$$\dfrac{\dfrac{\dfrac{}{1{:}^{\epsilon}p, 0{:}^{here}\mathcal{K}_a(p \to q), 0{:}^{here}\mathcal{K}_a p, (0,[])\mathsf{R}^{\epsilon}_a(1,[]) \Rightarrow 1{:}^{\epsilon}p, 1{:}^{\epsilon}q,}\,(init) \quad \dfrac{}{0{:}^{here}\mathcal{K}_a(p \to q), 0{:}^{here}\mathcal{K}_a p, (0,[])\mathsf{R}}}{0{:}^{here}\mathcal{K}_a(p \to q), 0{:}^{\epsilon}\mathcal{K}_a p, (0,[])\mathsf{R}^{\epsilon}_a(1,[]) \Rightarrow 1{:}^{\epsilon}q, 1{:}^{\epsilon}p,}}{1{:}^{\epsilon}p \to q, 0{:}}$$

Table 1: G3PAL'

(Initial Sequent)

$$x{:}A, \Gamma ==> \Delta, x{:}A$$

(Rules for propositional connectives)

$$\frac{\Gamma ==> \Delta, x(\alpha){:}A}{x(\alpha){:} \sim A, \Gamma ==> \Delta}\ (L \sim) \quad \frac{x(\alpha){:}A, \Gamma ==>}{\Gamma ==> \Delta, x(\alpha){:}}$$

$$\frac{\Gamma ==> \Delta, x(\alpha){:}A \quad x(\alpha){:}B, \Gamma ==> \Delta}{x(\alpha){:}A -> B, \Gamma ==> \Delta}\ (L->) \quad \frac{x(\alpha){:}A, \Gamma =}{\Gamma ==> \Delta,}$$

(Rules for knowledge operators)

$$\frac{x(\alpha){:}\#a(\beta, y)A, \Gamma ==> \Delta, x\mathsf{R}_a(\alpha)y, \quad y(\alpha){:}A, x(\alpha){:}\#a(\beta, y}{x(\alpha){:}\#a(\beta)A, \Gamma ==> \Delta}$$

$$\frac{x\mathsf{R}_a(\alpha)y, \Gamma ==> \Delta, y(\alpha){:}A}{\Gamma ==> \Delta, x(\alpha){:}\#a(\beta)A}\ (R\#a)\ddagger$$

† y does not appear in β.
‡ y does not appear in the lower seque

(Rules for PAL)

$$\frac{x(\alpha){:}A, x(\alpha){:}p, \Gamma ==> \Delta}{x(\alpha, A){:}p, \Gamma ==> \Delta}\ (Lat) \quad \frac{\Gamma ==> \Delta, x(\alpha){:}A \quad \Gamma =}{\Gamma ==> \Delta, x(\alpha}$$

$$\frac{\Gamma ==> \Delta, x(\alpha){:}A \quad x(\alpha, A){:}B, \Gamma ==> \Delta}{x(\alpha){:}[A]B, \Gamma ==> \Delta}\ (\mathrm{L}[.\ ]) \quad \frac{x(\alpha){:}A, \Gamma =}{\Gamma ==>}$$

$$\frac{x{:}A, y{:}A, x\mathsf{R}_a(\alpha)y, \Gamma ==> \Delta}{x\mathsf{R}_a(\alpha, A)y, \Gamma ==> \Delta}\ (Lrel)$$

$$\frac{\Gamma ==> \Delta, x{:}A \quad \Gamma ==> \Delta, y{:}A \quad \Gamma ==> \Delta, x\mathsf{R}_a}{\Gamma ==> \Delta, x\mathsf{R}_a(\alpha, A)y}$$

(Rules for propositional connectives)

$$\frac{}{x(\alpha){:}bot, \Gamma ==> \Delta}\ (Lbot) \quad \frac{}{\Gamma ==> \Delta, x(\alpha){:}t}$$

$$\frac{x(\alpha){:}A, x(\alpha){:}B, \Gamma ==> \Delta}{x(\alpha){:}A\ \&\ B, \Gamma ==> \Delta}\ (L\&) \quad \frac{\Gamma ==> \Delta, x(\alpha){:}A \quad \Gamma =}{\Gamma ==> \Delta, x(\alpha)}$$

$$\frac{x(\alpha){:}A, \Gamma ==> \Delta \quad x(\alpha){:}B, \Gamma ==> \Delta}{x(\alpha){:}A\ v\ B, \Gamma ==> \Delta}\ (Lv) \quad \frac{\Gamma ==> \Delta,}{\Gamma ==> \Delta}$$

(Rules for knowledge operators)

$$\frac{x(\alpha, A, B){:}C, \Gamma ==> \Delta}{x(\alpha, A\ \&\ [A]B){:}C, \Gamma ==> \Delta}\ (Lcmp)\ {}_2\frac{\Gamma ==> \Delta, x(\alpha}{\Gamma ==> \Delta, x(\alpha, A}$$

other

$$\frac{x(\alpha){:}A -> B, x(\alpha){:}B -> A, \Gamma ==> \Delta}{x(\alpha){:}A <-> B, \Gamma ==> \Delta}\ (L <->) \quad \frac{\Gamma ==> \Delta, x(\alpha){:}A ->}{\Gamma ==> \Delta,}$$