Scalar Quartic Couplings in the Left-Right Symmetric Models

Higgs Quartic Coupling Vertices: LR triplet model

Here, we have encoded the possible non-zero quartic couplings that appear in this model in terms of the physical Higgs fields.

$$H_0^0H_0^0H_0^0H_0^0 : \left[\frac{6\left(\lambda_1\left(k_1^2+k_2^2\right)^2+4k_1k_2\left(\lambda_4\left(k_1^2+k_2^2\right)+\left(2\lambda_2+\lambda_3\right)k_1k_2\right)\right)}{\left(k_1^2+k_2^2\right)^2}\right]$$

$$H_1^0H_0^0H_0^0H_0^0 : \left[\frac{6(k_1-k_2)(k_1+k_2)\left(\lambda_4\left(k_1^2+k_2^2\right)+2\left(2\lambda_2+\lambda_3\right)k_1k_2\right)}{\left(k_1^2+k_2^2\right)^2}\right]$$

$$H_1^0H_1^0H_0^0H_0^0 : \left[\frac{2\left(\lambda_1\left(k_1^2+k_2^2\right)^2+2\left(2\lambda_2+\lambda_3\right)\left(k_1^4-4k_1^2k_2^2+k_2^4\right)\right)}{\left(k_1^2+k_2^2\right)^2}\right]$$

$$H_2^0H_2^0H_0^0H_0^0 : \left[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_2\left(4\alpha_2k_1+\alpha_3k_2\right)}{k_1^2+k_2^2}\right]$$

$$H_3^0H_3^0H_0^0H_0^0 : \left[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_2\left(4\alpha_2k_1+\alpha_3k_2\right)}{k_1^2+k_2^2}\right]$$

$$H_1^-H_1^+H_0^0H_0^0 : \left[\alpha_1+\frac{\alpha_3}{2}+\frac{4\alpha_2k_1k_2}{k_1^2+k_2^2}\right]$$

$$H_2^-H_2^+H_0^0H_0^0 : \left[\frac{2\left(\lambda_1\left(k_1^2+k_2^2\right)^2-4\left(2\lambda_2+\lambda_3\right)k_1^2k_2^2\right)}{\left(k_1^2+k_2^2\right)^2}\right]$$

$$H_1^{--}H_1^{++}H_0^0H_0^0 : \left[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_1\left(\alpha_3k_1+4\alpha_2k_2\right)}{k_1^2+k_2^2}\right]$$

$$H_2^{--}H_2^{++}H_0^0H_0^0 : \left[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_1\left(\alpha_3k_1+4\alpha_2k_2\right)}{k_1^2+k_2^2}\right]$$

$$A_1^0A_1^0H_0^0H_0^0 : \left[\frac{2\left(2\lambda_3\left(k_1^4+k_2^4\right)+\lambda_1\left(k_1^2+k_2^2\right)^2-4\lambda_2\left(k_1^4+4k_1^2k_2^2+k_2^4\right)\right)}{\left(k_1^2+k_2^2\right)^2}\right]$$

$$H_1^0H_1^0H_1^0H_0^0 : \left[\frac{6(k_1-k_2)(k_1+k_2)\left(\lambda_4\left(k_1^2+k_2^2\right)-2\left(2\lambda_2+\lambda_3\right)k_1k_2\right)}{\left(k_1^2+k_2^2\right)^2}\right]$$

$$H_2^0H_2^0H_1^0H_0^0 : \left[\frac{2\alpha_2(k_1-k_2)(k_1+k_2)+\alpha_3k_1k_2}{k_1^2+k_2^2}\right]$$

$$H_3^0H_3^0H_1^0H_0^0 : \left[\frac{2\alpha_2(k_1-k_2)(k_1+k_2)+\alpha_3k_1k_2}{k_1^2+k_2^2}\right]$$

