To simulate lumped elements (LEs) more accurately in metamaterial absorber (MA) designs, a finite-volume LE (FVLE) model based on the time-domain finite-integral theorem (TDFIT) is proposed in this paper. In MA designs, lumped resistors and capacitors play an important role in dissipating electromagnetic (EM) fields, controlling resonant frequencies, and achieving an impedance matching. Through a rigorous mathematical derivation, we successfully prove that an arbitrary lumped resistor or capacitor can be modeled more accurately by modifying the conductivity or permittivity of a finite-volume model in TDFIT method. Compared with existing traditional zero-volume LE (ZVLE) solutions, the coupling effect between the circuit part and the EM part can be considered much better in the proposed FVLE model. For this reason, the numerical results of the FVLE model match the measured results much better. In addition, a result comparison is given to validate that the challenges of grid dispersion error and frequency response error in the classic ZVLE solution can be greatly overcome by the proposed FVLE model.