ABSTRACT The advent of Nanoscale IC technology towards pulse-based neural systems reactivates the dead nervous to restore the functionality of paralytic disorders. This work reports in first time a design of a novel CMOS biological neuron system, which replaces a dead neuron between two active neurons to restore communication in paralyzed individuals. The work binds into three stages: design of a spiking leaky Integrator and Fire (LIF) neuron with refractory period mechanisms, which achieves a low power consumption of 2.4 μW, in the first stage; an adaptive homeostatic synapse with short and long term spike plasticity, that reconfigures the spiking neuron networks of multichannel sensor electrodes to record the electric signal from the active cell as second stage; the final stage presents a low-power common source current reuse regulated cascode (CS-CR-RGC) TIA for amplifying the weak synapse current signal, which achieves a high gain of 135.71 dBΩ with an optimized noise performance of 0.19 pA/√Hz. The entire work is implemented in a CMOS 65 nm technology that occupies a die area of 400 μm×120 μm.