$$H_1^- H_1^+ H_1^0 H_0^0 : \Big[\frac{2\alpha_2(k_1-k_2)(k_1+k_2)}{k_1^2+k_2^2}\Big]$$

$$H_2^- H_2^+ H_1^0 H_0^0 : \Big[\frac{2(k_1-k_2)(k_1+k_2)\left(\lambda_4\left(k_1^2+k_2^2\right)-2\left(2\lambda_2+\lambda_3\right)k_1k_2\right)}{\left(k_1^2+k_2^2\right)^2}\Big]$$

$$H_1^{--} H_1^{++} H_1^0 H_0^0 : \Big[\frac{2\alpha_2(k_1-k_2)(k_1+k_2)-\alpha_3k_1k_2}{k_1^2+k_2^2}\Big]$$

$$H_2^{--} H_2^{++} H_1^0 H_0^0 : \Big[\frac{2\alpha_2(k_1-k_2)(k_1+k_2)-\alpha_3k_1k_2}{k_1^2+k_2^2}\Big]$$

$$A_1^0 A_1^0 H_1^0 H_0^0 : \Big[\frac{2(k_1-k_2)(k_1+k_2)\left(\lambda_4\left(k_1^2+k_2^2\right)-2\left(2\lambda_2+\lambda_3\right)k_1k_2\right)}{\left(k_1^2+k_2^2\right)^2}\Big]$$

$$H_2^- H_1^+ H_3^0 H_0^0 : \Big[\frac{\alpha_3k_1k_2}{\sqrt{2}\left(k_1^2+k_2^2\right)}\Big]$$

$$H_2^+ H_1^- H_3^0 H_0^0 : \Big[\frac{\alpha_3k_1k_2}{\sqrt{2}\left(k_1^2+k_2^2\right)}\Big]$$

$$H_1^{--} H_2^+ H_1^+ H_0^0 : \Big[-\frac{\alpha_3k_1k_2}{k_1^2+k_2^2}\Big]$$

$$H_1^{++} H_2^- H_1^- H_0^0 : \Big[-\frac{\alpha_3k_1k_2}{k_1^2+k_2^2}\Big]$$

$$H_1^0 H_1^0 H_1^0 H_1^0 : \Big[\frac{6\left(\lambda_1\left(k_1^2+k_2^2\right)^2+4k_1k_2\left(\left(2\lambda_2+\lambda_3\right)k_1k_2-\lambda_4\left(k_1^2+k_2^2\right)\right)\right)}{\left(k_1^2+k_2^2\right)^2}\Big]$$

$$H_2^0 H_2^0 H_1^0 H_1^0 : \Big[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_1\left(\alpha_3k_1-4\alpha_2k_2\right)}{k_1^2+k_2^2}\Big]$$

$$H_3^0 H_3^0 H_1^0 H_1^0 : \Big[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_1\left(\alpha_3k_1-4\alpha_2k_2\right)}{k_1^2+k_2^2}\Big]$$

$$H_1^- H_1^+ H_1^0 H_1^0 : \Big[\alpha_1+\frac{\alpha_3}{2}-\frac{4\alpha_2k_1k_2}{k_1^2+k_2^2}\Big]$$

$$H_2^- H_2^+ H_1^0 H_1^0 : \Big[\frac{2\left(\lambda_1\left(k_1^2+k_2^2\right)^2+4k_1k_2\left(\left(2\lambda_2+\lambda_3\right)k_1k_2-\lambda_4\left(k_1^2+k_2^2\right)\right)\right)}{\left(k_1^2+k_2^2\right)^2}\Big]$$

$$H_1^{--} H_1^{++} H_1^0 H_1^0 : \Big[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_2\left(\alpha_3k_2-4\alpha_2k_1\right)}{k_1^2+k_2^2}\Big]$$

$$H_2^{--} H_2^{++} H_1^0 H_1^0 : \Big[\frac{\alpha_1\left(k_1^2+k_2^2\right)+k_2\left(\alpha_3k_2-4\alpha_2k_1\right)}{k_1^2+k_2^2}\Big]$$

