Dynamic control of thermal transport in solid-state systems is a transformative capability with the promise to propel technologies including phononic logic, thermal management, and energy harvesting. A solid-state solution to rapidly manipulate phonons has escaped the scientific community. We demonstrate active and reversible tuning of thermal conductivity by manipulating the nanoscale ferroelastic domain structure of a Pb(Zr$_{0.3}$Ti$_{0.7}$)O$_3$ film with applied electric fields. With subsecond response times, the room-temperature thermal conductivity was modulated by 11%. 