Abstract: Self-driving vehicles must be able to safely navigate in any traffic scenario. However, all situations are different; even when clustering them, an impractical amount of scenarios would have to be verified. Thus, we propose a safety framework to verify the safety of each planned trajectory on-the-fly, using formal methods to handle uncertain measurements and future behaviors of traffic participants and disturbances acting on the ego vehicle, among others. Our framework can easily be integrated in existing motion planning architectures and enables fail-safe operation of self-driving vehicles, since we provide a safe plan for any given point in time. We demonstrate the benefits of our framework in different highway and urban scenarios of the CommonRoad benchmark suite.