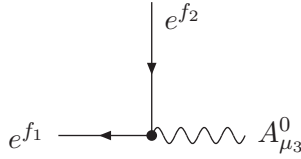
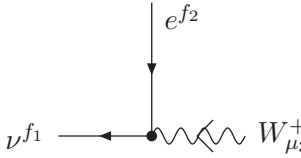


A SMEFT interaction vertices

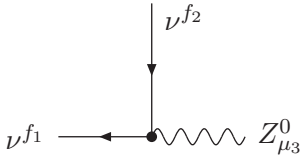
A.1 Lepton–gauge vertices



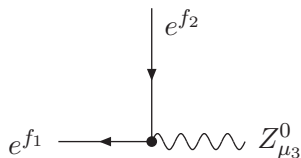
$$\begin{aligned}
& + \frac{i\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} \delta_{f_1 f_2} \gamma^{\mu_3} - \frac{i\bar{g}^2 \bar{g}'^2 v^2}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi W B} \gamma^{\mu_3} \\
& - \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{e B*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{e B} \sigma^{\mu_3 \nu} P_R) \\
& + \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{e W*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{e W} \sigma^{\mu_3 \nu} P_R)
\end{aligned}$$



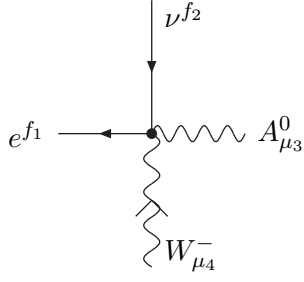
$$\begin{aligned}
& - \frac{i\bar{g}}{\sqrt{2}} U_{f_2 f_1}^* \gamma^{\mu_3} P_L - 2v p_3^\nu U_{g_1 f_1}^* C_{g_1 f_2}^{e W} \sigma^{\mu_3 \nu} P_R - \frac{i\bar{g}v^2}{\sqrt{2}} U_{g_1 f_1}^* C_{g_1 f_2}^{\varphi l 3} \gamma^{\mu_3} P_L
\end{aligned}$$



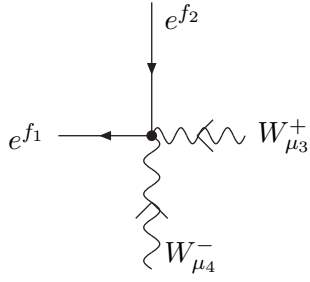
$$\begin{aligned}
& + \frac{1}{2} i \sqrt{\bar{g}^2 + \bar{g}'^2} \delta_{f_1 f_2} \gamma^{\mu_3} \gamma^5 + \frac{i\bar{g}\bar{g}'v^2}{2\sqrt{\bar{g}^2 + \bar{g}'^2}} \delta_{f_1 f_2} C^{\varphi W B} \gamma^{\mu_3} \gamma^5 \\
& + \frac{1}{2} i v^2 \sqrt{\bar{g}^2 + \bar{g}'^2} C_{g_1 g_2}^{\varphi l 1} (U_{g_2 f_2} U_{g_1 f_1}^* \gamma^{\mu_3} P_L - U_{g_2 f_1} U_{g_1 f_2}^* \gamma^{\mu_3} P_R) \\
& - \frac{1}{2} i v^2 \sqrt{\bar{g}^2 + \bar{g}'^2} C_{g_1 g_2}^{\varphi l 3} (U_{g_2 f_2} U_{g_1 f_1}^* \gamma^{\mu_3} P_L - U_{g_2 f_1} U_{g_1 f_2}^* \gamma^{\mu_3} P_R)
\end{aligned}$$



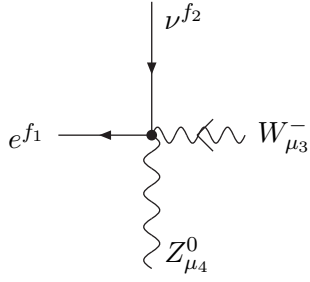
$$\begin{aligned}
& - \frac{i}{2\sqrt{\bar{g}^2 + \bar{g}'^2}} \delta_{f_1 f_2} \left((\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L + 2\bar{g}'^2 \gamma^{\mu_3} P_R \right) \\
& + \frac{i\bar{g}\bar{g}'v^2}{2(\bar{g}^2 + \bar{g}'^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi W B} \left((\bar{g}'^2 - \bar{g}^2) \gamma^{\mu_3} P_L - 2\bar{g}^2 \gamma^{\mu_3} P_R \right) \\
& + \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{e B*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{e B} \sigma^{\mu_3 \nu} P_R) \\
& + \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{e W*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{e W} \sigma^{\mu_3 \nu} P_R) \\
& + \frac{1}{2} i v^2 \sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi e} \gamma^{\mu_3} P_R \\
& + \frac{1}{2} i v^2 \sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi l 1} \gamma^{\mu_3} P_L + \frac{1}{2} i v^2 \sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi l 3} \gamma^{\mu_3} P_L
\end{aligned}$$



$$+ \frac{2\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} U_{g_1 f_2} \sigma^{\mu_3 \mu_4} P_L C_{g_1 f_1}^{eW*}$$

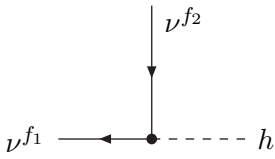


$$+ \sqrt{2}\bar{g}v \left(\sigma^{\mu_3 \mu_4} P_L C_{f_2 f_1}^{eW*} + C_{f_1 f_2}^{eW} \sigma^{\mu_3 \mu_4} P_R \right)$$

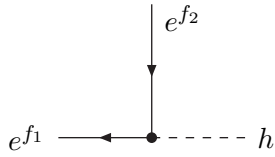


$$- \frac{2\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} U_{g_1 f_2} \sigma^{\mu_3 \mu_4} P_L C_{g_1 f_1}^{eW*}$$

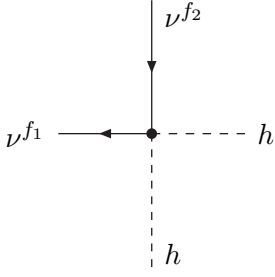
A.2 Lepton-Higgs-gauge vertices



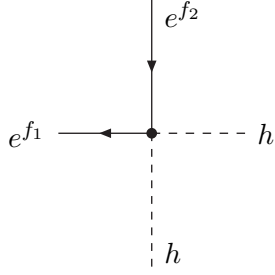
$$- \frac{2i}{v} m_{\nu_{f_1}} \delta_{f_1 f_2}$$



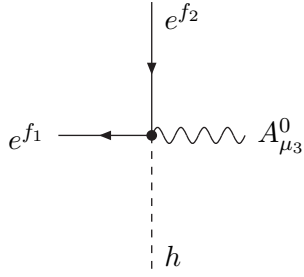
$$- \frac{i}{v} m_{l_{f_1}} \delta_{f_1 f_2} - i v m_{l_{f_1}} \delta_{f_1 f_2} C^{\varphi \square} + \frac{i v}{4} m_{l_{f_1}} \delta_{f_1 f_2} C^{\varphi D} + \frac{i v^2}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{e\varphi*} + P_R C_{f_1 f_2}^{e\varphi} \right)$$



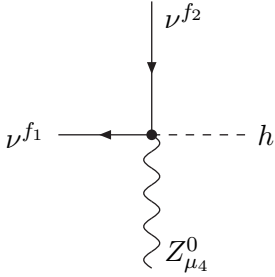
$$-\frac{2i}{v^2} m_{\nu_{f_1}} \delta_{f_1 f_2}$$



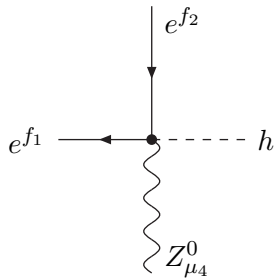
$$+\frac{3iv}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{e\varphi*} + P_R C_{f_1 f_2}^{e\varphi} \right)$$



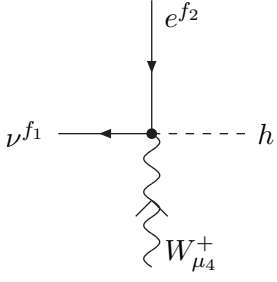
$$-\frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu \left(C_{f_2 f_1}^{eB*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{eB} \sigma^{\mu_3 \nu} P_R \right) \\ + \frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu \left(C_{f_2 f_1}^{eW*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{eW} \sigma^{\mu_3 \nu} P_R \right)$$



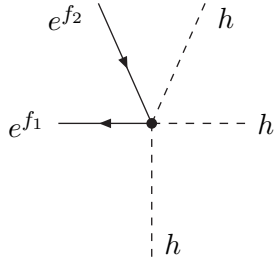
$$+iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{g_1 g_2}^{\varphi l1} \left(U_{g_2 f_2} U_{g_1 f_1}^* \gamma^{\mu_4} P_L - U_{g_2 f_1} U_{g_1 f_2}^* \gamma^{\mu_4} P_R \right) \\ - iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{g_1 g_2}^{\varphi l3} \left(U_{g_2 f_2} U_{g_1 f_1}^* \gamma^{\mu_4} P_L - U_{g_2 f_1} U_{g_1 f_2}^* \gamma^{\mu_4} P_R \right)$$



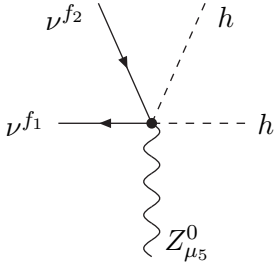
$$+\frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_4^\nu \left(C_{f_2 f_1}^{eB*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{eB} \sigma^{\mu_4 \nu} P_R \right) \\ + \frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_4^\nu \left(C_{f_2 f_1}^{eW*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{eW} \sigma^{\mu_4 \nu} P_R \right) \\ + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi e} \gamma^{\mu_4} P_R \\ + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi l1} \gamma^{\mu_4} P_L + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi l3} \gamma^{\mu_4} P_L$$



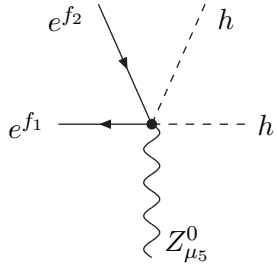
$$-2p_4^\nu U_{g_1 f_1}^* C_{g_1 f_2}^{eW} \sigma^{\mu_4 \nu} P_R - i\sqrt{2}\bar{g}v U_{g_1 f_1}^* C_{g_1 f_2}^{\varphi l3} \gamma^{\mu_4} P_L$$



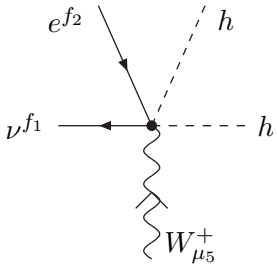
$$+\frac{3i}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{e\varphi*} + P_R C_{f_1 f_2}^{e\varphi} \right)$$



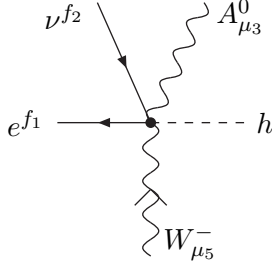
$$+i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{g_1 g_2}^{\varphi l1} (U_{g_2 f_2} U_{g_1 f_1}^* \gamma^{\mu_5} P_L - U_{g_2 f_1} U_{g_1 f_2}^* \gamma^{\mu_5} P_R) \\ -i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{g_1 g_2}^{\varphi l3} (U_{g_2 f_2} U_{g_1 f_1}^* \gamma^{\mu_5} P_L - U_{g_2 f_1} U_{g_1 f_2}^* \gamma^{\mu_5} P_R)$$



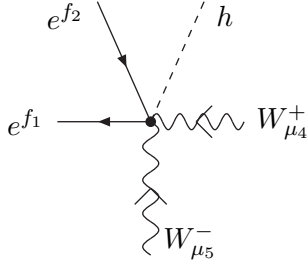
$$+i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi e} \gamma^{\mu_5} P_R + i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi l1} \gamma^{\mu_5} P_L + i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi l3} \gamma^{\mu_5} P_L$$



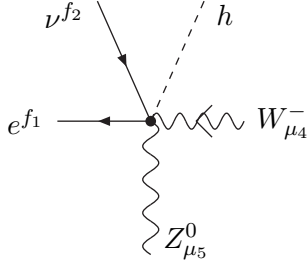
$$-i\sqrt{2}\bar{g}U_{g_1 f_1}^* C_{g_1 f_2}^{\varphi l3} \gamma^{\mu_5} P_L$$



$$+ \frac{2\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} U_{g_1 f_2} \sigma^{\mu_3 \mu_5} P_L C_{g_1 f_1}^{eW*}$$

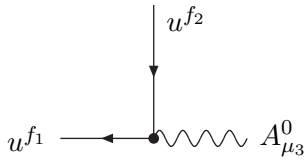


$$+ \sqrt{2}\bar{g} (\sigma^{\mu_4 \mu_5} P_L C_{f_2 f_1}^{eW*} + C_{f_1 f_2}^{eW} \sigma^{\mu_4 \mu_5} P_R)$$

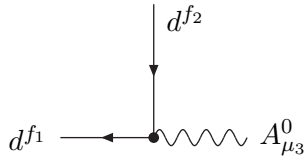


$$- \frac{2\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} U_{g_1 f_2} \sigma^{\mu_4 \mu_5} P_L C_{g_1 f_1}^{eW*}$$

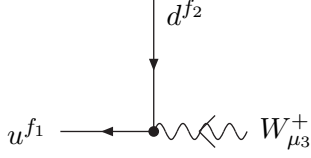
A.3 Quark-gauge vertices



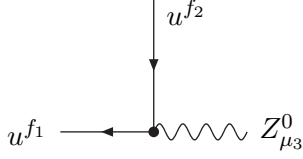
$$\begin{aligned} & - \frac{2i\bar{g}\bar{g}'}{3\sqrt{\bar{g}^2 + \bar{g}'^2}} \delta_{f_1 f_2} \gamma^{\mu_3} + \frac{2i\bar{g}^2 \bar{g}'^2 v^2}{3(\bar{g}^2 + \bar{g}'^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} \gamma^{\mu_3} \\ & - \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{uB*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{uB} \sigma^{\mu_3 \nu} P_R) \\ & - \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{uW*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{uW} \sigma^{\mu_3 \nu} P_R) \end{aligned}$$



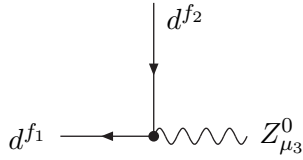
$$\begin{aligned} & + \frac{i\bar{g}\bar{g}'}{3\sqrt{\bar{g}^2 + \bar{g}'^2}} \delta_{f_1 f_2} \gamma^{\mu_3} - \frac{i\bar{g}^2 \bar{g}'^2 v^2}{3(\bar{g}^2 + \bar{g}'^2)^{3/2}} \delta_{f_1 f_2} C^{\varphi WB} \gamma^{\mu_3} \\ & - \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{dB*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{dB} \sigma^{\mu_3 \nu} P_R) \\ & + \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_3^\nu (C_{f_2 f_1}^{dW*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{dW} \sigma^{\mu_3 \nu} P_R) \end{aligned}$$



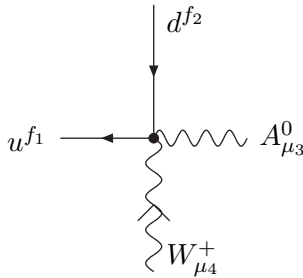
$$\begin{aligned}
& -\frac{i\bar{g}}{\sqrt{2}}K_{f_1f_2}\gamma^{\mu_3}P_L - 2vp_3^\nu K_{f_1g_1}C_{g_1f_2}^{dW}\sigma^{\mu_3\nu}P_R - \frac{i\bar{g}v^2}{\sqrt{2}}K_{f_1g_1}C_{g_1f_2}^{\varphi q3}\gamma^{\mu_3}P_L \\
& - \frac{i\bar{g}v^2}{2\sqrt{2}}C_{f_1f_2}^{\varphi ud}\gamma^{\mu_3}P_R - 2vp_3^\nu K_{g_1f_2}\sigma^{\mu_3\nu}P_L C_{g_1f_1}^{uW*}
\end{aligned}$$



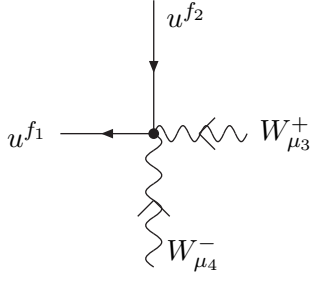
$$\begin{aligned}
& + \frac{i}{6\sqrt{\bar{g}^2 + \bar{g}'^2}}\delta_{f_1f_2}\left(\left(\bar{g}'^2 - 3\bar{g}^2\right)\gamma^{\mu_3}P_L + 4\bar{g}'^2\gamma^{\mu_3}P_R\right) \\
& - \frac{i\bar{g}\bar{g}'v^2}{6\left(\bar{g}^2 + \bar{g}'^2\right)^{3/2}}\delta_{f_1f_2}C^{\varphi WB}\left(\left(3\bar{g}'^2 - \bar{g}^2\right)\gamma^{\mu_3}P_L - 4\bar{g}^2\gamma^{\mu_3}P_R\right) \\
& + \frac{1}{2}iv^2\sqrt{\bar{g}^2 + \bar{g}'^2}K_{f_1g_2}K_{f_2g_1}^*C_{g_2g_1}^{\varphi q1}\gamma^{\mu_3}P_L \\
& - \frac{1}{2}iv^2\sqrt{\bar{g}^2 + \bar{g}'^2}K_{f_1g_2}K_{f_2g_1}^*C_{g_2g_1}^{\varphi q3}\gamma^{\mu_3}P_L \\
& + \frac{1}{2}iv^2\sqrt{\bar{g}^2 + \bar{g}'^2}C_{f_1f_2}^{\varphi u}\gamma^{\mu_3}P_R \\
& + \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}}p_3^\nu\left(C_{f_2f_1}^{uB*}\sigma^{\mu_3\nu}P_L + C_{f_1f_2}^{uB}\sigma^{\mu_3\nu}P_R\right) \\
& - \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}^2 + \bar{g}'^2}}p_3^\nu\left(C_{f_2f_1}^{uW*}\sigma^{\mu_3\nu}P_L + C_{f_1f_2}^{uW}\sigma^{\mu_3\nu}P_R\right)
\end{aligned}$$