$$A_1^0 A_1^0 H_1^0 H_1^0 : \Big[\frac{2\left(\lambda_1\left(k_1^2+k_2^2\right)^2+4k_1k_2\left(\left(2\lambda_2+\lambda_3\right)k_1k_2-\lambda_4\left(k_1^2+k_2^2\right)\right)\right)}{\left(k_1^2+k_2^2\right)^2}\Big]$$

$$H_2^- H_1^+ H_3^0 H_1^0 : \left[\frac{\alpha_3(k_1-k_2)(k_1+k_2)}{2\sqrt{2}\,(k_1^2+k_2^2)}\right]$$

$$H_2^+ H_1^- H_3^0 H_1^0 : \left[\frac{\alpha_3(k_1-k_2)(k_1+k_2)}{2\sqrt{2}\,(k_1^2+k_2^2)}\right]$$

$$H_1^{--} H_2^+ H_1^+ H_1^0 : \left[\frac{\alpha_3\,(k_2^2-k_1^2)}{2\,(k_1^2+k_2^2)}\right]$$

$$H_1^{++} H_2^- H_1^- H_1^0 : \left[\frac{\alpha_3\,(k_2^2-k_1^2)}{2\,(k_1^2+k_2^2)}\right]$$

$$H_2^0 H_2^0 H_2^0 H_2^0 : \left[6\rho_1\right]$$

$$H_3^0 H_3^0 H_2^0 H_2^0 : \left[\rho_3\right]$$

$$H_1^- H_1^+ H_2^0 H_2^0 : \left[\rho_3\right]$$

$$H_2^- H_2^+ H_2^0 H_2^0 : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_1\,(\alpha_3 k_1-4\alpha_2 k_2)}{k_1^2+k_2^2}\right]$$

$$H_1^{--} H_1^{++} H_2^0 H_2^0 : \left[\rho_3\right]$$

$$H_2^{--} H_2^{++} H_2^0 H_2^0 : \left[2\,(\rho_1+2\rho_2)\right]$$

$$A_1^0 A_1^0 H_2^0 H_2^0 : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_1\,(\alpha_3 k_1-4\alpha_2 k_2)}{k_1^2+k_2^2}\right]$$

$$H_2^{--} H_1^{++} H_3^0 H_2^0 : \left[2\rho_4\right]$$

$$H_2^{++} H_1^{--} H_3^0 H_2^0 : \left[2\rho_4\right]$$

$$H_2^{--} H_1^+ H_1^+ H_2^0 : \left[2\sqrt{2}\rho_4\right]$$

$$H_2^{++} H_1^- H_1^- H_2^0 : \left[2\sqrt{2}\rho_4\right]$$

$$H_3^0 H_3^0 H_3^0 H_3^0 : \left[6\rho_1\right]$$

$$H_1^- H_1^+ H_3^0 H_3^0 : \left[2\rho_1\right]$$

$$H_2^- H_2^+ H_3^0 H_3^0 : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_2\,(\alpha_3 k_2-4\alpha_2 k_1)}{k_1^2+k_2^2}\right]$$

$$H_1^{--} H_1^{++} H_3^0 H_3^0 : \left[2\,(\rho_1+2\rho_2)\right]$$

$$H_2^{--} H_2^{++} H_3^0 H_3^0 : \left[\rho_3\right]$$

$$A_1^0 A_1^0 H_3^0 H_3^0 : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_1\,(\alpha_3 k_1-4\alpha_2 k_2)}{k_1^2+k_2^2}\right]$$

$$H_1^{--} H_1^+ H_1^+ H_3^0 : \left[2\sqrt{2}\rho_2\right]$$

$$A_1^0 H_2^- H_1^+ H_3^0 : \left[-\frac{i\alpha_3(k_1-k_2)(k_1+k_2)}{2\sqrt{2}\,(k_1^2+k_2^2)}\right]$$

