Floating-gate FPAAs: Circuit Characterization and Applications

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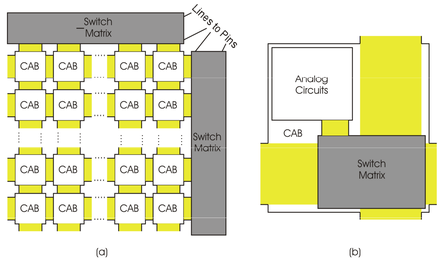
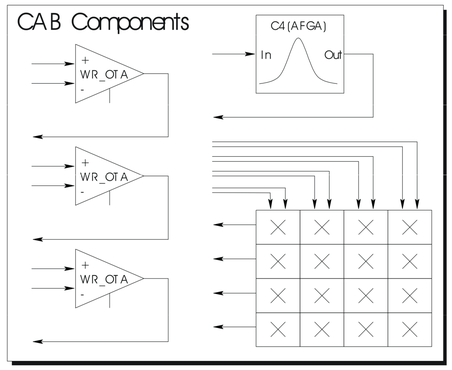
FPAA Architecture

- FPAA will have 100 or more Computational Analog Blocks (CABs).

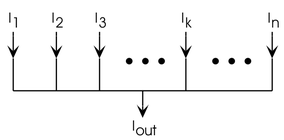


- Instead of basing the computational logic solely on low-level analog components (e.g., op-amps), our FPAA also includes higher-level signal processing blocks such as filters, multipliers, and matrix-array operators.

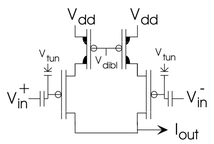
- Each CAB contains
  - 1 four-by-four matrix multiplier
  - 3 wide-range op-amps
  - 1 capacatively coupled current conveyor (C^4)



- CAB logic allows integration, differentiation, gain amplification, addition, matrix-vector multiplication, bandpass filtering, adaptive filtering, fourier processing, etc.



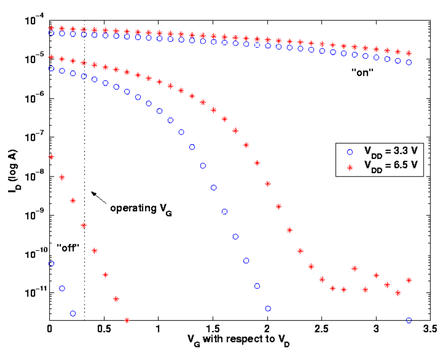
$$I_{out} = \sum_{k=1}^{N} I_k$$

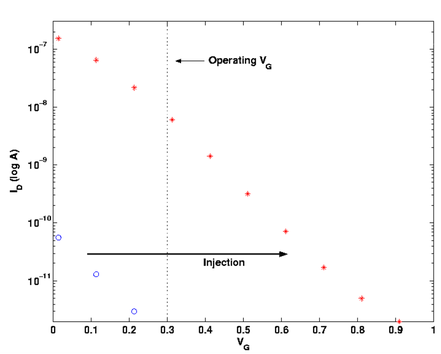


$$I_{out} = I_{bias} + W(V_{in}^{+} - V_{in}^{-})$$

Programming Floating-gate Transistors

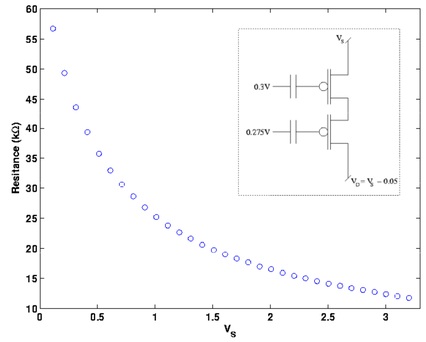
- Floating-gate transistors can be accurately programmed over a wide range.

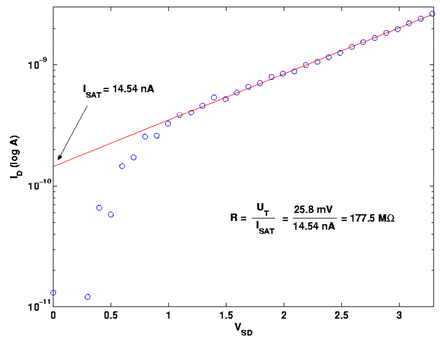




Floating-gate Switches

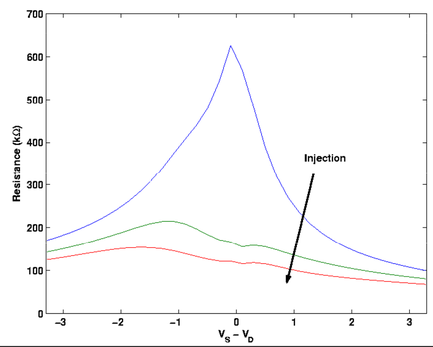
- Floating-gate transistors can be accurately programmed over a wide range of currents (impedances).
- To form a switch, floating-gate transistors are ideally programmed to the extreme low and high impedance states for “on” and “off” respectively. However, the desired quality of the switch must be balanced against the time needed for programming.

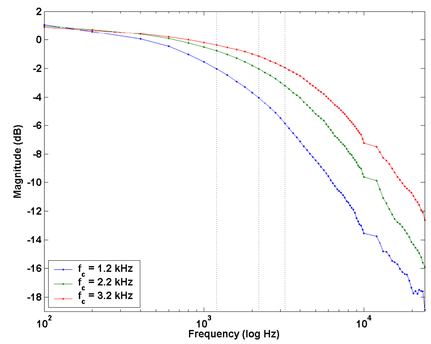




Floating-gate Computational Elements

- The floating-gate switches can also be a computational element. By adjusting the charge, the impedance of the switch can be varied.
- The floating-gate transistors are also used within the CABs to set biases, program multiplier coefficients, and cutoff frequencies.





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