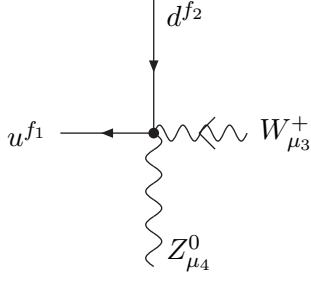
$$\begin{aligned}
& + \frac{i}{6\sqrt{\bar{g}^2 + \bar{g}'^2}}\delta_{f_1f_2}\left(\left(3\bar{g}^2 + \bar{g}'^2\right)\gamma^{\mu_3}P_L - 2\bar{g}'^2\gamma^{\mu_3}P_R\right) \\
& + \frac{i\bar{g}\bar{g}'v^2}{6\left(\bar{g}^2 + \bar{g}'^2\right)^{3/2}}\delta_{f_1f_2}C^{\varphi WB}\left(\left(\bar{g}^2 + 3\bar{g}'^2\right)\gamma^{\mu_3}P_L - 2\bar{g}^2\gamma^{\mu_3}P_R\right) \\
& + \frac{\sqrt{2}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}}p_3^\nu\left(C_{f_2f_1}^{dB*}\sigma^{\mu_3\nu}P_L + C_{f_1f_2}^{dB}\sigma^{\mu_3\nu}P_R\right) \\
& + \frac{\sqrt{2}\bar{g}v}{\sqrt{\bar{g}^2 + \bar{g}'^2}}p_3^\nu\left(C_{f_2f_1}^{dW*}\sigma^{\mu_3\nu}P_L + C_{f_1f_2}^{dW}\sigma^{\mu_3\nu}P_R\right) \\
& + \frac{1}{2}iv^2\sqrt{\bar{g}^2 + \bar{g}'^2}C_{f_1f_2}^{\varphi d}\gamma^{\mu_3}P_R \\
& + \frac{1}{2}iv^2\sqrt{\bar{g}^2 + \bar{g}'^2}C_{f_1f_2}^{\varphi q1}\gamma^{\mu_3}P_L + \frac{1}{2}iv^2\sqrt{\bar{g}^2 + \bar{g}'^2}C_{f_1f_2}^{\varphi q3}\gamma^{\mu_3}P_L
\end{aligned}$$



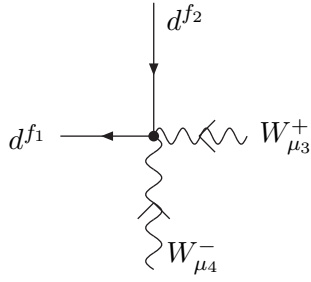
$$-\frac{2\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}}K_{f_1g_1}\sigma^{\mu_3\mu_4}P_R C_{g_1f_2}^{dW} - \frac{2\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}}K_{g_1f_2}\sigma^{\mu_3\mu_4}P_L C_{g_1f_1}^{uW*}$$



$$-\sqrt{2}\bar{g}v \left(\sigma^{\mu_3\mu_4} P_L C_{f_2 f_1}^{uW*} + C_{f_1 f_2}^{uW} \sigma^{\mu_3\mu_4} P_R \right)$$

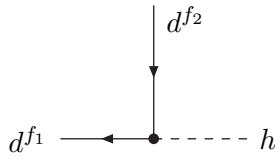


$$+\frac{2\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} K_{f_1 g_1} \sigma^{\mu_3\mu_4} P_R C_{g_1 f_2}^{dW} + \frac{2\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} K_{g_1 f_2} \sigma^{\mu_3\mu_4} P_L C_{g_1 f_1}^{uW*}$$

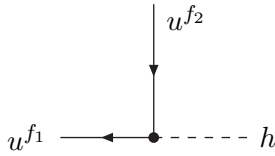


$$+\sqrt{2}\bar{g}v \left(\sigma^{\mu_3\mu_4} P_L C_{f_2 f_1}^{dW*} + C_{f_1 f_2}^{dW} \sigma^{\mu_3\mu_4} P_R \right)$$

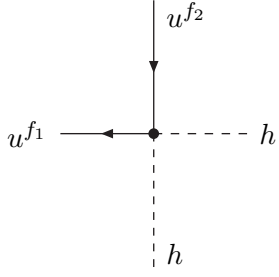
A.4 Quark-Higgs-gauge vertices



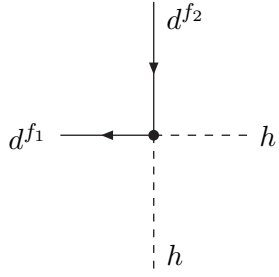
$$-\frac{i}{v} m_{d_{f_1}} \delta_{f_1 f_2} - i v m_{d_{f_1}} \delta_{f_1 f_2} C^{\varphi\Box} + \frac{iv}{4} m_{d_{f_1}} \delta_{f_1 f_2} C^{\varphi D} + \frac{iv^2}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



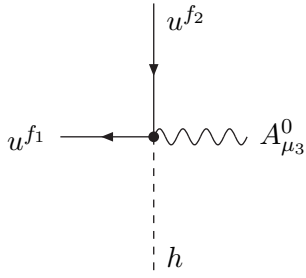
$$-\frac{i}{v} m_{u_{f_1}} \delta_{f_1 f_2} - i v m_{u_{f_1}} \delta_{f_1 f_2} C^{\varphi\Box} + \frac{iv}{4} m_{u_{f_1}} \delta_{f_1 f_2} C^{\varphi D} + \frac{iv^2}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{u\varphi*} + P_R C_{f_1 f_2}^{u\varphi} \right)$$



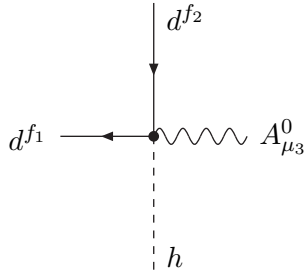
$$+\frac{3iv}{\sqrt{2}}\left(P_L C_{f_2 f_1}^{u\varphi*}+P_R C_{f_1 f_2}^{u\varphi}\right)$$



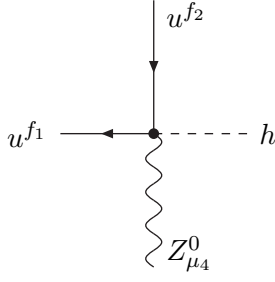
$$+\frac{3iv}{\sqrt{2}}\left(P_L C_{f_2 f_1}^{d\varphi*}+P_R C_{f_1 f_2}^{d\varphi}\right)$$



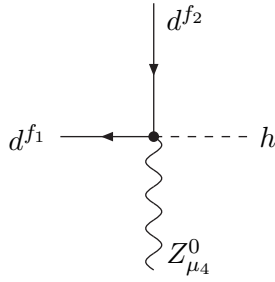
$$\begin{aligned} &-\frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}^2+\bar{g}'^2}}p_3^\nu\left(C_{f_2 f_1}^{uB*}\sigma^{\mu_3\nu}P_L+C_{f_1 f_2}^{uB}\sigma^{\mu_3\nu}P_R\right) \\ &-\frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}^2+\bar{g}'^2}}p_3^\nu\left(C_{f_2 f_1}^{uW*}\sigma^{\mu_3\nu}P_L+C_{f_1 f_2}^{uW}\sigma^{\mu_3\nu}P_R\right) \end{aligned}$$



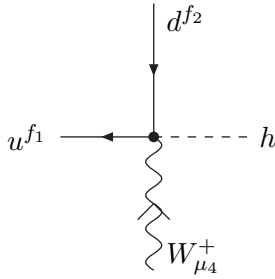
$$\begin{aligned} &-\frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}^2+\bar{g}'^2}}p_3^\nu\left(C_{f_2 f_1}^{dB*}\sigma^{\mu_3\nu}P_L+C_{f_1 f_2}^{dB}\sigma^{\mu_3\nu}P_R\right) \\ &+\frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}^2+\bar{g}'^2}}p_3^\nu\left(C_{f_2 f_1}^{dW*}\sigma^{\mu_3\nu}P_L+C_{f_1 f_2}^{dW}\sigma^{\mu_3\nu}P_R\right) \end{aligned}$$



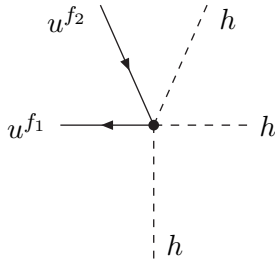
$$\begin{aligned}
& +iv\sqrt{\bar{g}^2 + \bar{g}'^2} K_{f_1 g_2} K_{f_2 g_1}^* C_{g_2 g_1}^{\varphi q 1} \gamma^{\mu_4} P_L \\
& - iv\sqrt{\bar{g}^2 + \bar{g}'^2} K_{f_1 g_2} K_{f_2 g_1}^* C_{g_2 g_1}^{\varphi q 3} \gamma^{\mu_4} P_L + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi u} \gamma^{\mu_4} P_R \\
& + \frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_4^\nu (C_{f_2 f_1}^{u B*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{u B} \sigma^{\mu_4 \nu} P_R) \\
& - \frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_4^\nu (C_{f_2 f_1}^{u W*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{u W} \sigma^{\mu_4 \nu} P_R)
\end{aligned}$$



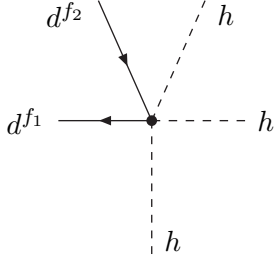
$$\begin{aligned}
& + \frac{\sqrt{2}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_4^\nu (C_{f_2 f_1}^{dB*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{dB} \sigma^{\mu_4 \nu} P_R) \\
& + \frac{\sqrt{2}\bar{g}}{\sqrt{\bar{g}^2 + \bar{g}'^2}} p_4^\nu (C_{f_2 f_1}^{d W*} \sigma^{\mu_4 \nu} P_L + C_{f_1 f_2}^{d W} \sigma^{\mu_4 \nu} P_R) \\
& + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi d} \gamma^{\mu_4} P_R \\
& + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi q 1} \gamma^{\mu_4} P_L + iv\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi q 3} \gamma^{\mu_4} P_L
\end{aligned}$$



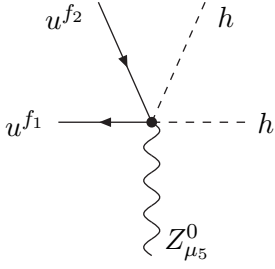
$$\begin{aligned}
& -2p_4^\nu K_{f_1 g_1} C_{g_1 f_2}^{d W} \sigma^{\mu_4 \nu} P_R - i\sqrt{2}\bar{g}v K_{f_1 g_1} C_{g_1 f_2}^{\varphi q 3} \gamma^{\mu_4} P_L \\
& - \frac{i\bar{g}v}{\sqrt{2}} C_{f_1 f_2}^{\varphi ud} \gamma^{\mu_4} P_R - 2p_4^\nu K_{g_1 f_2} \sigma^{\mu_4 \nu} P_L C_{g_1 f_1}^{u W*}
\end{aligned}$$



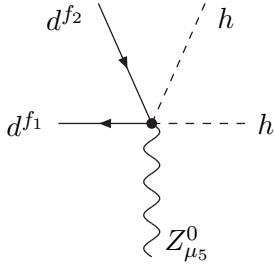
$$+ \frac{3i}{\sqrt{2}} (P_L C_{f_2 f_1}^{u \varphi*} + P_R C_{f_1 f_2}^{u \varphi})$$



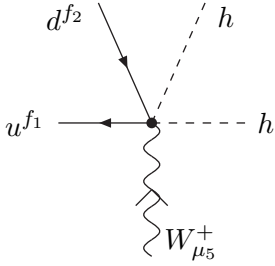
$$+\frac{3i}{\sqrt{2}} \left(P_L C_{f_2 f_1}^{d\varphi*} + P_R C_{f_1 f_2}^{d\varphi} \right)$$



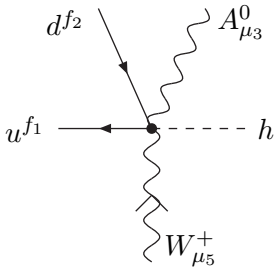
$$+i\sqrt{\bar{g}^2 + \bar{g}'^2} K_{f_1 g_2} K_{f_2 g_1}^* C_{g_2 g_1}^{\varphi q 1} \gamma^{\mu_5} P_L \\ - i\sqrt{\bar{g}^2 + \bar{g}'^2} K_{f_1 g_2} K_{f_2 g_1}^* C_{g_2 g_1}^{\varphi q 3} \gamma^{\mu_5} P_L + i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi u} \gamma^{\mu_5} P_R$$



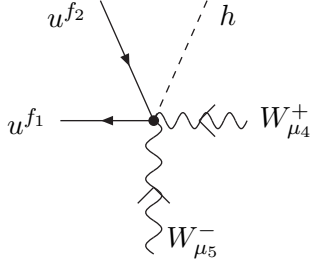
$$+i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi d} \gamma^{\mu_5} P_R + i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi q 1} \gamma^{\mu_5} P_L + i\sqrt{\bar{g}^2 + \bar{g}'^2} C_{f_1 f_2}^{\varphi q 3} \gamma^{\mu_5} P_L$$



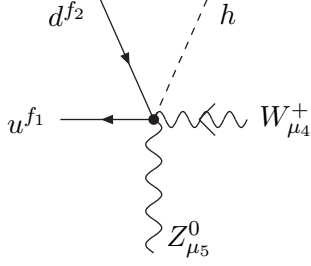
$$-i\sqrt{2}\bar{g} K_{f_1 g_1} C_{g_1 f_2}^{\varphi q 3} \gamma^{\mu_5} P_L - \frac{i\bar{g}}{\sqrt{2}} C_{f_1 f_2}^{\varphi ud} \gamma^{\mu_5} P_R$$



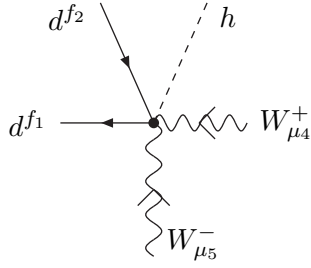
$$-\frac{2\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} K_{f_1 g_1} \sigma^{\mu_3 \mu_5} P_R C_{g_1 f_2}^{dW} - \frac{2\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} K_{g_1 f_2} \sigma^{\mu_3 \mu_5} P_L C_{g_1 f_1}^{uW*}$$



$$-\sqrt{2}\bar{g} \left(\sigma^{\mu_4\mu_5} P_L C_{f_2f_1}^{uW^*} + C_{f_1f_2}^{uW} \sigma^{\mu_4\mu_5} P_R \right)$$

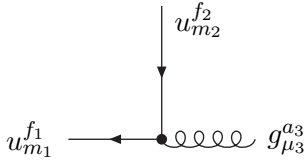


$$+\frac{2\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} K_{f_1g_1} \sigma^{\mu_4\mu_5} P_R C_{g_1f_2}^{dW} + \frac{2\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} K_{g_1f_2} \sigma^{\mu_4\mu_5} P_L C_{g_1f_1}^{uW^*}$$

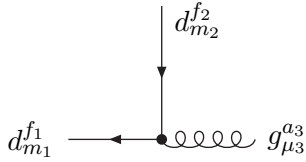


$$+\sqrt{2}\bar{g} \left(\sigma^{\mu_4\mu_5} P_L C_{f_2f_1}^{dW^*} + C_{f_1f_2}^{dW} \sigma^{\mu_4\mu_5} P_R \right)$$

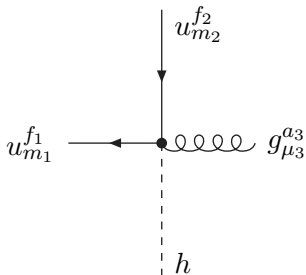
A.5 Quark-gluon vertices



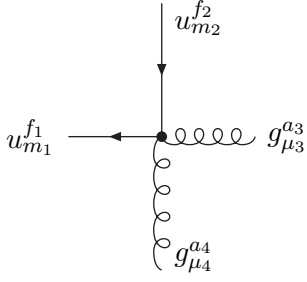
$$-i\bar{g}_s \delta_{f_1f_2} \mathcal{T}_{m_1m_2}^{a_3} \gamma^{\mu_3} - \sqrt{2}vp_3^\nu \mathcal{T}_{m_1m_2}^{a_3} \left(C_{f_2f_1}^{uG^*} \sigma^{\mu_3\nu} P_L + C_{f_1f_2}^{uG} \sigma^{\mu_3\nu} P_R \right)$$



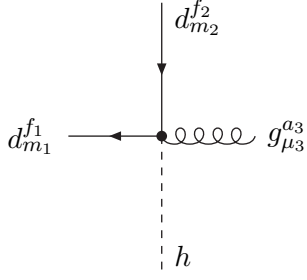
$$-i\bar{g}_s \delta_{f_1f_2} \mathcal{T}_{m_1m_2}^{a_3} \gamma^{\mu_3} - \sqrt{2}vp_3^\nu \mathcal{T}_{m_1m_2}^{a_3} \left(C_{f_2f_1}^{dG^*} \sigma^{\mu_3\nu} P_L + C_{f_1f_2}^{dG} \sigma^{\mu_3\nu} P_R \right)$$



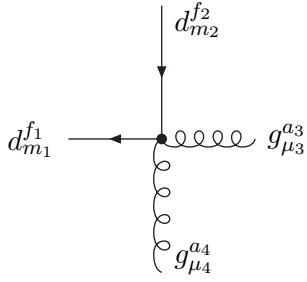
$$-\sqrt{2}p_3^\nu \mathcal{T}_{m_1m_2}^{a_3} \left(C_{f_2f_1}^{uG^*} \sigma^{\mu_3\nu} P_L + C_{f_1f_2}^{uG} \sigma^{\mu_3\nu} P_R \right)$$



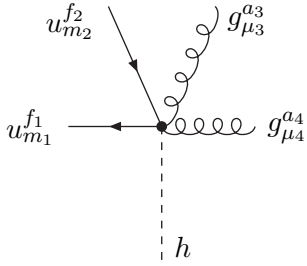
$$-i\sqrt{2}v\bar{g}_s f_{a_3 a_4 b_1} \mathcal{T}_{m_1 m_2}^{b_1} \left(\sigma^{\mu_3 \mu_4} P_L C_{f_2 f_1}^{uG*} + C_{f_1 f_2}^{uG} \sigma^{\mu_3 \mu_4} P_R \right)$$



