Methoxy radical, CH$_3$O is a widely studied and benchmark molecule, both for its spectroscopy and its role in chemical reactions. It possesses a ground $^2E$ state which is distorted by the Jahn-Teller interaction and split into $^2E_1/2$ and $^2E_3/2$ components by the spin-orbit interaction. The LIF spectra of the $\tilde{A}^2A_1-\tilde{X}^2E$ transitions is well-known, but under jet expansion conditions the $^2E_1/2$ component is not observed because it is $\sim$60 cm$^{-1}$ higher than $^2E_3/2$ and not populated. A feasible way to study the features of the $^2E_1/2$ level is to use the Stimulated Emission Pumping (SEP) technique. We have combined our high-resolution laser-induced fluorescence (LIF) spectroscopic ($\Delta\nu \sim 200$ MHz) with a moderate-resolution laser ($\Delta\nu \sim 0.2$ cm$^{-1}$). These lasers are controlled by a computer program, which permits both the pump and dump lasers to be fired at specified delays after the photolysis laser producing CH$_3$O. SEP spectra of CH$_3$O were recorded with a resolution of $\sim$300 MHz linewidth and measured with a precision $\sim$100 MHz and these data were included in a global data (LIF, SEP, microwave) fitting to determine the parameters of the $\tilde{X}^2E_1/2$ state. The previous assignment of parity for the $^2E_1/2$ state is modified and the value of the spin-orbit splitting revised.