Supplementary Material

Stage 1

$$k = k_0 e^{-Ft}$$

$$v = \left[v_0 - I/A + \frac{Gv_{th}}{A-F}\right] e^{-At} + I/A - \frac{Gv_{th}}{A-F} e^{-Ft}$$

Stage 2

$$k = k_{t1} e^{-Ft}$$

$$v = \frac{k_{t1}G}{F-A}(e^{-Ft} - e^{-At}) + \left(v_{th} - \frac{I+F(v_s-1)}{A}\right) e^{-At} + \frac{I+F(v_s-1)}{A}$$

Stage 3

$$k = v_s + (k_{t2} - v_s) e^{-Ft}$$

$$v = (v_{ref} - \frac{I+F(v_s-1)}{A} + \frac{G(k_{t2}-v_s)}{A-F} + \frac{Gv_s}{A}) e^{-At} - \frac{G(k_{t2}-v_s)}{A-F} e^{-Ft} + \frac{I+F(v_s-1)}{A} - \frac{Gv_s}{A}$$

Stage 4

$$k = \frac{1}{2}(v_{th} + v_s) + \frac{1}{2}(v_{th} - v_s) e^{-2Ft}$$

$$v = \frac{(v_s - v_{th})(G+E)(e^{-At} - e^{-2Ft})}{2(2F-A)} + (v_{t3} - \frac{I+F(v_s-1)}{A} - \frac{v_s(G+E)+v_{th}(G-E)}{2A}) e^{-At} + \frac{I+F(v_s-1)}{A} - \frac{v_s(G+E)+v_{th}(G-E)}{2A}$$

Stage 5

$$k = (k_{t4} - \frac{v_{th}}{2}) e^{-2Ft} + \frac{v_{th}}{2}$$

$$v = \left(k_{t4} - \frac{v_{th}}{2}\right) \frac{G+E}{2F-A}(e^{-2Ft} - e^{-At}) + \left(v_{ref} - \frac{I+F(v_s-1)}{A} + \frac{v_{th}(E-G)}{2A}\right) e^{-At} + \frac{I+F(v_s-1)}{A} + \frac{v_{th}(E-G)}{2A}$$

Stage 6

$$k = \left(k_{t5} - \frac{v_{th}}{2}\right) e^{-2Ft} + \frac{v_{th}}{2}$$

$$v = \left(k_{t5} - \frac{v_{th}}{2}\right) \frac{G+E}{2F-A}(e^{-2Ft} - e^{-At}) + v_{th} e^{-At} + \left(I/A + \frac{v_{th}(E-G)}{2A}\right)(1 - e^{-At})$$

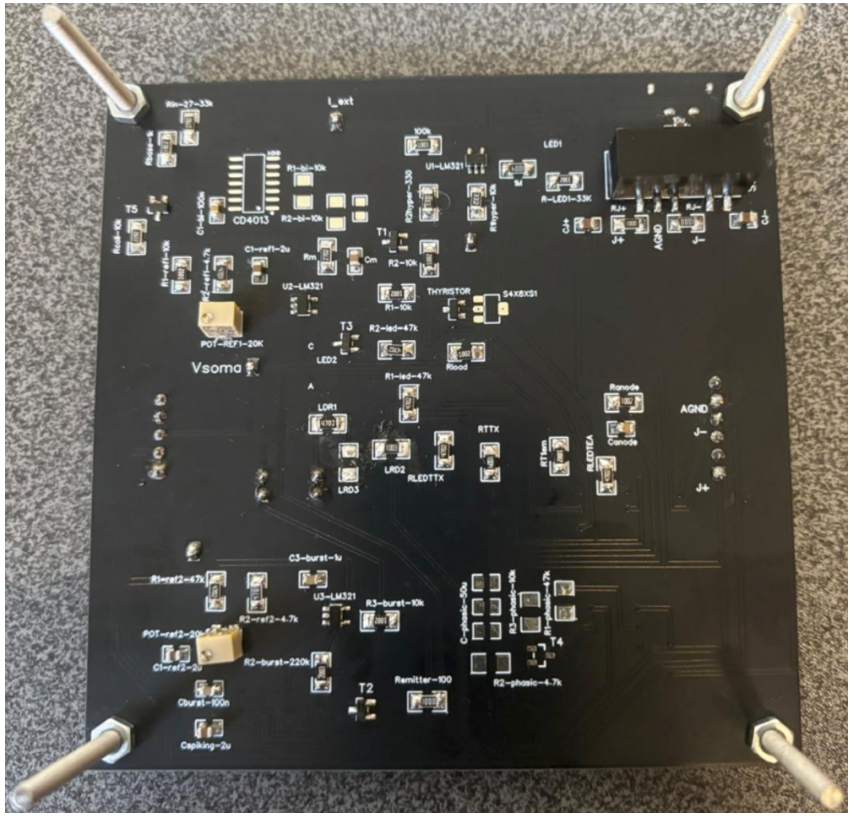


Figure S1: **Electronic implementation of the planar model**. Photograph of the printed circuit board containing the switching and recovery stages. The board uses USB-C power. The photograph documents the hardware implementation; comparison of its measured voltage signal with the model is presented in Figure 4.