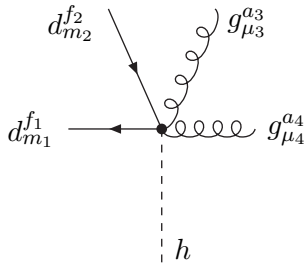
$$-\sqrt{2}p_3^\nu \mathcal{T}_{m_1 m_2}^{a_3} \left(C_{f_2 f_1}^{dG*} \sigma^{\mu_3 \nu} P_L + C_{f_1 f_2}^{dG} \sigma^{\mu_3 \nu} P_R \right)$$



$$-i\sqrt{2}v\bar{g}_s f_{a_3 a_4 b_1} \mathcal{T}_{m_1 m_2}^{b_1} \left(\sigma^{\mu_3 \mu_4} P_L C_{f_2 f_1}^{dG*} + C_{f_1 f_2}^{dG} \sigma^{\mu_3 \mu_4} P_R \right)$$

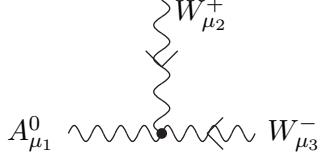


$$-i\sqrt{2}\bar{g}_s f_{a_3 a_4 b_1} \mathcal{T}_{m_1 m_2}^{b_1} \left(\sigma^{\mu_3 \mu_4} P_L C_{f_2 f_1}^{uG*} + C_{f_1 f_2}^{uG} \sigma^{\mu_3 \mu_4} P_R \right)$$

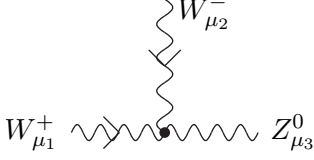


$$-i\sqrt{2}\bar{g}_s f_{a_3 a_4 b_1} \mathcal{T}_{m_1 m_2}^{b_1} \left(\sigma^{\mu_3 \mu_4} P_L C_{f_2 f_1}^{dG*} + C_{f_1 f_2}^{dG} \sigma^{\mu_3 \mu_4} P_R \right)$$

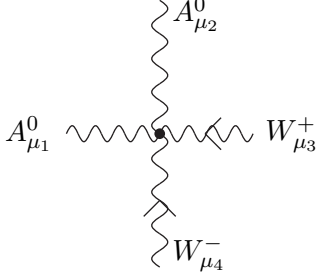
A.6 Gauge self interaction vertices



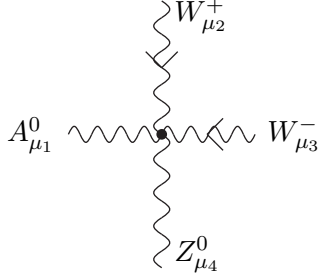
$$\begin{aligned}
& + \frac{i\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} (\eta_{\mu_1\mu_2} p_1^{\mu_3} - \eta_{\mu_1\mu_2} p_2^{\mu_3} - \eta_{\mu_1\mu_3} p_1^{\mu_2} \\
& + \eta_{\mu_1\mu_3} p_3^{\mu_2} + \eta_{\mu_2\mu_3} p_2^{\mu_1} - \eta_{\mu_2\mu_3} p_3^{\mu_1}) \\
& + \frac{i\bar{g}^2 v^2}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^{\varphi WB} \left(\bar{g}^2 \eta_{\mu_1\mu_2} p_1^{\mu_3} - \bar{g}^2 \eta_{\mu_1\mu_3} p_1^{\mu_2} \right. \\
& + \bar{g}'^2 \eta_{\mu_1\mu_2} p_2^{\mu_3} - \bar{g}'^2 \eta_{\mu_1\mu_3} p_3^{\mu_2} - \bar{g}'^2 \eta_{\mu_2\mu_3} p_2^{\mu_1} + \bar{g}'^2 \eta_{\mu_2\mu_3} p_3^{\mu_1} \Big) \\
& - \frac{2i\bar{g}\bar{g}' v^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W}} (p_1^{\alpha_1} + p_2^{\alpha_1} + p_3^{\alpha_1}) \epsilon_{\mu_1\mu_2\mu_3\alpha_1} \\
& + \frac{i\bar{g}^2 v^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W} B} p_1^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} \\
& - \frac{6i\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^W (p_1 \cdot p_2 \eta_{\mu_1\mu_3} p_3^{\mu_2} - p_1 \cdot p_2 \eta_{\mu_2\mu_3} p_3^{\mu_1} \\
& - p_1 \cdot p_3 \eta_{\mu_1\mu_2} p_2^{\mu_3} + p_1 \cdot p_3 \eta_{\mu_2\mu_3} p_2^{\mu_1} \\
& + p_1^{\mu_3} (p_2 \cdot p_3 \eta_{\mu_1\mu_2} - p_2^{\mu_1} p_3^{\mu_2}) + p_1^{\mu_2} (p_2^{\mu_3} p_3^{\mu_1} - p_2 \cdot p_3 \eta_{\mu_1\mu_3})) \\
& - \frac{2i\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\widetilde{W}} \left(p_1 \cdot p_2 p_3^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} + p_1 \cdot p_3 p_2^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} \right. \\
& + p_2 \cdot p_3 p_1^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} + \eta_{\mu_1\mu_2} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_3\alpha_1\beta_1\gamma_1} \\
& + \eta_{\mu_1\mu_3} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_2\alpha_1\beta_1\gamma_1} + \eta_{\mu_2\mu_3} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_1\alpha_1\beta_1\gamma_1} \\
& + p_1^{\alpha_1} p_3^{\beta_1} p_2^{\mu_1} (-\epsilon_{\mu_2\mu_3\alpha_1\beta_1}) + p_3^{\beta_1} (p_2^{\alpha_1} p_1^{\mu_3} + p_1^{\alpha_1} p_2^{\mu_3}) \epsilon_{\mu_1\mu_2\alpha_1\beta_1} \\
& \left. - p_1^{\alpha_1} p_2^{\beta_1} p_3^{\mu_1} \epsilon_{\mu_2\mu_3\alpha_1\beta_1} + \epsilon_{\mu_1\mu_3\alpha_1\beta_1} \left(p_2^{\alpha_1} p_3^{\beta_1} p_1^{\mu_2} - p_1^{\alpha_1} p_2^{\beta_1} p_3^{\mu_2} \right) \right)
\end{aligned}$$



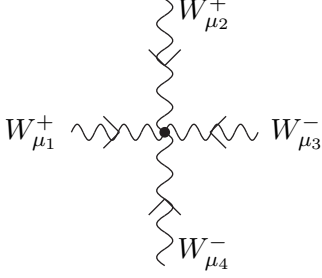
$$\begin{aligned}
& + \frac{i\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} (\eta_{\mu_1\mu_2} p_1^{\mu_3} - \eta_{\mu_1\mu_2} p_2^{\mu_3} - \eta_{\mu_1\mu_3} p_1^{\mu_2} \\
& + \eta_{\mu_1\mu_3} p_3^{\mu_2} + \eta_{\mu_2\mu_3} p_2^{\mu_1} - \eta_{\mu_2\mu_3} p_3^{\mu_1}) \\
& + \frac{i\bar{g}\bar{g}'v^2}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^{\varphi WB} \left(\bar{g}^2 \eta_{\mu_1\mu_3} (-p_3^{\mu_2}) + \bar{g}'^2 \eta_{\mu_2\mu_3} p_3^{\mu_1} \right. \\
& + \bar{g}'^2 \eta_{\mu_1\mu_2} p_1^{\mu_3} - \bar{g}'^2 \eta_{\mu_1\mu_2} p_2^{\mu_3} - \bar{g}'^2 \eta_{\mu_1\mu_3} p_1^{\mu_2} + \bar{g}'^2 \eta_{\mu_2\mu_3} p_2^{\mu_1} \Big) \\
& - \frac{2i\bar{g}^2 v^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W}} (p_1^{\alpha_1} + p_2^{\alpha_1} + p_3^{\alpha_1}) \epsilon_{\mu_1\mu_2\mu_3\alpha_1} \\
& - \frac{i\bar{g}\bar{g}'v^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W} B} p_3^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} \\
& - \frac{6i\bar{g}}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^W (p_1 \cdot p_2 \eta_{\mu_1\mu_3} p_3^{\mu_2} - p_1 \cdot p_2 \eta_{\mu_2\mu_3} p_3^{\mu_1} \\
& - p_1 \cdot p_3 \eta_{\mu_1\mu_2} p_2^{\mu_3} + p_1 \cdot p_3 \eta_{\mu_2\mu_3} p_2^{\mu_1} \\
& + p_1^{\mu_3} (p_2 \cdot p_3 \eta_{\mu_1\mu_2} - p_2^{\mu_1} p_3^{\mu_2}) + p_1^{\mu_2} (p_2^{\mu_3} p_3^{\mu_1} - p_2 \cdot p_3 \eta_{\mu_1\mu_3})) \\
& - \frac{2i\bar{g}}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\widetilde{W}} \left(p_1 \cdot p_2 p_3^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} + p_1 \cdot p_3 p_2^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} \right. \\
& + p_2 \cdot p_3 p_1^{\alpha_1} \epsilon_{\mu_1\mu_2\mu_3\alpha_1} + \eta_{\mu_1\mu_2} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_3\alpha_1\beta_1\gamma_1} \\
& + \eta_{\mu_1\mu_3} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_2\alpha_1\beta_1\gamma_1} + \eta_{\mu_2\mu_3} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_1\alpha_1\beta_1\gamma_1} \\
& + p_1^{\alpha_1} p_3^{\beta_1} p_2^{\mu_1} (-\epsilon_{\mu_2\mu_3\alpha_1\beta_1}) + p_3^{\beta_1} (p_2^{\alpha_1} p_1^{\mu_3} + p_1^{\alpha_1} p_2^{\mu_3}) \epsilon_{\mu_1\mu_2\alpha_1\beta_1} \\
& \left. - p_1^{\alpha_1} p_2^{\beta_1} p_3^{\mu_1} \epsilon_{\mu_2\mu_3\alpha_1\beta_1} + \epsilon_{\mu_1\mu_3\alpha_1\beta_1} \left(p_2^{\alpha_1} p_3^{\beta_1} p_1^{\mu_2} - p_1^{\alpha_1} p_2^{\beta_1} p_3^{\mu_2} \right) \right)
\end{aligned}$$



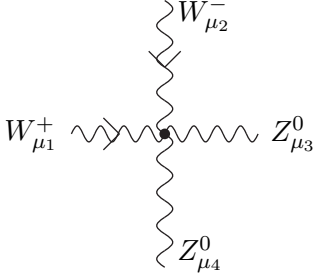
$$\begin{aligned}
& + \frac{i\bar{g}^2\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) \\
& - \frac{2i\bar{g}^3\bar{g}'^3v^2}{(\bar{g}^2 + \bar{g}'^2)^2} (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) C^{\varphi WB} \\
& - \frac{6i\bar{g}\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} C^W (\eta_{\mu_1\mu_2}p_1^{\mu_4}p_4^{\mu_3} + \eta_{\mu_1\mu_2}p_2^{\mu_4}p_4^{\mu_3} + \eta_{\mu_1\mu_3}p_1^{\mu_4}p_3^{\mu_2} \\
& - \eta_{\mu_1\mu_3}p_2^{\mu_4}p_3^{\mu_2} - \eta_{\mu_1\mu_3}p_1^{\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_3}p_1^{\mu_4}p_4^{\mu_2} - \eta_{\mu_1\mu_4}p_1^{\mu_2}p_4^{\mu_3} \\
& - \eta_{\mu_2\mu_3}p_1^{\mu_4}p_3^{\mu_1} + \eta_{\mu_2\mu_3}p_2^{\mu_4}p_3^{\mu_1} - \eta_{\mu_2\mu_3}p_2^{\mu_1}p_3^{\mu_4} - \eta_{\mu_2\mu_3}p_2^{\mu_4}p_4^{\mu_1} \\
& - \eta_{\mu_2\mu_4}p_2^{\mu_1}p_4^{\mu_3} + p_1^{\mu_3}(\eta_{\mu_1\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_4}p_3^{\mu_2} + \eta_{\mu_1\mu_4}p_4^{\mu_2} - \eta_{\mu_2\mu_4}p_4^{\mu_1}) \\
& + p_2^{\mu_3}(\eta_{\mu_1\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_4}p_4^{\mu_2} + \eta_{\mu_2\mu_4}(p_4^{\mu_1} - p_3^{\mu_1})) + \eta_{\mu_3\mu_4}p_1^{\mu_2}p_3^{\mu_1} \\
& + \eta_{\mu_3\mu_4}p_2^{\mu_1}p_3^{\mu_2} + \eta_{\mu_3\mu_4}p_1^{\mu_2}p_4^{\mu_1} + \eta_{\mu_3\mu_4}p_2^{\mu_1}p_4^{\mu_2} - p_1 \cdot p_3 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} \\
& - p_1 \cdot p_4 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} - p_2 \cdot p_3 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} - p_2 \cdot p_4 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} + p_1 \cdot p_3 \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} \\
& + p_1 \cdot p_4 \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_4} + p_2 \cdot p_3 \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_4} + p_2 \cdot p_4 \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3}) \\
& + \frac{2i\bar{g}\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} C^{\tilde{W}} \left(-\epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_1^{\mu_4} p_3^{\alpha_1} + \epsilon_{\mu_2\mu_4\mu_3\alpha_1} p_2^{\mu_1} p_3^{\alpha_1} + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_2^{\mu_4} p_3^{\alpha_1} \right. \\
& + \epsilon_{\mu_2\mu_4\mu_3\alpha_1} p_1^{\alpha_1} p_3^{\mu_1} + \epsilon_{\mu_2\mu_4\mu_3\alpha_1} p_2^{\alpha_1} p_3^{\mu_1} - \epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_1^{\alpha_1} p_3^{\mu_4} + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_2^{\alpha_1} p_3^{\mu_4} \\
& - \epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_1^{\mu_4} p_4^{\alpha_1} - \epsilon_{\mu_2\mu_4\mu_3\alpha_1} p_2^{\mu_1} p_4^{\alpha_1} + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_2^{\mu_4} p_4^{\alpha_1} - \epsilon_{\mu_2\mu_4\mu_3\alpha_1} p_1^{\alpha_1} p_4^{\mu_1} \\
& - \epsilon_{\mu_2\mu_4\mu_3\alpha_1} p_2^{\alpha_1} p_4^{\mu_1} + \epsilon_{\mu_1\mu_4\mu_3\alpha_1} (p_1^{\mu_2} (p_3^{\alpha_1} - p_4^{\alpha_1}) + (p_1^{\alpha_1} + p_2^{\alpha_1}) (p_3^{\mu_2} - p_4^{\mu_2})) \\
& + \epsilon_{\mu_1\mu_2\mu_4\alpha_1} (-p_1^{\mu_3} (p_3^{\alpha_1} + p_4^{\alpha_1}) + p_2^{\mu_3} (p_3^{\alpha_1} + p_4^{\alpha_1}) + (p_2^{\alpha_1} - p_1^{\alpha_1}) p_4^{\mu_3}) \\
& - \epsilon_{\mu_4\mu_3\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_2} - \epsilon_{\mu_4\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_2} + \epsilon_{\mu_4\mu_3\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_2} \\
& + \epsilon_{\mu_4\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_2} + \epsilon_{\mu_2\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_3} + \epsilon_{\mu_2\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_3} \\
& + \epsilon_{\mu_2\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_3} + \epsilon_{\mu_2\mu_3\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_4} + \epsilon_{\mu_2\mu_3\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_4} \\
& + \epsilon_{\mu_2\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_4} + \epsilon_{\mu_1\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_2\mu_3} + \epsilon_{\mu_1\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_2\mu_3} \\
& + \epsilon_{\mu_1\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_3} + \epsilon_{\mu_1\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_2\mu_4} + \epsilon_{\mu_1\mu_3\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_4} \\
& + \epsilon_{\mu_1\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_4} - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} + \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} \\
& - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_3\mu_4} + \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_3\mu_4} + \epsilon_{\mu_1\mu_2\mu_4\mu_3} p_1 \cdot p_3 \\
& \left. - \epsilon_{\mu_1\mu_2\mu_4\mu_3} p_1 \cdot p_4 - \epsilon_{\mu_1\mu_2\mu_4\mu_3} p_2 \cdot p_3 + \epsilon_{\mu_1\mu_2\mu_4\mu_3} p_2 \cdot p_4 \right)
\end{aligned}$$



