A design approach for substrate-integrated waveguide (SIW) to rectangular waveguide (RWG) transitions based on the synthesis of antipodal finline tapers is proposed. The taper is designed using a reflection-based impedance definition as no suitable model is available for antipodal finlines. The characteristics of the finline are determined from full-wave simulation. To demonstrate the proposed method, two SIW-to-RWG transitions are designed and characterized at the K-band. The measured back-to-back transitions exhibit a return loss above 15 dB and an insertion loss below 1 dB between 16.7 and 20.5 GHz and between 21.1 and more than 31 GHz, respectively. A good agreement between the synthesis model and full-wave simulation of the taper on one hand and between simulation and measurements of back-to-back transitions on the other hand is demonstrated.