$$H_1^{++}H_1^-H_1^-H_3^0 : \left[2\sqrt{2}\rho_2\right]$$

$$A_1^0H_2^+H_1^-H_3^0 : \left[\frac{i\alpha_3(k_1-k_2)(k_1+k_2)}{2\sqrt{2}\,(k_1^2+k_2^2)}\right]$$

$$H_1^-H_1^-H_1^+H_1^+ : \left[4\,(\rho_1+\rho_2)\right]$$

$$H_2^-H_2^+H_1^-H_1^+ : \left[\alpha_1+\frac{\alpha_3}{2}-\frac{4\alpha_2k_1k_2}{k_1^2+k_2^2}\right]$$

$$H_1^{--}H_1^{++}H_1^-H_1^+ : \left[2\rho_1\right]$$

$$H_2^-H_2^{++}H_1^-H_1^+ : \left[\rho_3\right]$$

$$A_1^0A_1^0H_1^-H_1^+ : \left[\alpha_1+\frac{\alpha_3}{2}-\frac{4\alpha_2k_1k_2}{k_1^2+k_2^2}\right]$$

$$A_1^0H_1^{--}H_2^+H_1^+ : \left[-\frac{i\alpha_3(k_1-k_2)(k_1+k_2)}{2\,(k_1^2+k_2^2)}\right]$$

$$A_1^0H_1^{++}H_2^-H_1^- : \left[\frac{i\alpha_3(k_1-k_2)(k_1+k_2)}{2\,(k_1^2+k_2^2)}\right]$$

$$H_2^-H_2^-H_2^+H_2^+ : \left[\frac{4\left(\lambda_1\,(k_1^2+k_2^2)^2+4k_1k_2\,((2\lambda_2+\lambda_3)\,k_1k_2-\lambda_4\,(k_1^2+k_2^2))\right)}{(k_1^2+k_2^2)^2}\right]$$

$$H_1^{--}H_1^{++}H_2^-H_2^+ : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_1\,(\alpha_3k_1-4\alpha_2k_2)}{k_1^2+k_2^2}\right]$$

$$H_2^{--}H_2^{++}H_2^{--}H_2^+ : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_2\,(\alpha_3k_2-4\alpha_2k_1)}{k_1^2+k_2^2}\right]$$

$$A_1^0A_1^0H_2^-H_2^+ : \left[\frac{2\left(\lambda_1\,(k_1^2+k_2^2)^2+4k_1k_2\,((2\lambda_2+\lambda_3)\,k_1k_2-\lambda_4\,(k_1^2+k_2^2))\right)}{(k_1^2+k_2^2)^2}\right]$$

$$H_1^{--}H_1^{--}H_1^{++}H_1^{++} : \left[4\rho_1\right]$$

$$H_2^{--}H_2^{++}H_1^{--}H_1^{++} : \left[\rho_3\right]$$

$$A_1^0A_1^0H_1^{--}H_1^{++} : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_2\,(\alpha_3k_2-4\alpha_2k_1)}{k_1^2+k_2^2}\right]$$

$$H_2^{--}H_2^{--}H_2^{++}H_2^{++} : \left[4\rho_1\right]$$

$$A_1^0A_1^0H_2^{--}H_2^{++} : \left[\frac{\alpha_1\,(k_1^2+k_2^2)+k_2\,(\alpha_3k_2-4\alpha_2k_1)}{k_1^2+k_2^2}\right]$$

$$A_1^0A_1^0A_1^0A_1^0 : \left[\frac{6\left(\lambda_1\,(k_1^2+k_2^2)^2+4k_1k_2\,((2\lambda_2+\lambda_3)\,k_1k_2-\lambda_4\,(k_1^2+k_2^2))\right)}{(k_1^2+k_2^2)^2}\right]$$