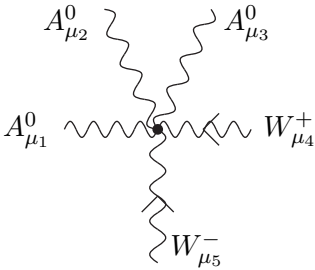
$$\begin{aligned}
& -\frac{i\bar{g}^3\bar{g}'}{\bar{g}^2+\bar{g}'^2}(2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) \\
& -\frac{i\bar{g}^2\bar{g}'^2v^2(\bar{g}'^2-\bar{g}^2)}{(\bar{g}^2+\bar{g}'^2)^2}(2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}-\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})C^{\varphi WB} \\
& +\frac{6i\bar{g}^2\bar{g}'}{\bar{g}^2+\bar{g}'^2}C^W(\eta_{\mu_1\mu_2}p_2^{\mu_4}p_4^{\mu_3}+\eta_{\mu_1\mu_3}p_1^{\mu_2}p_2^{\mu_4}-\eta_{\mu_1\mu_3}p_1^{\mu_2}p_3^{\mu_4}+\eta_{\mu_1\mu_3}p_3^{\mu_4}p_4^{\mu_2} \\
& -\eta_{\mu_1\mu_4}p_1^{\mu_2}p_2^{\mu_3}-\eta_{\mu_1\mu_4}p_2^{\mu_3}p_4^{\mu_2}-\eta_{\mu_1\mu_4}p_3^{\mu_2}p_4^{\mu_3}-\eta_{\mu_2\mu_3}p_2^{\mu_4}p_4^{\mu_1}-\eta_{\mu_2\mu_3}p_3^{\mu_4}p_4^{\mu_1} \\
& +p_1^{\mu_4}(\eta_{\mu_1\mu_2}p_2^{\mu_3}+\eta_{\mu_1\mu_3}p_3^{\mu_2}-\eta_{\mu_2\mu_3}(p_2^{\mu_1}+p_3^{\mu_1}))+\eta_{\mu_2\mu_4}p_2^{\mu_3}p_4^{\mu_1}-\eta_{\mu_2\mu_4}p_2^{\mu_1}p_4^{\mu_3} \\
& +\eta_{\mu_2\mu_4}p_3^{\mu_1}p_4^{\mu_3}+p_1^{\mu_3}(\eta_{\mu_1\mu_2}(-p_2^{\mu_4})+\eta_{\mu_1\mu_2}p_3^{\mu_4}-\eta_{\mu_1\mu_4}p_3^{\mu_2}+\eta_{\mu_2\mu_4}p_2^{\mu_1}) \\
& +\eta_{\mu_3\mu_4}p_1^{\mu_2}p_3^{\mu_1}+\eta_{\mu_3\mu_4}p_3^{\mu_2}p_4^{\mu_1}+\eta_{\mu_3\mu_4}p_2^{\mu_1}p_4^{\mu_2}-\eta_{\mu_3\mu_4}p_3^{\mu_1}p_4^{\mu_2}-p_1\cdot p_3\eta_{\mu_3\mu_4}\eta_{\mu_1\mu_2} \\
& -p_2\cdot p_4\eta_{\mu_3\mu_4}\eta_{\mu_1\mu_2}+p_1\cdot p_2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-p_1\cdot p_2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}+p_1\cdot p_3\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} \\
& +p_2\cdot p_4\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}+p_3\cdot p_4\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}-p_3\cdot p_4\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}) \\
& +\frac{2i\bar{g}^2\bar{g}'}{\bar{g}^2+\bar{g}'^2}C^{\widetilde{W}}\left(\epsilon_{\mu_1\mu_3\mu_2\alpha_1}p_1^{\mu_4}p_2^{\alpha_1}-\epsilon_{\mu_3\mu_4\mu_2\alpha_1}p_4^{\mu_1}p_2^{\alpha_1}+\epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_4^{\beta_1}\eta_{\mu_1\mu_2}p_2^{\alpha_1} \right. \\
& +\epsilon_{\mu_3\mu_2\alpha_1\beta_1}p_4^{\beta_1}\eta_{\mu_1\mu_4}p_2^{\alpha_1}-\epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_4^{\beta_1}\eta_{\mu_2\mu_3}p_2^{\alpha_1}-\epsilon_{\mu_1\mu_3\alpha_1\beta_1}p_4^{\beta_1}\eta_{\mu_2\mu_4}p_2^{\alpha_1} \\
& -\epsilon_{\mu_1\mu_2\alpha_1\beta_1}p_4^{\beta_1}\eta_{\mu_3\mu_4}p_2^{\alpha_1}-\epsilon_{\mu_3\mu_4\mu_2\alpha_1}p_1^{\mu_1}p_2^{\mu_1}+\epsilon_{\mu_1\mu_3\mu_2\alpha_1}p_1^{\mu_1}p_2^{\mu_4} \\
& -\epsilon_{\mu_1\mu_3\mu_2\alpha_1}p_1^{\mu_4}p_3^{\alpha_1}+\epsilon_{\mu_3\mu_4\mu_2\alpha_1}p_1^{\alpha_1}p_3^{\mu_1}-\epsilon_{\mu_1\mu_3\mu_2\alpha_1}p_1^{\alpha_1}p_3^{\mu_4}-\epsilon_{\mu_3\mu_4\mu_2\alpha_1}p_2^{\mu_1}p_4^{\alpha_1} \\
& +\epsilon_{\mu_1\mu_3\mu_2\alpha_1}p_2^{\mu_4}p_4^{\alpha_1}+\epsilon_{\mu_3\mu_4\mu_2\alpha_1}p_3^{\mu_1}p_4^{\alpha_1}-\epsilon_{\mu_1\mu_3\mu_2\alpha_1}p_3^{\mu_4}p_4^{\alpha_1}+\epsilon_{\mu_3\mu_4\mu_2\alpha_1}p_3^{\alpha_1}p_4^{\mu_1} \\
& +\epsilon_{\mu_1\mu_3\mu_4\alpha_1}(p_1^{\mu_2}(p_2^{\alpha_1}+p_3^{\alpha_1})+p_1^{\alpha_1}p_3^{\mu_2}-p_3^{\mu_2}p_4^{\alpha_1}-p_2^{\alpha_1}p_4^{\mu_2}-p_3^{\alpha_1}p_4^{\mu_2}) \\
& +\epsilon_{\mu_1\mu_4\mu_2\alpha_1}(-p_1^{\alpha_1}p_2^{\mu_3}+p_4^{\alpha_1}p_2^{\mu_3}-p_1^{\mu_3}(p_2^{\alpha_1}+p_3^{\alpha_1})+p_2^{\alpha_1}p_4^{\mu_3}+p_3^{\alpha_1}p_4^{\mu_3}) \\
& -\epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_2^{\beta_1}\eta_{\mu_1\mu_2}-\epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_2}+\epsilon_{\mu_4\mu_2\alpha_1\beta_1}p_1^{\alpha_1}p_2^{\beta_1}\eta_{\mu_1\mu_3} \\
& +\epsilon_{\mu_4\mu_2\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_3}-\epsilon_{\mu_4\mu_2\alpha_1\beta_1}p_3^{\alpha_1}p_4^{\beta_1}\eta_{\mu_1\mu_3}-\epsilon_{\mu_3\mu_2\alpha_1\beta_1}p_1^{\alpha_1}p_2^{\beta_1}\eta_{\mu_1\mu_4} \\
& +\epsilon_{\mu_3\mu_2\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_4}-\epsilon_{\mu_3\mu_2\alpha_1\beta_1}p_3^{\alpha_1}p_4^{\beta_1}\eta_{\mu_1\mu_4}-\epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_2^{\beta_1}\eta_{\mu_2\mu_3} \\
& -\epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_2\mu_3}-\epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_3^{\alpha_1}p_4^{\beta_1}\eta_{\mu_2\mu_3}+\epsilon_{\mu_1\mu_3\alpha_1\beta_1}p_1^{\alpha_1}p_2^{\beta_1}\eta_{\mu_2\mu_4} \\
& -\epsilon_{\mu_1\mu_3\alpha_1\beta_1}p_3^{\alpha_1}p_4^{\beta_1}\eta_{\mu_2\mu_4}+\epsilon_{\mu_1\mu_2\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_3\mu_4}-\epsilon_{\mu_1\mu_2\alpha_1\beta_1}p_3^{\alpha_1}p_4^{\beta_1}\eta_{\mu_3\mu_4} \\
& \left. -\epsilon_{\mu_1\mu_3\mu_4\mu_2}p_1\cdot p_2+\epsilon_{\mu_1\mu_3\mu_4\mu_2}p_1\cdot p_3+\epsilon_{\mu_1\mu_3\mu_4\mu_2}p_2\cdot p_4-\epsilon_{\mu_1\mu_3\mu_4\mu_2}p_3\cdot p_4\right)
\end{aligned}$$



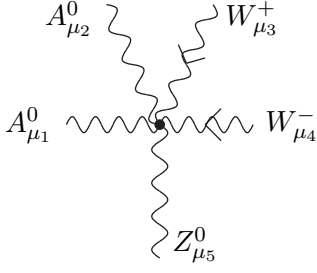
$$\begin{aligned}
& -i\bar{g}^2 (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) \\
& + 6i\bar{g}C^W (\eta_{\mu_1\mu_2}p_1^{\mu_4}p_4^{\mu_3} + \eta_{\mu_1\mu_2}p_2^{\mu_4}p_4^{\mu_3} + \eta_{\mu_1\mu_3}p_1^{\mu_4}p_3^{\mu_2} - \eta_{\mu_1\mu_3}p_2^{\mu_4}p_3^{\mu_2} - \eta_{\mu_1\mu_3}p_1^{\mu_2}p_3^{\mu_4} \\
& - \eta_{\mu_1\mu_3}p_1^{\mu_4}p_4^{\mu_2} - \eta_{\mu_1\mu_4}p_1^{\mu_2}p_4^{\mu_3} - \eta_{\mu_2\mu_3}p_1^{\mu_4}p_3^{\mu_1} + \eta_{\mu_2\mu_3}p_2^{\mu_4}p_3^{\mu_1} - \eta_{\mu_2\mu_3}p_2^{\mu_1}p_3^{\mu_4} \\
& - \eta_{\mu_2\mu_3}p_2^{\mu_4}p_4^{\mu_1} - \eta_{\mu_2\mu_4}p_2^{\mu_1}p_4^{\mu_3} + p_1^{\mu_3} (\eta_{\mu_1\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_4}p_3^{\mu_2} + \eta_{\mu_1\mu_4}p_4^{\mu_2} - \eta_{\mu_2\mu_4}p_4^{\mu_1}) \\
& + p_2^{\mu_3} (\eta_{\mu_1\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_4}p_4^{\mu_2} + \eta_{\mu_2\mu_4} (p_4^{\mu_1} - p_3^{\mu_1})) + \eta_{\mu_3\mu_4}p_1^{\mu_2}p_3^{\mu_1} \\
& + \eta_{\mu_3\mu_4}p_2^{\mu_1}p_3^{\mu_2} + \eta_{\mu_3\mu_4}p_1^{\mu_2}p_4^{\mu_1} + \eta_{\mu_3\mu_4}p_2^{\mu_1}p_4^{\mu_2} - p_1 \cdot p_3 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} \\
& - p_1 \cdot p_4 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} - p_2 \cdot p_3 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} - p_2 \cdot p_4 \eta_{\mu_3\mu_4} \eta_{\mu_1\mu_2} + p_1 \cdot p_3 \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} \\
& + p_1 \cdot p_4 \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_4} + p_2 \cdot p_3 \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_4} + p_2 \cdot p_4 \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3}) \\
& + 2i\bar{g}C^{\widetilde{W}} \left(-\epsilon_{\mu_1\mu_3\mu_2\alpha_1} p_1^{\mu_4} p_3^{\alpha_1} - \epsilon_{\mu_3\mu_2\mu_4\alpha_1} p_2^{\mu_1} p_3^{\alpha_1} + \epsilon_{\mu_1\mu_3\mu_2\alpha_1} p_2^{\mu_4} p_3^{\alpha_1} \right. \\
& - \epsilon_{\mu_3\mu_2\mu_4\alpha_1} p_1^{\alpha_1} p_3^{\mu_1} - \epsilon_{\mu_3\mu_2\mu_4\alpha_1} p_2^{\alpha_1} p_3^{\mu_1} - \epsilon_{\mu_1\mu_3\mu_2\alpha_1} p_1^{\alpha_1} p_3^{\mu_4} + \epsilon_{\mu_1\mu_3\mu_2\alpha_1} p_2^{\alpha_1} p_3^{\mu_4} \\
& - \epsilon_{\mu_1\mu_3\mu_2\alpha_1} p_1^{\mu_4} p_4^{\alpha_1} + \epsilon_{\mu_3\mu_2\mu_4\alpha_1} p_2^{\mu_1} p_4^{\alpha_1} + \epsilon_{\mu_1\mu_3\mu_2\alpha_1} p_2^{\mu_4} p_4^{\alpha_1} + \epsilon_{\mu_3\mu_2\mu_4\alpha_1} p_1^{\alpha_1} p_4^{\mu_1} \\
& + \epsilon_{\mu_3\mu_2\mu_4\alpha_1} p_2^{\alpha_1} p_4^{\mu_1} + \epsilon_{\mu_1\mu_3\mu_4\alpha_1} (p_1^{\mu_2} (p_3^{\alpha_1} - p_4^{\alpha_1}) + (p_1^{\alpha_1} + p_2^{\alpha_1}) (p_3^{\mu_2} - p_4^{\mu_2})) \\
& + \epsilon_{\mu_1\mu_2\mu_4\alpha_1} (p_1^{\mu_3} (p_3^{\alpha_1} + p_4^{\alpha_1}) - p_2^{\mu_3} (p_3^{\alpha_1} + p_4^{\alpha_1}) + (p_1^{\alpha_1} - p_2^{\alpha_1}) p_4^{\mu_3}) \\
& - \epsilon_{\mu_3\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_2} - \epsilon_{\mu_3\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_2} + \epsilon_{\mu_3\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_2} \\
& + \epsilon_{\mu_3\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_2} - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_3} - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_3} \\
& - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_3} + \epsilon_{\mu_3\mu_2\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_4} + \epsilon_{\mu_3\mu_2\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_4} \\
& + \epsilon_{\mu_3\mu_2\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_4} - \epsilon_{\mu_1\mu_4\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_2\mu_3} - \epsilon_{\mu_1\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_2\mu_3} \\
& - \epsilon_{\mu_1\mu_4\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_3} - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_2\mu_4} - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_4} \\
& - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_4} + \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_2^{\alpha_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} \\
& + \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_3\mu_4} - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} p_2^{\alpha_1} p_4^{\beta_1} \eta_{\mu_3\mu_4} - \epsilon_{\mu_1\mu_3\mu_2\mu_4} p_1 \cdot p_3 \\
& \left. + \epsilon_{\mu_1\mu_3\mu_2\mu_4} p_1 \cdot p_4 + \epsilon_{\mu_1\mu_3\mu_2\mu_4} p_2 \cdot p_3 - \epsilon_{\mu_1\mu_3\mu_2\mu_4} p_2 \cdot p_4 \right)
\end{aligned}$$



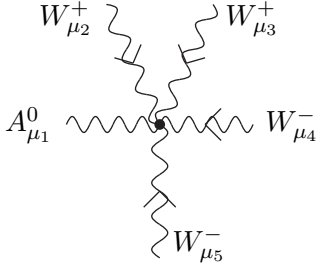
$$\begin{aligned}
& + \frac{i\bar{g}^4}{\bar{g}^2 + \bar{g}'^2} (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) \\
& + \frac{2i\bar{g}^3\bar{g}'^3v^2}{(\bar{g}^2 + \bar{g}'^2)^2} (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) C^{\varphi WB} \\
& - \frac{6i\bar{g}^3}{\bar{g}^2 + \bar{g}'^2} C^W (\eta_{\mu_1\mu_2}p_1^{\mu_4}p_4^{\mu_3} + \eta_{\mu_1\mu_2}p_2^{\mu_4}p_4^{\mu_3} + \eta_{\mu_1\mu_3}p_1^{\mu_4}p_3^{\mu_2} \\
& - \eta_{\mu_1\mu_3}p_2^{\mu_4}p_3^{\mu_2} - \eta_{\mu_1\mu_3}p_1^{\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_3}p_1^{\mu_4}p_4^{\mu_2} - \eta_{\mu_1\mu_4}p_1^{\mu_2}p_4^{\mu_3} \\
& - \eta_{\mu_2\mu_3}p_1^{\mu_4}p_3^{\mu_1} + \eta_{\mu_2\mu_3}p_2^{\mu_4}p_3^{\mu_1} - \eta_{\mu_2\mu_3}p_2^{\mu_1}p_3^{\mu_4} - \eta_{\mu_2\mu_3}p_2^{\mu_4}p_4^{\mu_1} \\
& - \eta_{\mu_2\mu_4}p_2^{\mu_1}p_4^{\mu_3} + p_1^{\mu_3}(\eta_{\mu_1\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_4}p_3^{\mu_2} + \eta_{\mu_1\mu_4}p_4^{\mu_2} - \eta_{\mu_2\mu_4}p_4^{\mu_1}) \\
& + p_2^{\mu_3}(\eta_{\mu_1\mu_2}p_3^{\mu_4} - \eta_{\mu_1\mu_4}p_4^{\mu_2} + \eta_{\mu_2\mu_4}(p_4^{\mu_1} - p_3^{\mu_1})) + \eta_{\mu_3\mu_4}p_1^{\mu_2}p_3^{\mu_1} \\
& + \eta_{\mu_3\mu_4}p_2^{\mu_1}p_3^{\mu_2} + \eta_{\mu_3\mu_4}p_1^{\mu_2}p_4^{\mu_1} + \eta_{\mu_3\mu_4}p_2^{\mu_2}p_4^{\mu_1} - p_1 \cdot p_3\eta_{\mu_3\mu_4}\eta_{\mu_1\mu_2} \\
& - p_1 \cdot p_4\eta_{\mu_3\mu_4}\eta_{\mu_1\mu_2} - p_2 \cdot p_3\eta_{\mu_3\mu_4}\eta_{\mu_1\mu_2} - p_2 \cdot p_4\eta_{\mu_3\mu_4}\eta_{\mu_1\mu_2} + p_1 \cdot p_3\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} \\
& + p_1 \cdot p_4\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} + p_2 \cdot p_3\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} + p_2 \cdot p_4\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}) \\
& + \frac{2i\bar{g}^3}{\bar{g}^2 + \bar{g}'^2} C^{\widetilde{W}} \left(-\epsilon_{\mu_2\mu_3\mu_1\alpha_1}p_1^{\mu_4}p_3^{\alpha_1} - \epsilon_{\mu_2\mu_3\mu_4\alpha_1}p_2^{\mu_1}p_3^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_1\alpha_1}p_2^{\mu_4}p_3^{\alpha_1} \right. \\
& - \epsilon_{\mu_2\mu_3\mu_4\alpha_1}p_1^{\alpha_1}p_3^{\mu_1} - \epsilon_{\mu_2\mu_3\mu_4\alpha_1}p_2^{\alpha_1}p_3^{\mu_1} - \epsilon_{\mu_2\mu_3\mu_1\alpha_1}p_1^{\alpha_1}p_3^{\mu_4} + \epsilon_{\mu_2\mu_3\mu_1\alpha_1}p_2^{\alpha_1}p_3^{\mu_4} \\
& - \epsilon_{\mu_2\mu_3\mu_1\alpha_1}p_1^{\mu_4}p_4^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_4\alpha_1}p_2^{\mu_1}p_4^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_1\alpha_1}p_2^{\mu_4}p_4^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_4\alpha_1}p_1^{\alpha_1}p_4^{\mu_1} \\
& + \epsilon_{\mu_2\mu_3\mu_4\alpha_1}p_2^{\alpha_1}p_4^{\mu_1} + \epsilon_{\mu_3\mu_1\mu_4\alpha_1}(p_1^{\mu_2}(p_3^{\alpha_1} - p_4^{\alpha_1}) + (p_1^{\alpha_1} + p_2^{\alpha_1})(p_3^{\mu_2} - p_4^{\mu_2})) \\
& + \epsilon_{\mu_2\mu_1\mu_4\alpha_1}(p_1^{\mu_3}(p_3^{\alpha_1} + p_4^{\alpha_1}) - p_2^{\mu_3}(p_3^{\alpha_1} + p_4^{\alpha_1}) + (p_1^{\alpha_1} - p_2^{\alpha_1})p_4^{\mu_3}) \\
& + \epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_2} + \epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_2^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_2} - \epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_4^{\beta_1}\eta_{\mu_1\mu_2} \\
& - \epsilon_{\mu_3\mu_4\alpha_1\beta_1}p_2^{\alpha_1}p_4^{\beta_1}\eta_{\mu_1\mu_2} + \epsilon_{\mu_2\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_3} + \epsilon_{\mu_2\mu_4\alpha_1\beta_1}p_2^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_3} \\
& + \epsilon_{\mu_2\mu_4\alpha_1\beta_1}p_1^{\beta_1}p_4^{\alpha_1}\eta_{\mu_1\mu_3} + \epsilon_{\mu_2\mu_3\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_1\mu_4} + \epsilon_{\mu_2\mu_3\alpha_1\beta_1}p_1^{\alpha_1}p_4^{\beta_1}\eta_{\mu_1\mu_4} \\
& + \epsilon_{\mu_2\mu_3\alpha_1\beta_1}p_2^{\alpha_1}p_4^{\beta_1}\eta_{\mu_1\mu_4} + \epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_2\mu_3} + \epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_2^{\alpha_1}p_3^{\beta_1}\eta_{\mu_2\mu_3} \\
& + \epsilon_{\mu_1\mu_4\alpha_1\beta_1}p_2^{\alpha_1}p_4^{\beta_1}\eta_{\mu_2\mu_3} - \epsilon_{\mu_3\mu_1\alpha_1\beta_1}p_2^{\alpha_1}p_3^{\beta_1}\eta_{\mu_2\mu_4} - \epsilon_{\mu_3\mu_1\alpha_1\beta_1}p_1^{\alpha_1}p_4^{\beta_1}\eta_{\mu_2\mu_4} \\
& - \epsilon_{\mu_3\mu_1\alpha_1\beta_1}p_2^{\alpha_1}p_4^{\beta_1}\eta_{\mu_2\mu_4} + \epsilon_{\mu_2\mu_1\alpha_1\beta_1}p_1^{\alpha_1}p_3^{\beta_1}\eta_{\mu_3\mu_4} - \epsilon_{\mu_2\mu_1\alpha_1\beta_1}p_2^{\alpha_1}p_3^{\beta_1}\eta_{\mu_3\mu_4} \\
& + \epsilon_{\mu_2\mu_1\alpha_1\beta_1}p_1^{\alpha_1}p_4^{\beta_1}\eta_{\mu_3\mu_4} - \epsilon_{\mu_2\mu_1\alpha_1\beta_1}p_2^{\alpha_1}p_4^{\beta_1}\eta_{\mu_3\mu_4} - \epsilon_{\mu_2\mu_3\mu_1\mu_4}p_1 \cdot p_3 \\
& \left. + \epsilon_{\mu_2\mu_3\mu_1\mu_4}p_1 \cdot p_4 + \epsilon_{\mu_2\mu_3\mu_1\mu_4}p_2 \cdot p_3 - \epsilon_{\mu_2\mu_3\mu_1\mu_4}p_2 \cdot p_4 \right)
\end{aligned}$$



