In this study, an attempt on pulsed-fiber laser welding on an austenitic-duplex stainless steel butt joint configuration was investigated. The influence of various welding parameters, such as beam diameter, peak power, pulse repetition rate, and pulse width on the weld beads geometry was studied by checking the width and depth of the welds after each round of welding parameters combination. The weld bead dimensions and microstructural progression of the weld joints were observed microscopically. Finally, the full penetration specimens were subjected to tensile tests, which were coupled with the analysis of the fracture surfaces. From the results, combination of the selected weld parameters resulted in robust weldments with similar features to those of duplex and austenitic weld metals. The weld depth and width were found to increase proportionally to the laser power. Furthermore, the weld bead geometry was found to be positively affected by the pulse width. Microstructural studies revealed the presence of dendritic and fine grain structures within the weld zone at low peak power, while ferritic microstructures were found on the sides of the weld metal near the SS 304 and austenitic-ferritic microstructure beside the duplex 2205 boundary. Regarding the micro-hardness tests, there was an improvement when compared to the hardness of duplex and austenitic stainless steels base metals. Additionally, the tensile strength of the fiber laser welded joints was found to be higher when compared to the tensile strength of the base metals (duplex and austenitic) in all of the joints.