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The present work contains a deformable trailing edge flap controller integrated in a numerically simulated modern, variablespeed, pitch-regulated megawatt (MW)-size wind turbine. The aeroservoelastic multi-body code HAWC2 acts as a component in the control loop design. At the core of the proposed controller, all unsteady loads are divided by frequency content. Blade pitching and generator moment react to low-frequency excitations, whereas flaps deal with high-frequency excitations. The present work should be regarded as an investigation into the fatigue load reduction potential when applying trailing edge flaps on a wind turbine blade rather than a conclusive control design with traditional issues like stability and robustness fully investigated. Recent works have shown that the fatigue load reduction by use of trailing edge flaps may be greater than for traditional pitch control methods. By enabling the trailing edge to move independently and quickly along the spanwise position of the blade, local small fluctuations in the aerodynamic forces can be alleviated by deformation of the airfoil flap. Strain gauges are used as input for the flap controller, and the effect of placing strain gauges at various radial positions on the blade is investigated. An optimization routine minimizes blade root fatigue loads. Calculations are based on the 5 MW reference wind turbine part of the UpWind project primarily with a mean turbulent wind speed close to rated power. A fatigue load reduction of 25% in the blade root moment was obtained for a continuous 6.3 m long flap. Copyright © 2009 John Wiley & Sons, Ltd.