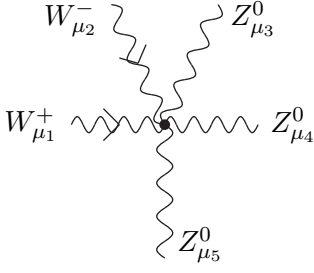
$$\begin{aligned}
& + \frac{6i\bar{g}^2\bar{g}'^3}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^W (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}(-p_3^{\mu_5}) - 2\eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_1^{\mu_4} + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_2^{\mu_4} \\
& + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_3^{\mu_4} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}p_3^{\mu_5} + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_1^{\mu_3} - \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_2^{\mu_3} \\
& + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_1^{\mu_4} - 2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_2^{\mu_4} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_3^{\mu_4} - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_1^{\mu_3} \\
& + \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_2^{\mu_3} + 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}p_3^{\mu_5} + \eta_{\mu_1\mu_5}\eta_{\mu_3\mu_4}p_1^{\mu_2} - \eta_{\mu_1\mu_5}\eta_{\mu_3\mu_4}p_2^{\mu_2} \\
& + \eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4}p_2^{\mu_1} - \eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4}p_3^{\mu_1} + (2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})p_1^{\mu_5} \\
& - (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - 2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} + \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4})p_2^{\mu_5} + \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_5}p_1^{\mu_4} \\
& + \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_5}p_2^{\mu_4} - 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_5}p_3^{\mu_4} - \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_1^{\mu_2} \\
& + \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_2^{\mu_2} - \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_2^{\mu_1} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_3^{\mu_1}) \\
& + \frac{2i\bar{g}^2\bar{g}'^3}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^{\widetilde{W}} (2\eta_{\mu_1\mu_2}p_1^{\alpha_1}\epsilon_{\mu_3\mu_4\mu_5\alpha_1} + 2\eta_{\mu_1\mu_2}p_2^{\alpha_1}\epsilon_{\mu_3\mu_4\mu_5\alpha_1} + 2\eta_{\mu_1\mu_2}p_3^{\alpha_1}\epsilon_{\mu_3\mu_4\mu_5\alpha_1} + 2\eta_{\mu_1\mu_2}p_4^{\alpha_1}\epsilon_{\mu_3\mu_4\mu_5\alpha_1} + 2\eta_{\mu_1\mu_2}p_5^{\alpha_1}\epsilon_{\mu_3\mu_4\mu_5\alpha_1})
\end{aligned}$$



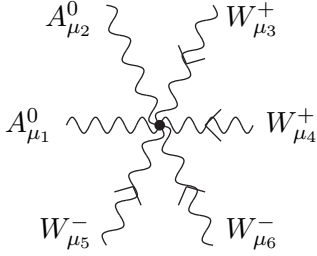
$$\begin{aligned}
& + \frac{6i\bar{g}^3\bar{g}'^2}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^W (\eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}(-p_1^{\mu_4}) + 2\eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_2^{\mu_4} \\
& - \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_5^{\mu_4} - \eta_{\mu_4\mu_5}\eta_{\mu_2\mu_3}p_2^{\mu_1} + \eta_{\mu_4\mu_5}\eta_{\mu_2\mu_3}p_5^{\mu_1} + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_1^{\mu_3} \\
& - 2\eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_2^{\mu_3} + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_5^{\mu_3} + (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4})p_1^{\mu_5} \\
& + (\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3})p_2^{\mu_5} + 2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_1^{\mu_4} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_2^{\mu_4} \\
& - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_5^{\mu_4} - 2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_1^{\mu_3} + \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_2^{\mu_3} + \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_5^{\mu_3} \\
& - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_5}p_1^{\mu_4} - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_5}p_2^{\mu_4} + 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_5}p_5^{\mu_4} + \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_1^{\mu_2} \\
& - \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_5^{\mu_2} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_2^{\mu_1} - \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_5^{\mu_1} + \eta_{\mu_1\mu_2}\eta_{\mu_4\mu_5}p_1^{\mu_3} \\
& + \eta_{\mu_1\mu_2}\eta_{\mu_4\mu_5}p_2^{\mu_3} - 2\eta_{\mu_1\mu_2}\eta_{\mu_4\mu_5}p_5^{\mu_3} - \eta_{\mu_1\mu_3}\eta_{\mu_4\mu_5}p_1^{\mu_2} + \eta_{\mu_1\mu_3}\eta_{\mu_4\mu_5}p_5^{\mu_2}) \\
& + \frac{2i\bar{g}^3\bar{g}'^2}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^{\widetilde{W}} (2\eta_{\mu_1\mu_2}p_1^{\alpha_1}\epsilon_{\mu_5\mu_3\mu_4\alpha_1} + 2\eta_{\mu_1\mu_2}p_2^{\alpha_1}\epsilon_{\mu_5\mu_3\mu_4\alpha_1} + 2\eta_{\mu_1\mu_2}p_5^{\alpha_1}\epsilon_{\mu_5\mu_3\mu_4\alpha_1} - \eta_{\mu_1\mu_2}p_1^{\alpha_1}\epsilon_{\mu_5\mu_3\mu_4\alpha_1} - \eta_{\mu_1\mu_2}p_2^{\alpha_1}\epsilon_{\mu_5\mu_3\mu_4\alpha_1} - \eta_{\mu_1\mu_2}p_5^{\alpha_1}\epsilon_{\mu_5\mu_3\mu_4\alpha_1})
\end{aligned}$$



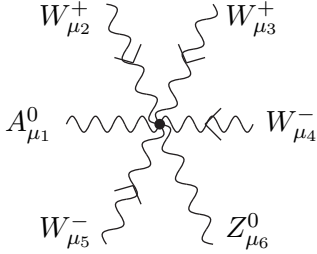
$$\begin{aligned}
& + \frac{6i\bar{g}^2\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^W (-2p_4^{\mu_5} \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} \\
& + p_2^{\mu_4} \eta_{\mu_1\mu_5} \eta_{\mu_2\mu_3} + p_3^{\mu_4} \eta_{\mu_1\mu_5} \eta_{\mu_2\mu_3} \\
& - 2p_5^{\mu_4} \eta_{\mu_1\mu_5} \eta_{\mu_2\mu_3} - 2p_2^{\mu_1} \eta_{\mu_4\mu_5} \eta_{\mu_2\mu_3} \\
& - 2p_3^{\mu_1} \eta_{\mu_4\mu_5} \eta_{\mu_2\mu_3} + 2p_4^{\mu_1} \eta_{\mu_4\mu_5} \eta_{\mu_2\mu_3} \\
& + 2p_5^{\mu_1} \eta_{\mu_4\mu_5} \eta_{\mu_2\mu_3} + p_4^{\mu_5} \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_4} \\
& - p_2^{\mu_3} \eta_{\mu_1\mu_5} \eta_{\mu_2\mu_4} + p_5^{\mu_3} \eta_{\mu_1\mu_5} \eta_{\mu_2\mu_4} \\
& + p_3^{\mu_5} (\eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_4}) \\
& - p_3^{\mu_4} \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_5} \\
& + p_5^{\mu_4} \eta_{\mu_1\mu_3} \eta_{\mu_2\mu_5} - p_2^{\mu_3} \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_5} \\
& + p_4^{\mu_3} \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_5} + p_4^{\mu_5} \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_4} \\
& - p_3^{\mu_2} \eta_{\mu_1\mu_5} \eta_{\mu_3\mu_4} + p_5^{\mu_2} \eta_{\mu_1\mu_5} \eta_{\mu_3\mu_4} \\
& + p_2^{\mu_1} \eta_{\mu_2\mu_5} \eta_{\mu_3\mu_4} + p_3^{\mu_1} \eta_{\mu_2\mu_5} \eta_{\mu_3\mu_4} \\
& - p_4^{\mu_1} \eta_{\mu_2\mu_5} \eta_{\mu_3\mu_4} - p_5^{\mu_1} \eta_{\mu_2\mu_5} \eta_{\mu_3\mu_4} \\
& + p_2^{\mu_5} (\eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_4}) \\
& - p_2^{\mu_4} \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_5} + p_5^{\mu_4} \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_5} \\
& - p_3^{\mu_2} \eta_{\mu_1\mu_4} \eta_{\mu_3\mu_5} + p_4^{\mu_2} \eta_{\mu_1\mu_4} \eta_{\mu_3\mu_5} \\
& + p_2^{\mu_1} \eta_{\mu_2\mu_4} \eta_{\mu_3\mu_5} + p_3^{\mu_1} \eta_{\mu_2\mu_4} \eta_{\mu_3\mu_5} \\
& - p_4^{\mu_1} \eta_{\mu_2\mu_4} \eta_{\mu_3\mu_5} - p_5^{\mu_1} \eta_{\mu_2\mu_4} \eta_{\mu_3\mu_5} \\
& + 2p_2^{\mu_3} \eta_{\mu_1\mu_2} \eta_{\mu_4\mu_5} - p_4^{\mu_3} \eta_{\mu_1\mu_2} \eta_{\mu_4\mu_5} \\
& - p_5^{\mu_3} \eta_{\mu_1\mu_2} \eta_{\mu_4\mu_5} + 2p_3^{\mu_2} \eta_{\mu_1\mu_3} \eta_{\mu_4\mu_5} \\
& - p_4^{\mu_2} \eta_{\mu_1\mu_3} \eta_{\mu_4\mu_5} - p_5^{\mu_2} \eta_{\mu_1\mu_3} \eta_{\mu_4\mu_5}) \\
& - \frac{2i\bar{g}^2\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\widetilde{W}} (2\epsilon_{\mu_1\mu_2\mu_3\mu_5} (p_2^{\mu_4} - p_3^{\mu_4}) \\
& + 2\epsilon_{\mu_1\mu_4\mu_2\mu_3} (p_2^{\mu_5} - p_3^{\mu_5}) \\
& + 2\epsilon_{\mu_1\mu_4\mu_3\mu_5} p_4^{\mu_2} + 2\epsilon_{\mu_1\mu_4\mu_2\mu_5} p_4^{\mu_3} \\
& - 2\epsilon_{\mu_1\mu_4\mu_3\mu_5} p_5^{\mu_2} - 2\epsilon_{\mu_1\mu_4\mu_2\mu_5} p_5^{\mu_3} \\
& - \epsilon_{\mu_4\mu_3\mu_5\alpha_1} p_4^{\alpha_1} \eta_{\mu_1\mu_2} + \epsilon_{\mu_4\mu_3\mu_5\alpha_1} p_5^{\alpha_1} \eta_{\mu_1\mu_2} \\
& - \epsilon_{\mu_4\mu_2\mu_5\alpha_1} p_4^{\alpha_1} \eta_{\mu_1\mu_3} + \epsilon_{\mu_4\mu_2\mu_5\alpha_1} p_5^{\alpha_1} \eta_{\mu_1\mu_3} \\
& - \epsilon_{\mu_2\mu_3\mu_5\alpha_1} p_2^{\alpha_1} \eta_{\mu_1\mu_4} + \epsilon_{\mu_2\mu_3\mu_5\alpha_1} p_3^{\alpha_1} \eta_{\mu_1\mu_4} \\
& - \epsilon_{\mu_4\mu_2\mu_3\alpha_1} p_2^{\alpha_1} \eta_{\mu_1\mu_5} + \epsilon_{\mu_4\mu_2\mu_3\alpha_1} p_3^{\alpha_1} \eta_{\mu_1\mu_5} \\
& - 2\epsilon_{\mu_1\mu_4\mu_5\alpha_1} p_4^{\alpha_1} \eta_{\mu_2\mu_3} + 2\epsilon_{\mu_1\mu_4\mu_5\alpha_1} p_5^{\alpha_1} \eta_{\mu_2\mu_3} \\
& - 2\epsilon_{\mu_1\mu_3\mu_5\alpha_1} p_2^{\alpha_1} \eta_{\mu_2\mu_4} - \epsilon_{\mu_1\mu_3\mu_5\alpha_1} p_3^{\alpha_1} \eta_{\mu_2\mu_4} \\
& - 2\epsilon_{\mu_1\mu_3\mu_5\alpha_1} p_4^{\alpha_1} \eta_{\mu_2\mu_4} - \epsilon_{\mu_1\mu_3\mu_5\alpha_1} p_5^{\alpha_1} \eta_{\mu_2\mu_4} \\
& + 2\epsilon_{\mu_1\mu_4\mu_3\alpha_1} p_2^{\alpha_1} \eta_{\mu_2\mu_5} + \epsilon_{\mu_1\mu_4\mu_3\alpha_1} p_3^{\alpha_1} \eta_{\mu_2\mu_5} \\
& + \epsilon_{\mu_1\mu_4\mu_3\alpha_1} p_4^{\alpha_1} \eta_{\mu_2\mu_5} + 2\epsilon_{\mu_1\mu_4\mu_3\alpha_1} p_5^{\alpha_1} \eta_{\mu_2\mu_5} \\
& - \epsilon_{\mu_1\mu_2\mu_5\alpha_1} p_2^{\alpha_1} \eta_{\mu_3\mu_4} - 2\epsilon_{\mu_1\mu_2\mu_5\alpha_1} p_3^{\alpha_1} \eta_{\mu_3\mu_4} \\
& - 2\epsilon_{\mu_1\mu_2\mu_5\alpha_1} p_4^{\alpha_1} \eta_{\mu_3\mu_4} - \epsilon_{\mu_1\mu_2\mu_5\alpha_1} p_5^{\alpha_1} \eta_{\mu_3\mu_4} \\
& + \epsilon_{\mu_1\mu_4\mu_2\alpha_1} p_2^{\alpha_1} \eta_{\mu_3\mu_5} + 2\epsilon_{\mu_1\mu_4\mu_2\alpha_1} p_3^{\alpha_1} \eta_{\mu_3\mu_5} \\
& + \epsilon_{\mu_1\mu_4\mu_2\alpha_1} p_4^{\alpha_1} \eta_{\mu_3\mu_5} + 2\epsilon_{\mu_1\mu_4\mu_2\alpha_1} p_5^{\alpha_1} \eta_{\mu_3\mu_5} \\
& + 2\epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_2^{\alpha_1} \eta_{\mu_4\mu_5} - 2\epsilon_{\mu_1\mu_2\mu_3\alpha_1} p_3^{\alpha_1} \eta_{\mu_4\mu_5})
\end{aligned}$$



