A Discrete Ferroelectric Memory using a Basic Stamp Microprocessor

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Introduction

A ferroelectric capacitor exhibits remanent polarization allowing it to be used as a non-volatile memory. The charged state of the crystal lattice of a ferroelectric capacitor is a natural characteristic of the material. It need only be pointed in the desired direction by the application of the appropriate voltage. A ferroelectric capacitor maintains memory without support from a battery or the environmental protection of a package. A package is needed only to facilitate handling.

Non-volatile memory based on ferroelectricity is charge-based. Its state is destructively read by counting electrons coming from the capacitor when it is forced into a known direction. Ferroelectric hysteresis is typically shown as a full loop, implying continuity. Memory is intrinsically discontinuous.

The charge coming from a ferroelectric capacitor is most easily converted to a voltage by a linear capacitor in series with the ferroelectric capacitor, hence the Sawyer-Tower circuit [1]. Taking advantage of the unique property of microprocessor pins whereby they can act either as active outputs or as high impedance level-sensing inputs, a ferroelectric memory bit may be created by connecting a Sawyer-Tower circuit to two I/O pins of a microprocessor.

**Capacitor Properties**

The circuit operation shown in the oscilloscope image above was achieved using a capacitor with 10,000 square microns of area (AD103) and a 1nF sense capacitor. For detailed information on how to select the sense capacitor and mathematically determine circuit performance, go to www.ferroemems.com and click on the link for “Introduction to the FeMem.” For information on long term reliability, click on the link “Ferroelectric Capacitor Properties.”

**Two Bits instead of One**

The Type AD capacitor package contains two identical capacitors. By connecting the second capacitor to its own I/O pin, a two-bit non-volatile memory is created.

**Conclusion**

Once the single-bit or two-bit FeMem has been constructed, you can perform a variety of experiments or use the memory in the operation of the microprocessor. You can also remove the package from the circuit after writing data and carry it in your pocket without losing the stored information.

**References:**