Low-Power Electrostatic MEMS System for Remote Sensor Applications

Mark N. Horenstein, Steven Cornelissen, Jason Stewart, and David Freedman

Dept. of Electrical and Computer Engineering,
Boston University
8 Saint Mary's Street, Boston MA 02215, USA

Abstract:

Optical data transmission via laser has emerged as a viable alternative to radio communication, especially in situations where data security and/or radio silence are important. Additionally, certain applications involving multi-node sensor networks require a data transmission system in which a central control node can interrogate many remote, battery powered sensors. In this latter case, long battery life is of paramount importance, because the remote sensors are likely to be unattended for long periods of time. To meet these needs, we have developed an laser-based communication system incorporating an electrostatically driven MEMS micromirror configured in a retro-reflective mode. An interrogating laser beam illuminates a retroreflective mirror at the remote sensor node. The mirror, energized by high-voltage signals, then returns information-carrying digital light pulses to the base node where they can be received by a detector and decoded.

One requirement of the remote node is that it be powered by an off-the-shelf battery such as a standard 9-V cell. The MEMS mirror, on the other hand, requires voltages as high as 100 V. Normally, the high voltage in such a MEMS system is provided by a DC-to-DC switching power supply. The latter is not very efficient, however, and requires too much power from the battery to be practical for remote sensing applications. By using an LC resonant boost circuit configuration, we are able to produce the required high voltage directly from a 9-V battery, eliminating the need for a separate DC-to-DC converter. The boost circuit consumes very little power because the energy stored in the capacitance of the energized mirror is returned the battery when the mirror is no longer energized. This mode of operation reduces power consumption considerably and helps the system truly achieve the “low power” claim of MEMS devices. Various other techniques, such as the reduction of energy stored in MEMS capacitance, are also used to reduce power consumption to a bare minimum.