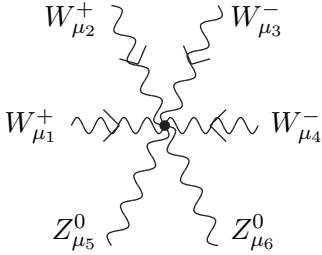
$$\begin{aligned}
& + \frac{6i\bar{g}^5}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^W (\eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_3^{\mu_4} - \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_3}p_5^{\mu_4} - 2\eta_{\mu_4\mu_5}\eta_{\mu_2\mu_3}p_3^{\mu_1} \\
& + \eta_{\mu_4\mu_5}\eta_{\mu_2\mu_3}p_4^{\mu_1} + \eta_{\mu_4\mu_5}\eta_{\mu_2\mu_3}p_5^{\mu_1} + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_4^{\mu_3} - \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4}p_5^{\mu_3} \\
& + (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4})p_3^{\mu_5} + (\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3})p_4^{\mu_5} \\
& - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_3^{\mu_4} + \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}p_5^{\mu_4} - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_4^{\mu_3} + \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}p_5^{\mu_3} \\
& - \eta_{\mu_1\mu_5}\eta_{\mu_3\mu_4}p_3^{\mu_2} - \eta_{\mu_1\mu_5}\eta_{\mu_3\mu_4}p_4^{\mu_2} + 2\eta_{\mu_1\mu_5}\eta_{\mu_3\mu_4}p_5^{\mu_2} \\
& + \eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4}p_3^{\mu_1} + \eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4}p_4^{\mu_1} - 2\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4}p_5^{\mu_1} - \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_3^{\mu_2} \\
& + 2\eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_4^{\mu_2} - \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5}p_5^{\mu_2} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_3^{\mu_1} - 2\eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_4^{\mu_1} \\
& + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5}p_5^{\mu_1} + 2\eta_{\mu_1\mu_3}\eta_{\mu_4\mu_5}p_3^{\mu_2} - \eta_{\mu_1\mu_3}\eta_{\mu_4\mu_5}p_4^{\mu_2} - \eta_{\mu_1\mu_3}\eta_{\mu_4\mu_5}p_5^{\mu_2}) \\
& + \frac{2i\bar{g}^5}{(\bar{g}^2 + \bar{g}'^2)^{3/2}} C^{\widetilde{W}} (-\eta_{\mu_1\mu_3}p_4^{\alpha_1}\epsilon_{\mu_2\mu_4\mu_5\alpha_1} + \eta_{\mu_1\mu_3}p_5^{\alpha_1}\epsilon_{\mu_2\mu_4\mu_5\alpha_1} + \eta_{\mu_1\mu_4}p_3^{\alpha_1}\epsilon_{\mu_3\mu_2\mu_5\alpha_1} - \eta_{\mu_1\mu_4}p_5^{\alpha_1}\epsilon_{\mu_3\mu_2\mu_5\alpha_1} - \eta_{\mu_1\mu_5}p_3^{\alpha_1}\epsilon_{\mu_3\mu_2\mu_4\alpha_1} + \eta_{\mu_1\mu_5}p_5^{\alpha_1}\epsilon_{\mu_3\mu_2\mu_4\alpha_1})
\end{aligned}$$



$$\begin{aligned}
& - \frac{12i\bar{g}^3\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} (-\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_6}\eta_{\mu_3\mu_5} + 2\eta_{\mu_1\mu_2}\eta_{\mu_4\mu_6}\eta_{\mu_3\mu_5} \\
& - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_6} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_6}\eta_{\mu_4\mu_5} + 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_6}\eta_{\mu_4\mu_5} \\
& + \eta_{\mu_1\mu_6}(2\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4} - \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5} - \eta_{\mu_2\mu_3}\eta_{\mu_4\mu_5}) \\
& - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}\eta_{\mu_4\mu_6} + \eta_{\mu_1\mu_5}(2\eta_{\mu_2\mu_6}\eta_{\mu_3\mu_4} - \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_6} - \eta_{\mu_2\mu_3}\eta_{\mu_4\mu_6}) \\
& + 2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}\eta_{\mu_5\mu_6} + 2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}\eta_{\mu_5\mu_6} - 4\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}\eta_{\mu_5\mu_6}) C^W
\end{aligned}$$

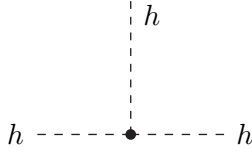


$$\begin{aligned}
& - \frac{12i\bar{g}^4\bar{g}'}{\bar{g}^2 + \bar{g}'^2} (-\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_6}\eta_{\mu_3\mu_5} - \eta_{\mu_1\mu_2}\eta_{\mu_4\mu_6}\eta_{\mu_3\mu_5} \\
& - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_6} + 2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_6}\eta_{\mu_4\mu_5} + 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_6}\eta_{\mu_4\mu_5} \\
& + 2\eta_{\mu_1\mu_6}(\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5} - 2\eta_{\mu_2\mu_3}\eta_{\mu_4\mu_5}) \\
& - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}\eta_{\mu_4\mu_6} - \eta_{\mu_1\mu_5}(\eta_{\mu_2\mu_6}\eta_{\mu_3\mu_4} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_6} - 2\eta_{\mu_2\mu_3}\eta_{\mu_4\mu_6}) \\
& + 2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}\eta_{\mu_5\mu_6} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}\eta_{\mu_5\mu_6} - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}\eta_{\mu_5\mu_6}) C^W
\end{aligned}$$

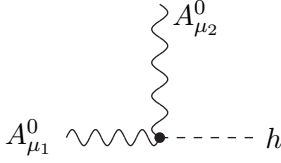


$$\begin{aligned}
& - \frac{12i\bar{g}^5}{\bar{g}^2 + \bar{g}'^2} (-\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_6}\eta_{\mu_3\mu_5} + 2\eta_{\mu_1\mu_2}\eta_{\mu_4\mu_6}\eta_{\mu_3\mu_5} \\
& - \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_6} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_6}\eta_{\mu_4\mu_5} + 2\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_6}\eta_{\mu_4\mu_5} \\
& + \eta_{\mu_1\mu_6}(2\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4} - \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5} - \eta_{\mu_2\mu_3}\eta_{\mu_4\mu_5}) \\
& - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_5}\eta_{\mu_4\mu_6} + \eta_{\mu_1\mu_5}(2\eta_{\mu_2\mu_6}\eta_{\mu_3\mu_4} - \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_6} - \eta_{\mu_2\mu_3}\eta_{\mu_4\mu_6}) \\
& + 2\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3}\eta_{\mu_5\mu_6} + 2\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}\eta_{\mu_5\mu_6} - 4\eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}\eta_{\mu_5\mu_6}) C^W
\end{aligned}$$

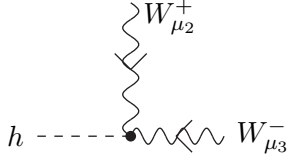
A.7 Higgs–gauge vertices



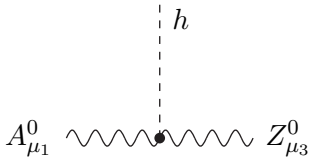
$$\begin{aligned}
& -3i\lambda v + 15iv^3 C^\varphi \\
& -ivC^{\varphi\Box} (3p_1 \cdot p_1 + 2p_1 \cdot p_2 + 2p_1 \cdot p_3 + 3p_2 \cdot p_2 + 2p_2 \cdot p_3 + 3p_3 \cdot p_3 + 9\lambda v^2) \\
& + \frac{iv}{4} C^{\varphi D} (9\lambda v^2 - 4(p_1 \cdot p_2 + p_1 \cdot p_3 + p_2 \cdot p_3))
\end{aligned}$$



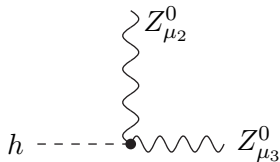
$$\begin{aligned}
& + \frac{4i\bar{g}^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi B} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) + \frac{4i\bar{g}^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{B}} p_1^{\alpha_1} p_2^{\beta_1} \epsilon_{\mu_1 \mu_2 \alpha_1 \beta_1} \\
& + \frac{4i\bar{g}'^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi W} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) \\
& - \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi WB} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) \\
& + \frac{4i\bar{g}'^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W}} p_1^{\alpha_1} p_2^{\beta_1} \epsilon_{\mu_1 \mu_2 \alpha_1 \beta_1} - \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W} B} p_1^{\alpha_1} p_2^{\beta_1} \epsilon_{\mu_1 \mu_2 \alpha_1 \beta_1}
\end{aligned}$$

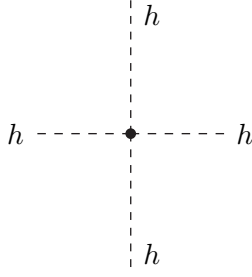


$$\begin{aligned}
& + \frac{1}{2} i\bar{g}^2 v \eta_{\mu_2 \mu_3} + \frac{1}{2} i\bar{g}^2 v^3 \eta_{\mu_2 \mu_3} C^{\varphi\Box} - \frac{1}{8} i\bar{g}^2 v^3 \eta_{\mu_2 \mu_3} C^{\varphi D} \\
& + 4ivC^{\varphi W} (p_2^{\mu_3} p_3^{\mu_2} - p_2 \cdot p_3 \eta_{\mu_2 \mu_3}) + 4ivC^{\varphi \tilde{W}} p_2^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_2 \mu_3 \alpha_1 \beta_1} \\
& - \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi B} (p_1^{\mu_3} p_3^{\mu_1} - p_1 \cdot p_3 \eta_{\mu_1 \mu_3}) - \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{B}} p_1^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_1 \mu_3 \alpha_1 \beta_1} \\
& + \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi W} (p_1^{\mu_3} p_3^{\mu_1} - p_1 \cdot p_3 \eta_{\mu_1 \mu_3}) \\
& + \frac{2iv(\bar{g}'^2 - \bar{g}^2)}{\bar{g}^2 + \bar{g}'^2} C^{\varphi WB} (p_1^{\mu_3} p_3^{\mu_1} - p_1 \cdot p_3 \eta_{\mu_1 \mu_3}) \\
& + \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W}} p_1^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_1 \mu_3 \alpha_1 \beta_1} \\
& + \frac{2iv(\bar{g}'^2 - \bar{g}^2)}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W} B} p_1^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_1 \mu_3 \alpha_1 \beta_1}
\end{aligned}$$

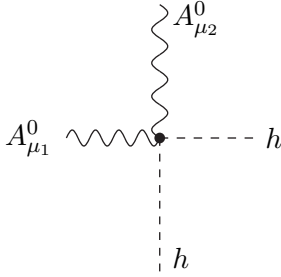


$$\begin{aligned}
& + \frac{iv}{2} (\bar{g}^2 + \bar{g}'^2) \eta_{\mu_2 \mu_3} + \frac{4i\bar{g}'^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi B} (p_2^{\mu_3} p_3^{\mu_2} - p_2 \cdot p_3 \eta_{\mu_2 \mu_3}) \\
& + \frac{iv^3}{2} (\bar{g}^2 + \bar{g}'^2) \eta_{\mu_2 \mu_3} C^{\varphi\Box} + \frac{4i\bar{g}'^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{B}} p_2^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_2 \mu_3 \alpha_1 \beta_1} \\
& + \frac{3iv^3}{8} (\bar{g}^2 + \bar{g}'^2) \eta_{\mu_2 \mu_3} C^{\varphi D} + \frac{4i\bar{g}^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi W} (p_2^{\mu_3} p_3^{\mu_2} - p_2 \cdot p_3 \eta_{\mu_2 \mu_3}) \\
& + \frac{i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi WB} (\eta_{\mu_2 \mu_3} (-4p_2 \cdot p_3 + \bar{g}^2 v^2 + \bar{g}'^2 v^2) + 4p_2^{\mu_3} p_3^{\mu_2}) \\
& + \frac{4i\bar{g}^2 v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W}} p_2^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_2 \mu_3 \alpha_1 \beta_1} + \frac{4i\bar{g}\bar{g}' v}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W} B} p_2^{\alpha_1} p_3^{\beta_1} \epsilon_{\mu_2 \mu_3 \alpha_1 \beta_1}
\end{aligned}$$

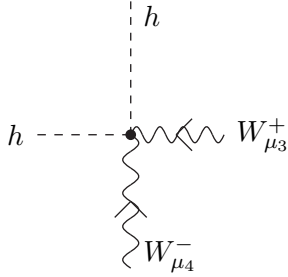




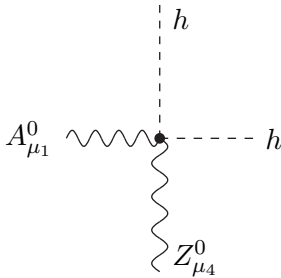
$$-3i\lambda + 45iv^2C^\varphi - iC^{\varphi\Box} (3p_1 \cdot p_1 + 2p_1 \cdot p_2 + 2p_1 \cdot p_3 + 2p_1 \cdot p_4 + 3p_2 \cdot p_2 + 2p_2 \cdot p_3 + 2p_2 \cdot p_4 + 3p_3 \cdot p_3 + 2p_3 \cdot p_4 + 3p_4 \cdot p_4 + 12\lambda v^2) + iC^{\varphi D} (-p_1 \cdot p_2 - p_1 \cdot p_3 - p_1 \cdot p_4 - p_2 \cdot p_3 - p_2 \cdot p_4 - p_3 \cdot p_4 + 3\lambda v^2)$$



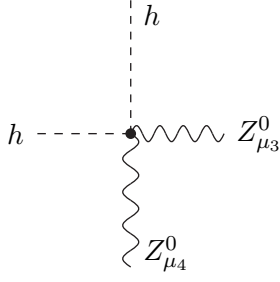
$$+\frac{4i\bar{g}^2}{\bar{g}^2 + \bar{g}'^2}C^{\varphi B} (p_1^{\mu_2}p_2^{\mu_1} - p_1 \cdot p_2\eta_{\mu_1\mu_2}) + \frac{4i\bar{g}^2}{\bar{g}^2 + \bar{g}'^2}C^{\varphi\tilde{B}} p_1^{\alpha_1}p_2^{\beta_1}\epsilon_{\mu_1\mu_2\alpha_1\beta_1} + \frac{4i\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2}C^{\varphi W} (p_1^{\mu_2}p_2^{\mu_1} - p_1 \cdot p_2\eta_{\mu_1\mu_2}) - \frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2}C^{\varphi WB} (p_1^{\mu_2}p_2^{\mu_1} - p_1 \cdot p_2\eta_{\mu_1\mu_2}) + \frac{4i\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2}C^{\varphi\tilde{W}} p_1^{\alpha_1}p_2^{\beta_1}\epsilon_{\mu_1\mu_2\alpha_1\beta_1} - \frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2}C^{\varphi\tilde{W}B} p_1^{\alpha_1}p_2^{\beta_1}\epsilon_{\mu_1\mu_2\alpha_1\beta_1}$$



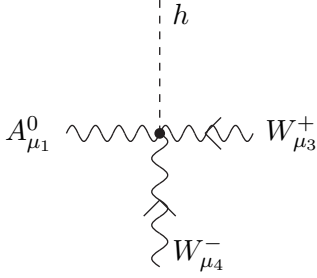
$$+\frac{i\bar{g}^2}{2}\eta_{\mu_3\mu_4} + i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi\Box} - \frac{1}{4}i\bar{g}^2v^2\eta_{\mu_3\mu_4}C^{\varphi D} + 4iC^{\varphi W} (p_3^{\mu_4}p_4^{\mu_3} - p_3 \cdot p_4\eta_{\mu_3\mu_4}) + 4iC^{\varphi\tilde{W}} p_3^{\alpha_1}p_4^{\beta_1}\epsilon_{\mu_3\mu_4\alpha_1\beta_1}$$



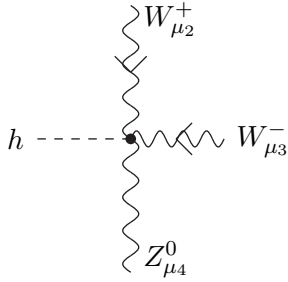
$$-\frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2}C^{\varphi B} (p_1^{\mu_4}p_4^{\mu_1} - p_1 \cdot p_4\eta_{\mu_1\mu_4}) - \frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2}C^{\varphi\tilde{B}} p_1^{\alpha_1}p_4^{\beta_1}\epsilon_{\mu_1\mu_4\alpha_1\beta_1} + \frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2}C^{\varphi W} (p_1^{\mu_4}p_4^{\mu_1} - p_1 \cdot p_4\eta_{\mu_1\mu_4}) + \frac{2i(\bar{g}'^2 - \bar{g}^2)}{\bar{g}^2 + \bar{g}'^2}C^{\varphi WB} (p_1^{\mu_4}p_4^{\mu_1} - p_1 \cdot p_4\eta_{\mu_1\mu_4}) + \frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2}C^{\varphi\tilde{W}} p_1^{\alpha_1}p_4^{\beta_1}\epsilon_{\mu_1\mu_4\alpha_1\beta_1} + \frac{2i(\bar{g}'^2 - \bar{g}^2)}{\bar{g}^2 + \bar{g}'^2}C^{\varphi\tilde{W}B} p_1^{\alpha_1}p_4^{\beta_1}\epsilon_{\mu_1\mu_4\alpha_1\beta_1}$$



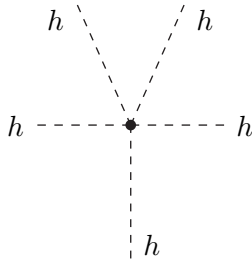
$$\begin{aligned}
& + \frac{i}{2} \left(\bar{g}^2 + \bar{g}'^2 \right) \eta_{\mu_3\mu_4} + \frac{4i\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} C^{\varphi B} (p_3^{\mu_4} p_4^{\mu_3} - p_3 \cdot p_4 \eta_{\mu_3\mu_4}) \\
& + iv^2 \left(\bar{g}^2 + \bar{g}'^2 \right) \eta_{\mu_3\mu_4} C^{\varphi \square} + \frac{4i\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{B}} p_3^{\alpha_1} p_4^{\beta_1} \epsilon_{\mu_3\mu_4\alpha_1\beta_1} \\
& + \frac{5iv^2}{4} \left(\bar{g}^2 + \bar{g}'^2 \right) \eta_{\mu_3\mu_4} C^{\varphi D} + \frac{4i\bar{g}^2}{\bar{g}^2 + \bar{g}'^2} C^{\varphi W} (p_3^{\mu_4} p_4^{\mu_3} - p_3 \cdot p_4 \eta_{\mu_3\mu_4}) \\
& + \frac{i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2} C^{\varphi WB} \left(\eta_{\mu_3\mu_4} \left(-4p_3 \cdot p_4 + \bar{g}^2 v^2 + \bar{g}'^2 v^2 \right) + 4p_3^{\mu_4} p_4^{\mu_3} \right) \\
& + \frac{4i\bar{g}^2}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W}} p_3^{\alpha_1} p_4^{\beta_1} \epsilon_{\mu_3\mu_4\alpha_1\beta_1} + \frac{4i\bar{g}\bar{g}'}{\bar{g}^2 + \bar{g}'^2} C^{\varphi \tilde{W}B} p_3^{\alpha_1} p_4^{\beta_1} \epsilon_{\mu_3\mu_4\alpha_1\beta_1}
\end{aligned}$$



