end of layer $i$; $\Delta W_i$ is the net increase per layer.

| $i$ | $M_i$ | $X_i$ | $K_i$ | $(K_i, K_i{+}2)$ | $Y_i = \frac{K_i+2}{3} + 1.5$ | $\lfloor Y_i \rfloor$ | Gate | ones@block_end | $(M{+}1/M{+}2)$ | match |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 7 | 4 | (4,6) | 3.500 | 3 | lead02 | 2 | 2 | ✓ |
| 1 | 3 | 17 | 14 | (14,16) | 6.833 | 6 | lead02 | 4 | 4 | ✓ |
| 2 | 6 | 32 | 32 | (32,34) | 12.833 | 12 | lead14 | 8 | 8 | ✓ |
| 3 | 12 | 62 | 62 | (62,64) | 22.833 | 22 | lead14 | 14 | 14 | ✓ |
| 4 | 22 | 112 | 112 | (112,114) | 39.500 | 39 | lead14 | 24 | 24 | ✓ |
| 5 | 39 | 197 | 194 | (194,196) | 66.833 | 66 | lead02 | 40 | 40 | ✓ |
| 6 | 66 | 332 | 332 | (332,334) | 112.833 | 112 | lead14 | 68 | 68 | ✓ |
| 7 | 112 | 562 | 562 | (562,564) | 189.500 | 189 | lead14 | 114 | 114 | ✓ |
| 8 | 189 | 947 | 944 | (944,946) | 316.833 | 316 | lead02 | 190 | 190 | ✓ |
| 9 | 316 | 1582 | 1582 | (1582,1584) | 529.500 | 529 | lead14 | 318 | 318 | ✓ |
| 10 | 529 | 2647 | 2644 | (2644,2646) | 883.500 | 883 | lead02 | 530 | 530 | ✓ |
| 11 | 883 | 4417 | 4414 | (4414,4416) | 1473.500 | 1473 | lead02 | 884 | 884 | ✓ |
| 12 | 1473 | 7367 | 7364 | (7364,7366) | 2456.833 | 2456 | lead02 | 1474 | 1474 | ✓ |
| 13 | 2456 | 12282 | 12282 | (12282,12284) | 4096.167 | 4096 | lead14 | 2458 | 2458 | ✓ |
| 14 | 4095 | – | – | – | – | – | halt | 4097 | 4097 | ✓ |

Table 2: Corrected macro table: $X_i = 5M_i + 2$, $K_i$ parity rule, $Y_i = (K_i + 2)/3 + 1.5$. Empirical invariant: ones@block_end $= M + 1$ if $M$ odd else $M + 2$.