$$A_2^0 A_2^0 H_0^0 H_0^0 \,:\, \Big[\frac{\alpha_1\left({k_1}^2+{k_2}^2\right)+k_2\left(4\alpha_2 k_1+\alpha_3 k_2\right)}{{k_1}^2+{k_2}^2}\Big]$$

$$A_2^0 A_2^0 H_1^0 H_0^0 \,:\, \Big[\frac{2\alpha_2(k_1-k_2)(k_1+k_2)+\alpha_3 k_1 k_2}{{k_1}^2+{k_2}^2}\Big]$$

$$A_2^0 H_2^- H_1^+ H_0^0 \,:\, \Big[-\frac{i\alpha_3 k_1 k_2}{\sqrt{2}\left({k_1}^2+{k_2}^2\right)}\Big]$$

$$A_2^0 H_2^+ H_1^- H_0^0 \,:\, \Big[\frac{i\alpha_3 k_1 k_2}{\sqrt{2}\left({k_1}^2+{k_2}^2\right)}\Big]$$

$$A_2^0 A_2^0 H_1^0 H_1^0 \,:\, \Big[\frac{\alpha_1\left({k_1}^2+{k_2}^2\right)+k_1\left(\alpha_3 k_1-4\alpha_2 k_2\right)}{{k_1}^2+{k_2}^2}\Big]$$

$$A_2^0 H_2^- H_1^+ H_1^0 \,:\, \Big[-\frac{i\alpha_3(k_1-k_2)(k_1+k_2)}{2\sqrt{2}\left({k_1}^2+{k_2}^2\right)}\Big]$$

$$A_2^0 H_2^+ H_1^- H_1^0 \,:\, \Big[\frac{i\alpha_3(k_1-k_2)(k_1+k_2)}{2\sqrt{2}\left({k_1}^2+{k_2}^2\right)}\Big]$$

$$A_2^0 A_2^0 H_2^0 H_2^0 \,:\, \Big[\rho_3\Big]$$

$$A_2^0 H_2^{--} H_1^{++} H_2^0 \,:\, \Big[2i\rho_4\Big]$$

$$A_2^0 A_2^0 H_3^0 H_3^0 \,:\, \Big[2\rho_1\Big]$$

$$A_2^0 H_1^{--} H_1^+ H_1^+ \,:\, \Big[-2i\sqrt{2}\rho_2\Big]$$

$$A_2^0 A_2^0 H_1^- H_1^+ \,:\, \Big[2\rho_1\Big]$$

$$A_2^0 A_1^0 H_2^- H_1^+ \,:\, \Big[\frac{\alpha_3\left({k_2}^2-{k_1}^2\right)}{2\sqrt{2}\left({k_1}^2+{k_2}^2\right)}\Big]$$

$$A_2^0 H_1^{++} H_1^- H_1^- \,:\, \Big[2i\sqrt{2}\rho_2\Big]$$

$$A_2^0 A_2^0 H_2^- H_2^+ \,:\, \Big[\frac{\alpha_1\left({k_1}^2+{k_2}^2\right)+k_2\left(\alpha_3 k_2-4\alpha_2 k_1\right)}{{k_1}^2+{k_2}^2}\Big]$$

$$A_2^0 A_2^0 H_1^{--} H_1^{++} \,:\, \Big[2\left(\rho_1+2\rho_2\right)\Big]$$

$$A_2^0 A_2^0 H_2^{--} H_2^{++} \,:\, \Big[\rho_3\Big]$$

$$A_2^0 A_2^0 A_1^0 A_1^0 \,:\, \Big[\frac{\alpha_1\left({k_1}^2+{k_2}^2\right)+k_1\left(\alpha_3 k_1-4\alpha_2 k_2\right)}{{k_1}^2+{k_2}^2}\Big]$$

$$A_2^0 A_2^0 A_2^0 A_2^0 \,:\, \Big[6\rho_1\Big]$$