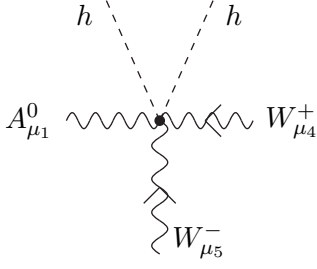
$$\begin{aligned}
& - \frac{4i\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi W} (\eta_{\mu_1\mu_3} p_1^{\mu_4} - \eta_{\mu_1\mu_3} p_3^{\mu_4} - \eta_{\mu_1\mu_4} p_1^{\mu_3} + \eta_{\mu_1\mu_4} p_4^{\mu_3} \\
& + \eta_{\mu_3\mu_4} p_3^{\mu_1} - \eta_{\mu_3\mu_4} p_4^{\mu_1}) + \frac{2i\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi WB} (\eta_{\mu_1\mu_3} p_1^{\mu_4} - \eta_{\mu_1\mu_4} p_1^{\mu_3}) \\
& + \frac{4i\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \tilde{W}} (p_1^{\alpha_1} + p_3^{\alpha_1} + p_4^{\alpha_1}) \epsilon_{\mu_1\mu_4\mu_3\alpha_1} \\
& - \frac{2i\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \tilde{W}B} p_1^{\alpha_1} \epsilon_{\mu_1\mu_4\mu_3\alpha_1}
\end{aligned}$$



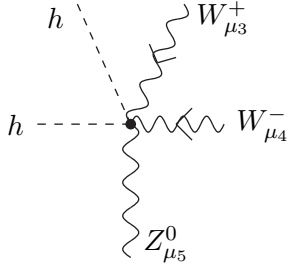
$$\begin{aligned}
& - \frac{4i\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi W} (\eta_{\mu_2\mu_3} p_2^{\mu_4} - \eta_{\mu_2\mu_3} p_3^{\mu_4} - \eta_{\mu_2\mu_4} p_2^{\mu_3} + \eta_{\mu_2\mu_4} p_4^{\mu_3} \\
& + \eta_{\mu_3\mu_4} p_3^{\mu_2} - \eta_{\mu_3\mu_4} p_4^{\mu_2}) - \frac{2i\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi WB} (\eta_{\mu_2\mu_4} p_4^{\mu_3} - \eta_{\mu_3\mu_4} p_4^{\mu_2}) \\
& - \frac{4i\bar{g}^2 v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \tilde{W}} (p_2^{\alpha_1} + p_3^{\alpha_1} + p_4^{\alpha_1}) \epsilon_{\mu_4\mu_2\mu_3\alpha_1} \\
& - \frac{2i\bar{g}\bar{g}'v}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \tilde{W}B} p_4^{\alpha_1} \epsilon_{\mu_4\mu_2\mu_3\alpha_1}
\end{aligned}$$



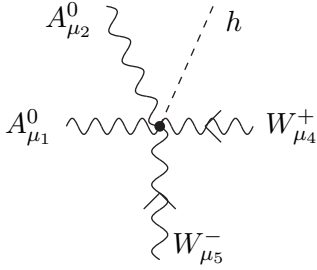
$$+90ivC^\varphi$$



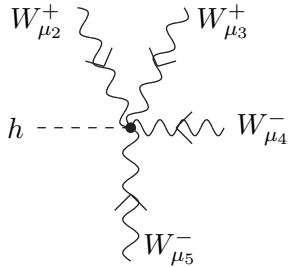
$$\begin{aligned}
& -\frac{4i\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi W} (\eta_{\mu_1\mu_4} p_1^{\mu_5} - \eta_{\mu_1\mu_4} p_4^{\mu_5} - \eta_{\mu_1\mu_5} p_1^{\mu_4} + \eta_{\mu_1\mu_5} p_5^{\mu_4} \\
& + \eta_{\mu_4\mu_5} p_4^{\mu_1} - \eta_{\mu_4\mu_5} p_5^{\mu_1}) + \frac{2i\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi WB} (\eta_{\mu_1\mu_4} p_1^{\mu_5} - \eta_{\mu_1\mu_5} p_1^{\mu_4}) \\
& + \frac{4i\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W}} (p_1^{\alpha_1} + p_4^{\alpha_1} + p_5^{\alpha_1}) \epsilon_{\mu_1\mu_5\mu_4\alpha_1} \\
& - \frac{2i\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W} B} p_1^{\alpha_1} \epsilon_{\mu_1\mu_5\mu_4\alpha_1}
\end{aligned}$$



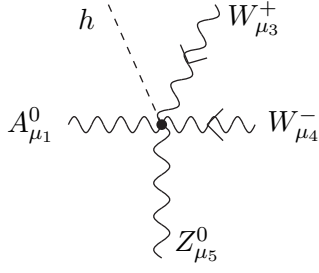
$$\begin{aligned}
& -\frac{4i\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi W} (\eta_{\mu_3\mu_4} p_3^{\mu_5} - \eta_{\mu_3\mu_4} p_4^{\mu_5} - \eta_{\mu_3\mu_5} p_3^{\mu_4} + \eta_{\mu_3\mu_5} p_5^{\mu_4} \\
& + \eta_{\mu_4\mu_5} p_4^{\mu_3} - \eta_{\mu_4\mu_5} p_5^{\mu_3}) - \frac{2i\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi WB} (\eta_{\mu_3\mu_5} p_5^{\mu_4} - \eta_{\mu_4\mu_5} p_5^{\mu_3}) \\
& - \frac{4i\bar{g}^2}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W}} (p_3^{\alpha_1} + p_4^{\alpha_1} + p_5^{\alpha_1}) \epsilon_{\mu_5\mu_3\mu_4\alpha_1} \\
& - \frac{2i\bar{g}\bar{g}'}{\sqrt{\bar{g}^2 + \bar{g}'^2}} C^{\varphi \widetilde{W} B} p_5^{\alpha_1} \epsilon_{\mu_5\mu_3\mu_4\alpha_1}
\end{aligned}$$



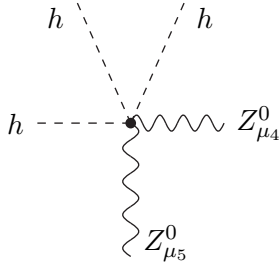
$$-\frac{4i\bar{g}^2\bar{g}'^2v}{\bar{g}^2 + \bar{g}'^2} (\eta_{\mu_1\mu_5}\eta_{\mu_2\mu_4} + \eta_{\mu_1\mu_4}\eta_{\mu_2\mu_5} - 2\eta_{\mu_1\mu_2}\eta_{\mu_4\mu_5}) C^{\varphi W}$$



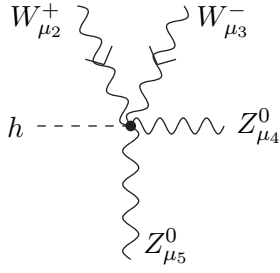
$$+4i\bar{g}^2v (\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5} - 2\eta_{\mu_2\mu_3}\eta_{\mu_4\mu_5}) C^{\varphi W}$$



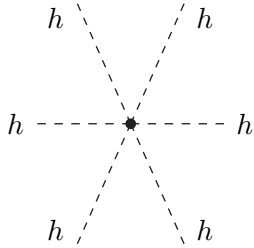
$$+ \frac{4i\bar{g}^3\bar{g}'v}{\bar{g}^2 + \bar{g}'^2} (2\eta_{\mu_1\mu_5}\eta_{\mu_3\mu_4} - \eta_{\mu_1\mu_4}\eta_{\mu_3\mu_5} - \eta_{\mu_1\mu_3}\eta_{\mu_4\mu_5}) C^{\varphi W}$$



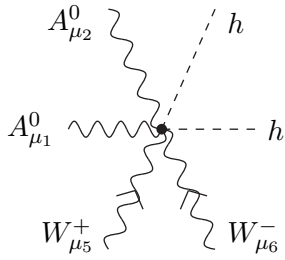
$$+ 3iv (\bar{g}^2 + \bar{g}'^2) \eta_{\mu_4\mu_5} C^{\varphi D}$$



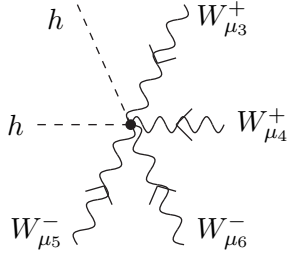
$$- \frac{4i\bar{g}^4v}{\bar{g}^2 + \bar{g}'^2} (\eta_{\mu_2\mu_5}\eta_{\mu_3\mu_4} + \eta_{\mu_2\mu_4}\eta_{\mu_3\mu_5} - 2\eta_{\mu_2\mu_3}\eta_{\mu_4\mu_5}) C^{\varphi W}$$



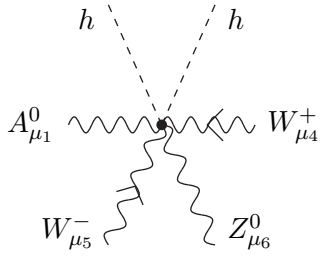
$$+ 90i C^{\varphi}$$



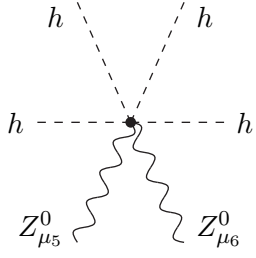
$$- \frac{4i\bar{g}^2\bar{g}'^2}{\bar{g}^2 + \bar{g}'^2} (\eta_{\mu_1\mu_6}\eta_{\mu_2\mu_5} + \eta_{\mu_1\mu_5}\eta_{\mu_2\mu_6} - 2\eta_{\mu_1\mu_2}\eta_{\mu_5\mu_6}) C^{\varphi W}$$



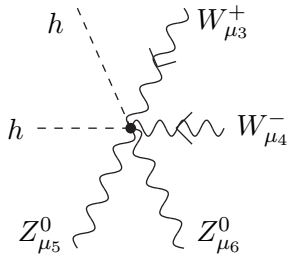
$$+4i\bar{g}^2 (\eta_{\mu_3\mu_6}\eta_{\mu_4\mu_5} + \eta_{\mu_3\mu_5}\eta_{\mu_4\mu_6} - 2\eta_{\mu_3\mu_4}\eta_{\mu_5\mu_6}) C^{\varphi W}$$



$$+\frac{4i\bar{g}^3\bar{g}'}{\bar{g}^2 + \bar{g}'^2} (2\eta_{\mu_1\mu_6}\eta_{\mu_4\mu_5} - \eta_{\mu_1\mu_5}\eta_{\mu_4\mu_6} - \eta_{\mu_1\mu_4}\eta_{\mu_5\mu_6}) C^{\varphi W}$$

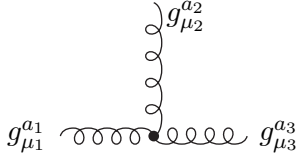


$$+3i(\bar{g}^2 + \bar{g}'^2) \eta_{\mu_5\mu_6} C^{\varphi D}$$

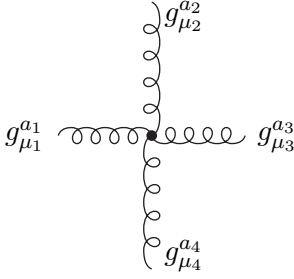


$$-\frac{4i\bar{g}^4}{\bar{g}^2 + \bar{g}'^2} (\eta_{\mu_3\mu_6}\eta_{\mu_4\mu_5} + \eta_{\mu_3\mu_5}\eta_{\mu_4\mu_6} - 2\eta_{\mu_3\mu_4}\eta_{\mu_5\mu_6}) C^{\varphi W}$$

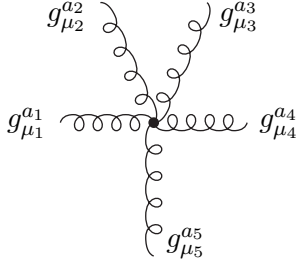
A.8 Gluon self interaction vertices



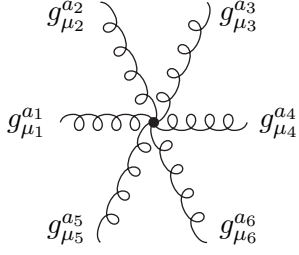
$$\begin{aligned}
& -\bar{g}_s f_{a_1 a_2 a_3} (\eta_{\mu_1 \mu_2} p_1^{\mu_3} - \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \eta_{\mu_1 \mu_3} p_3^{\mu_2} \\
& + \eta_{\mu_2 \mu_3} p_2^{\mu_1} - \eta_{\mu_2 \mu_3} p_3^{\mu_1}) + 6f_{a_1 a_2 a_3} C^G (p_1 \cdot p_2 \eta_{\mu_1 \mu_3} p_3^{\mu_2} \\
& - p_1 \cdot p_2 \eta_{\mu_2 \mu_3} p_3^{\mu_1} - p_1 \cdot p_3 \eta_{\mu_1 \mu_2} p_2^{\mu_3} + p_1 \cdot p_3 \eta_{\mu_2 \mu_3} p_2^{\mu_1} \\
& + p_1^{\mu_3} (p_2 \cdot p_3 \eta_{\mu_1 \mu_2} - p_2^{\mu_1} p_3^{\mu_2}) + p_1^{\mu_2} (p_2^{\mu_3} p_3^{\mu_1} - p_2 \cdot p_3 \eta_{\mu_1 \mu_3})) \\
& + 2f_{a_1 a_2 a_3} C^{\tilde{G}} \left(p_1 \cdot p_2 p_3^{\alpha_1} \epsilon_{\mu_1 \mu_2 \mu_3 \alpha_1} + p_1 \cdot p_3 p_2^{\alpha_1} \epsilon_{\mu_1 \mu_2 \mu_3 \alpha_1} \right. \\
& + p_2 \cdot p_3 p_1^{\alpha_1} \epsilon_{\mu_1 \mu_2 \mu_3 \alpha_1} + \eta_{\mu_1 \mu_2} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_3 \alpha_1 \beta_1 \gamma_1} \\
& + \eta_{\mu_1 \mu_3} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_2 \alpha_1 \beta_1 \gamma_1} + \eta_{\mu_2 \mu_3} p_1^{\alpha_1} p_2^{\beta_1} p_3^{\gamma_1} \epsilon_{\mu_1 \alpha_1 \beta_1 \gamma_1} \\
& + p_1^{\alpha_1} p_3^{\beta_1} p_2^{\mu_1} (-\epsilon_{\mu_2 \mu_3 \alpha_1 \beta_1}) + p_3^{\beta_1} (p_2^{\alpha_1} p_1^{\mu_3} + p_1^{\alpha_1} p_2^{\mu_3}) \epsilon_{\mu_1 \mu_2 \alpha_1 \beta_1} \\
& - p_1^{\alpha_1} p_2^{\beta_1} p_3^{\mu_1} \epsilon_{\mu_2 \mu_3 \alpha_1 \beta_1} + \epsilon_{\mu_1 \mu_3 \alpha_1 \beta_1} \left(p_2^{\alpha_1} p_3^{\beta_1} p_1^{\mu_2} - p_1^{\alpha_1} p_2^{\beta_1} p_3^{\mu_2} \right) \Big) \\
& + 2v^2 \bar{g}_s f_{a_1 a_2 a_3} C^{\varphi \tilde{G}} (p_1^{\alpha_1} + p_2^{\alpha_1} + p_3^{\alpha_1}) \epsilon_{\mu_1 \mu_2 \mu_3 \alpha_1}
\end{aligned}$$



