Propulsion systems continue to be influenced by the efficiency of combustion systems. One approach to substantially improve combustion efficiency is through pressure gain combustion or detonation-based engines. Additionally, detonations are being used as a high-energy ignition device by taking advantage of the rapid heat release that a detonation naturally exhibits. One method to utilize the power of detonations is through using a pulse detonation device to ignite an ethylene-fueled supersonic flame-holder, where the conditions are challenging due to the low temperatures, pressures, and residence times. In this study, we investigate the transient mechanisms of detonation wave diffraction through a geometric area expansion and contraction for pressure amplification. The sudden area expansion causes detonation diffraction, which results in complex interactions between deflagration fronts and reflected shock waves. Two expansion ratios are explored to tailor the detonation energy deposition and re-initiation location. High-speed broadband chemiluminescence and schlieren illustrate the gas dynamic mechanisms of the decoupling and re-initiation process through an optically accessible test section. Pressure and velocity measurements are also acquired simultaneously. The results show that the detonation is subcritical as it enters the expansion, causing it to decouple. The re-initiation mechanism is shown to be a coalescence of transverse waves or reflection off the back wall depending on the expansion ratio and length of the expansion chamber.