A major synaptic input to the thalamus originates from neurons in cortical layer 6 (L6); however, the function of this cortico-thalamic pathway during sensory processing is not well understood. In the mouse whisker system, we found that optogenetic stimulation of L6 in vivo results in a mixture of hyperpolarization and depolarization in the thalamic target neurons. The hyperpolarization was transient, and for longer L6 activation (>200 ms), thalamic neurons reached a depolarized resting membrane potential which affected key features of thalamic sensory processing. Most importantly, L6 stimulation reduced the adaptation of thalamic responses to repetitive whisker stimulation, thereby allowing thalamic neurons to relay higher frequencies of sensory input. Furthermore, L6 controlled the thalamic response mode by shifting thalamo-cortical transmission from bursting to single spiking. Analysis of intracellular sensory responses suggests that L6 impacts these thalamic properties by controlling the resting membrane potential and the availability of the transient calcium current IT, a hallmark of thalamic excitability. In summary, L6 input to the thalamus can shape both the overall gain and the temporal dynamics of sensory responses that reach the cortex.