I. INTRODUCTION

Quantum field theories defined in a noncommutative space have been under intense scrutiny in the last years [1, 2]. The outcome of these investigations have unveiled various unusual and intriguing aspects which are consequences of their inherent nonlocality. Among these properties, the most peculiar one is the transmutation of part of the ultraviolet divergences into infrared ones, a property that has been called infrared/ultraviolet mixing [3]. From a technical viewpoint, the mixing is due to the separation of the contributions of Feynman diagrams in parts nonplanar, which are ultraviolet finite but may present an infrared singularity, and planar, which may have only ultraviolet divergences. Aside the potentially dangerous character of the infrared divergences, the mere separation of the amplitudes in planar and nonplanar parts may obstruct the ultraviolet renormalization of noncommutative theories.

In the commutative setting, it is well known that Slavnov-Taylor (ST) identities [4] play a fundamental role in the renormalization of non-Abelian gauge theories [4, 5]. It is therefore essential to verify to what extension these identities are affected by the noncommutativity of the underlying space. In this work we will present a detailed analysis of the one-loop ST identities in noncommutative QED$_4$. As we will explicitly verify, there are no anomalies and the usual renormalization procedure is not basically modified.

We would like to point out some relevant studies on the subject. For the pure noncommutative $U(N)$ Yang-Mills model, the compatibility of dimensional renormalization with the ST identities have been verified in [6] up to one-loop order. Reference [7] contains an explicit on-shell verification of the one-loop ST identity for the trilinear fermion-photon vertex. In the tree approximation, the identities have been verified in various scattering processes in [8]. They were also used in [9] to investigate the dependence of the two point function of the gauge field on the gauge parameter. To prove the absence of radiative corrections to the Chern-Simons coefficient, the axial gauge identities were used and explicitly verified in a one-loop calculation [10].

This work is organized as follows. In section II we introduce our basic notation and the Feynman rules for noncommutative QED$_4$. Section III provides a formal derivation for the ST identities. In particular, using these relations the longitudinal part of photon propagator is fixed and the identities for the vectorial fermion-photon and triple photon vertex functions are presented. In Section IV these identities are subjected to a detailed analysis taking in consideration the counterterms needed to control the ultraviolet behavior. Section V contains some final comments and a discussion of our results.