$$\begin{aligned}
& + i\bar{g}_s^2 ((\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4}) f_{a_1a_2b_1} f_{a_3a_4b_1} \\
& + (\eta_{\mu_1\mu_4}\eta_{\mu_2\mu_3} - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) f_{a_1a_3b_1} f_{a_2a_4b_1} \\
& + (\eta_{\mu_1\mu_3}\eta_{\mu_2\mu_4} - \eta_{\mu_1\mu_2}\eta_{\mu_3\mu_4}) f_{a_1a_4b_1} f_{a_2a_3b_1}) \\
& - 6i\bar{g}_s C^G (f_{a_1a_4b_1} f_{a_2a_3b_1} (-p_2^{\mu_4} p_3^{\mu_2} \eta_{\mu_1\mu_3} + \eta_{\mu_2\mu_4} p_1 \cdot p_4 \eta_{\mu_1\mu_3} \\
& + \eta_{\mu_2\mu_4} p_2 \cdot p_3 \eta_{\mu_1\mu_3} + p_1^{\mu_4} (p_4^{\mu_3} \eta_{\mu_1\mu_2} - p_4^{\mu_2} \eta_{\mu_1\mu_3}) + p_1^{\mu_3} p_4^{\mu_2} \eta_{\mu_1\mu_4} - p_1^{\mu_2} p_4^{\mu_3} \eta_{\mu_1\mu_4} \\
& + p_2^{\mu_4} p_3^{\mu_1} \eta_{\mu_2\mu_3} - p_2^{\mu_1} p_3^{\mu_4} \eta_{\mu_2\mu_3} - p_1^{\mu_3} p_4^{\mu_1} \eta_{\mu_2\mu_4} + p_2^{\mu_3} (p_3^{\mu_4} \eta_{\mu_1\mu_2} - p_3^{\mu_1} \eta_{\mu_2\mu_4}) \\
& + p_2^{\mu_1} p_3^{\mu_2} \eta_{\mu_3\mu_4} + p_1^{\mu_2} p_4^{\mu_1} \eta_{\mu_3\mu_4} - \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_4} p_1 \cdot p_4 - \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_4} p_2 \cdot p_3) \\
& + f_{a_1a_3b_1} f_{a_2a_4b_1} (p_1^{\mu_4} p_3^{\mu_2} \eta_{\mu_1\mu_3} - p_1^{\mu_2} p_3^{\mu_4} \eta_{\mu_1\mu_3} - p_2^{\mu_3} p_4^{\mu_2} \eta_{\mu_1\mu_4} \\
& + p_1^{\mu_3} (p_3^{\mu_4} \eta_{\mu_1\mu_2} - p_3^{\mu_2} \eta_{\mu_1\mu_4}) - p_1^{\mu_4} p_3^{\mu_1} \eta_{\mu_2\mu_3} + p_2^{\mu_4} (p_4^{\mu_3} \eta_{\mu_1\mu_2} - p_4^{\mu_2} \eta_{\mu_2\mu_3}) \\
& + p_2^{\mu_3} p_4^{\mu_1} \eta_{\mu_2\mu_4} - p_2^{\mu_1} p_4^{\mu_3} \eta_{\mu_2\mu_4} + p_1^{\mu_2} p_3^{\mu_1} \eta_{\mu_3\mu_4} + p_2^{\mu_1} p_4^{\mu_2} \eta_{\mu_3\mu_4} + \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} p_1 \cdot p_3 \\
& - \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_4} p_1 \cdot p_3 + \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} p_2 \cdot p_4 - \eta_{\mu_1\mu_2} \eta_{\mu_3\mu_4} p_2 \cdot p_4) \\
& + f_{a_1a_2b_1} f_{a_3a_4b_1} (p_1^{\mu_2} p_2^{\mu_4} \eta_{\mu_1\mu_3} + p_3^{\mu_4} p_4^{\mu_2} \eta_{\mu_1\mu_3} - \eta_{\mu_2\mu_4} p_1 \cdot p_2 \eta_{\mu_1\mu_3} \\
& - \eta_{\mu_2\mu_4} p_3 \cdot p_4 \eta_{\mu_1\mu_3} - p_1^{\mu_2} p_2^{\mu_3} \eta_{\mu_1\mu_4} - p_3^{\mu_2} p_4^{\mu_3} \eta_{\mu_1\mu_4} - p_3^{\mu_4} p_4^{\mu_1} \eta_{\mu_2\mu_3} \\
& + p_1^{\mu_4} (p_2^{\mu_3} \eta_{\mu_1\mu_2} - p_2^{\mu_2} \eta_{\mu_2\mu_3}) + p_3^{\mu_4} p_4^{\mu_3} \eta_{\mu_2\mu_4} + p_1^{\mu_3} (p_2^{\mu_4} \eta_{\mu_2\mu_4} - p_2^{\mu_2} \eta_{\mu_1\mu_2}) \\
& + p_3^{\mu_2} p_4^{\mu_1} \eta_{\mu_3\mu_4} - p_3^{\mu_1} p_4^{\mu_2} \eta_{\mu_3\mu_4} + \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} p_1 \cdot p_2 + \eta_{\mu_1\mu_4} \eta_{\mu_2\mu_3} p_3 \cdot p_4)) \\
& - 2i\bar{g}_s C^{\tilde{G}} \left(-\epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_1^{\mu_4} p_2^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\mu_1} p_2^{\alpha_1} \right. \\
& - \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\mu_4} p_2^{\alpha_1} - \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_4^{\mu_1} p_2^{\alpha_1} \\
& - \epsilon_{\mu_3\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\beta_1} \eta_{\mu_1\mu_2} p_2^{\alpha_1} + \epsilon_{\mu_3\mu_4\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_4^{\beta_1} \eta_{\mu_1\mu_2} p_2^{\alpha_1} \\
& - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\beta_1} \eta_{\mu_1\mu_3} p_2^{\alpha_1} - \epsilon_{\mu_2\mu_3\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_4^{\beta_1} \eta_{\mu_1\mu_4} p_2^{\alpha_1} - \epsilon_{\mu_1\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\beta_1} \eta_{\mu_1\mu_4} p_2^{\alpha_1} \\
& - \epsilon_{\mu_1\mu_4\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_4^{\beta_1} \eta_{\mu_2\mu_3} p_2^{\alpha_1} - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\beta_1} \eta_{\mu_2\mu_4} p_2^{\alpha_1} - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_4^{\beta_1} \eta_{\mu_2\mu_4} p_2^{\alpha_1} \\
& - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} p_2^{\alpha_1} - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_4^{\beta_1} \eta_{\mu_3\mu_4} p_2^{\alpha_1} - \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\mu_1} p_2^{\alpha_1} \\
& - \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_1^{\mu_4} p_2^{\alpha_1} + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\mu_4} p_3^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\mu_1} p_2^{\alpha_1} \\
& - \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_2^{\mu_4} p_3^{\alpha_1} + \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\alpha_1} p_3^{\mu_1} + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\mu_1} p_3^{\alpha_1} \\
& + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\mu_4} p_4^{\alpha_1} - \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_2^{\mu_1} p_4^{\alpha_1} - \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_2^{\mu_1} p_4^{\alpha_1} \\
& + \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3^{\mu_1} p_4^{\alpha_1} + \epsilon_{\mu_1\mu_2\mu_3\alpha_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3^{\mu_4} p_4^{\alpha_1} - \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_3^{\mu_1} p_4^{\alpha_1} \\
& + \epsilon_{\mu_2\mu_3\mu_4\alpha_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3^{\alpha_1} p_4^{\mu_1} + \epsilon_{\mu_1\mu_3\mu_4\alpha_1} (f_{a_1a_4b_1} f_{a_2a_3b_1} (p_2^{\alpha_1} p_3^{\mu_2} - p_1^{\mu_2} p_4^{\alpha_1} - p_1^{\alpha_1} p_4^{\mu_2})) \\
& + f_{a_1a_3b_1} f_{a_2a_4b_1} (p_1^{\mu_2} p_3^{\alpha_1} + p_1^{\alpha_1} p_3^{\mu_2} - p_2^{\alpha_1} p_4^{\mu_2}) + f_{a_1a_2b_1} f_{a_3a_4b_1} (p_1^{\mu_2} p_2^{\alpha_1} - p_3^{\mu_2} p_4^{\alpha_1} - p_3^{\alpha_1} p_4^{\mu_2})) \\
& + \epsilon_{\mu_1\mu_2\mu_4\alpha_1} (f_{a_1a_4b_1} f_{a_2a_3b_1} (-p_2^{\mu_3} p_3^{\alpha_1} + p_1^{\mu_3} p_4^{\alpha_1} + p_1^{\alpha_1} p_4^{\mu_3}) + f_{a_1a_3b_1} f_{a_2a_4b_1} (p_1^{\mu_3} p_3^{\alpha_1} - p_2^{\mu_3} p_4^{\alpha_1} \\
& + f_{a_1a_2b_1} f_{a_3a_4b_1} (p_1^{\mu_3} p_2^{\alpha_1} + p_1^{\alpha_1} p_2^{\mu_3} - p_3^{\alpha_1} p_4^{\mu_3})) - \epsilon_{\mu_3\mu_4\alpha_1\beta_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_1^{\alpha_1} p_2^{\beta_1} \eta_{\mu_1\mu_2} \\
& - \epsilon_{\mu_3\mu_4\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_2} + \epsilon_{\mu_3\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_2} - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_3} \\
& - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_3} - \epsilon_{\mu_2\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_3} + \epsilon_{\mu_2\mu_4\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_1\mu_4} \\
& - \epsilon_{\mu_2\mu_3\alpha_1\beta_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_1^{\alpha_1} p_2^{\beta_1} \eta_{\mu_1\mu_4} - \epsilon_{\mu_2\mu_3\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_1\mu_4} - \epsilon_{\mu_2\mu_3\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_3} \\
& - \epsilon_{\mu_1\mu_4\alpha_1\beta_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_3} + \epsilon_{\mu_1\mu_3\alpha_1\beta_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_1^{\alpha_1} p_2^{\beta_1} \eta_{\mu_2\mu_4} - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_2^{\beta_1} \eta_{\mu_2\mu_4} \\
& - \epsilon_{\mu_1\mu_3\alpha_1\beta_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3^{\alpha_1} p_4^{\beta_1} \eta_{\mu_2\mu_4} + \epsilon_{\mu_1\mu_2\alpha_1\beta_1} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} + \epsilon_{\mu_1\mu_2\alpha_1\beta_1} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1^{\alpha_1} p_3^{\beta_1} \eta_{\mu_3\mu_4} \\
& - \epsilon_{\mu_1\mu_2\alpha_1\beta_1} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3^{\alpha_1} p_4^{\beta_1} \eta_{\mu_3\mu_4} - \epsilon_{\mu_1\mu_2\mu_3\mu_4} f_{a_1a_2b_1} f_{a_3a_4b_1} p_1 \cdot p_2 + \epsilon_{\mu_1\mu_2\mu_3\mu_4} f_{a_1a_3b_1} f_{a_2a_4b_1} p_1 \cdot p_2 \\
& - \epsilon_{\mu_1\mu_2\mu_3\mu_4} f_{a_1a_4b_1} f_{a_2a_3b_1} p_1 \cdot p_4 - \epsilon_{\mu_1\mu_2\mu_3\mu_4} f_{a_1a_4b_1} f_{a_2a_3b_1} p_2 \cdot p_3 + \epsilon_{\mu_1\mu_2\mu_3\mu_4} f_{a_1a_3b_1} f_{a_2a_4b_1} p_2 \cdot p_3 \\
& - \epsilon_{\mu_1\mu_2\mu_3\mu_4} f_{a_1a_2b_1} f_{a_3a_4b_1} p_3 \cdot p_4) \\
& + 2iv^2 \bar{g}_s^2 \epsilon_{\mu_1\mu_2\mu_3\mu_4} C^{\varphi\tilde{G}} (f_{a_1a_4b_1} f_{a_2a_3b_1} - f_{a_1a_3b_1} f_{a_2a_4b_1} + f_{a_1a_2b_1} f_{a_3a_4b_1})
\end{aligned}$$

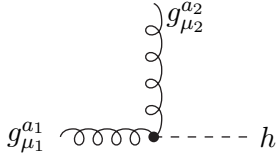


+LongExpressionNotDisplayed

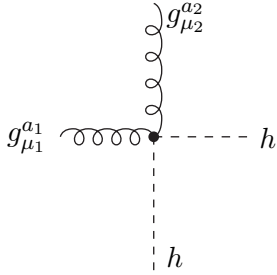


+LongExpressionNotDisplayed

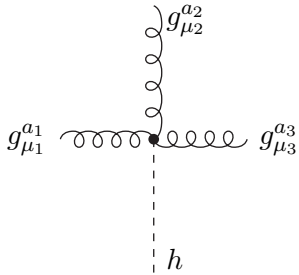
A.9 Higgs-gluon vertices



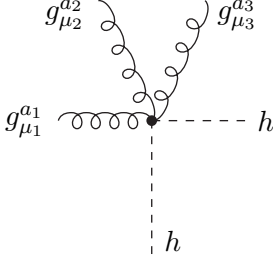
$$+4iv\delta_{a_1 a_2} C^{\varphi G} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) + 4iv\delta_{a_1 a_2} C^{\varphi \tilde{G}} p_1^{\alpha_1} p_2^{\beta_1} \epsilon_{\mu_1 \mu_2 \alpha_1 \beta_1}$$



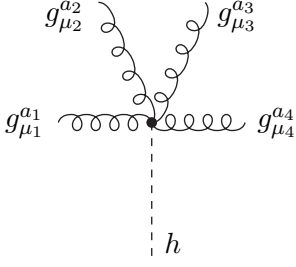
$$+4i\delta_{a_1 a_2} C^{\varphi G} (p_1^{\mu_2} p_2^{\mu_1} - p_1 \cdot p_2 \eta_{\mu_1 \mu_2}) + 4i\delta_{a_1 a_2} C^{\varphi \tilde{G}} p_1^{\alpha_1} p_2^{\beta_1} \epsilon_{\mu_1 \mu_2 \alpha_1 \beta_1}$$



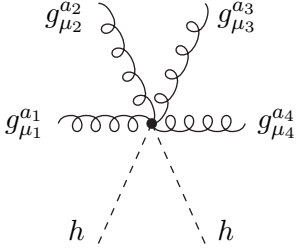
$$+4v\bar{g}_s f_{a_1 a_2 a_3} C^{\varphi G} (\eta_{\mu_1 \mu_2} p_1^{\mu_3} - \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \eta_{\mu_1 \mu_3} p_3^{\mu_2} \\ + \eta_{\mu_2 \mu_3} p_2^{\mu_1} - \eta_{\mu_2 \mu_3} p_3^{\mu_1}) + 4v\bar{g}_s f_{a_1 a_2 a_3} C^{\varphi \tilde{G}} (p_1^{\alpha_1} + p_2^{\alpha_1} + p_3^{\alpha_1}) \epsilon_{\mu_1 \mu_2 \mu_3 \alpha_1}$$



$$+4\bar{g}_s f_{a_1 a_2 a_3} C^{\varphi G} (\eta_{\mu_1 \mu_2} p_1^{\mu_3} - \eta_{\mu_1 \mu_2} p_2^{\mu_3} - \eta_{\mu_1 \mu_3} p_1^{\mu_2} + \eta_{\mu_1 \mu_3} p_3^{\mu_2} \\ + \eta_{\mu_2 \mu_3} p_2^{\mu_1} - \eta_{\mu_2 \mu_3} p_3^{\mu_1}) + 4\bar{g}_s f_{a_1 a_2 a_3} C^{\varphi \tilde{G}} (p_1^{\alpha_1} + p_2^{\alpha_1} + p_3^{\alpha_1}) \epsilon_{\mu_1 \mu_2 \mu_3 \alpha_1}$$

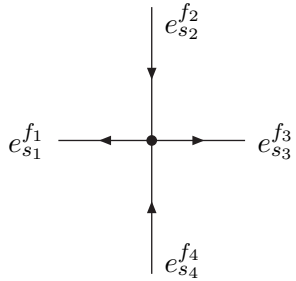


$$-4iv\bar{g}_s^2 C^{\varphi G} ((\eta_{\mu_1 \mu_4} \eta_{\mu_2 \mu_3} - \eta_{\mu_1 \mu_3} \eta_{\mu_2 \mu_4}) f_{a_1 a_2 b_1} f_{a_3 a_4 b_1} \\ + (\eta_{\mu_1 \mu_4} \eta_{\mu_2 \mu_3} - \eta_{\mu_1 \mu_2} \eta_{\mu_3 \mu_4}) f_{a_1 a_3 b_1} f_{a_2 a_4 b_1} \\ + (\eta_{\mu_1 \mu_3} \eta_{\mu_2 \mu_4} - \eta_{\mu_1 \mu_2} \eta_{\mu_3 \mu_4}) f_{a_1 a_4 b_1} f_{a_2 a_3 b_1}) \\ + 4iv\bar{g}_s^2 \epsilon_{\mu_1 \mu_2 \mu_3 \mu_4} C^{\varphi \tilde{G}} (f_{a_1 a_4 b_1} f_{a_2 a_3 b_1} - f_{a_1 a_3 b_1} f_{a_2 a_4 b_1} + f_{a_1 a_2 b_1} f_{a_3 a_4 b_1})$$

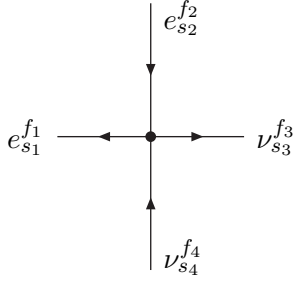


$$-4i\bar{g}_s^2 C^{\varphi G} ((\eta_{\mu_1 \mu_4} \eta_{\mu_2 \mu_3} - \eta_{\mu_1 \mu_3} \eta_{\mu_2 \mu_4}) f_{a_1 a_2 b_1} f_{a_3 a_4 b_1} \\ + (\eta_{\mu_1 \mu_4} \eta_{\mu_2 \mu_3} - \eta_{\mu_1 \mu_2} \eta_{\mu_3 \mu_4}) f_{a_1 a_3 b_1} f_{a_2 a_4 b_1} \\ + (\eta_{\mu_1 \mu_3} \eta_{\mu_2 \mu_4} - \eta_{\mu_1 \mu_2} \eta_{\mu_3 \mu_4}) f_{a_1 a_4 b_1} f_{a_2 a_3 b_1}) \\ + 4i\bar{g}_s^2 \epsilon_{\mu_1 \mu_2 \mu_3 \mu_4} C^{\varphi \tilde{G}} (f_{a_1 a_4 b_1} f_{a_2 a_3 b_1} - f_{a_1 a_3 b_1} f_{a_2 a_4 b_1} + f_{a_1 a_2 b_1} f_{a_3 a_4 b_1})$$

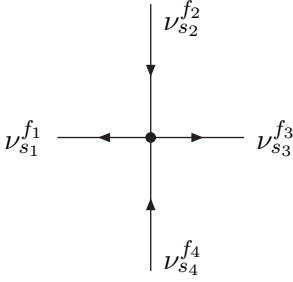
A.10 Four lepton vertices



$$-2i (C_{f_1 f_4 f_3 f_2}^e (\gamma^\mu P_R)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} \\ - C_{f_1 f_2 f_3 f_4}^e (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4}) \\ + i (C_{f_3 f_4 f_1 f_2}^{le} (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} - C_{f_3 f_2 f_1 f_4}^{le} (\gamma^\mu P_L)_{s_3 s_2} (\gamma_\mu P_R)_{s_1 s_4} \\ - C_{f_1 f_4 f_3 f_2}^{le} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} + C_{f_1 f_2 f_3 f_4}^{le} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4}) \\ - 2i (C_{f_1 f_4 f_3 f_2}^{ll} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \\ - C_{f_1 f_2 f_3 f_4}^{ll} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4})$$

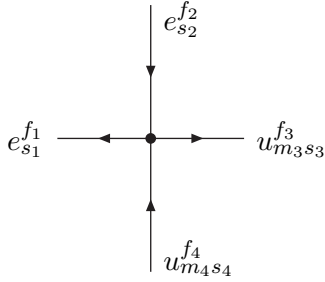


$$+i(\gamma^\mu P_R)_{s_1 s_2} C_{g_1 g_2 f_1 f_2}^{le} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4}) \\ + 2i(\gamma^\mu P_L)_{s_1 s_2} C_{f_1 f_2 g_1 g_2}^{ll} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4})$$

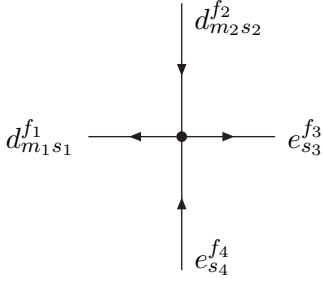


$$-2i \left(C_{g_1 g_3 g_2 g_4}^{ll} (U_{g_3 f_3} U_{g_1 f_1}^* (\gamma^\mu P_L)_{s_1 s_3} \right. \\ - U_{g_3 f_1} U_{g_1 f_3}^* (\gamma^\mu P_R)_{s_1 s_3}) (U_{g_4 f_4} U_{g_2 f_2}^* (\gamma^\mu P_L)_{s_2 s_4} \\ - U_{g_4 f_2} U_{g_2 f_4}^* (\gamma^\mu P_R)_{s_2 s_4}) + C_{g_1 g_4 g_3 g_2}^{ll} (U_{g_4 f_4} U_{g_1 f_1}^* (\gamma^\mu P_L)_{s_1 s_4} \\ - U_{g_4 f_1} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_1 s_4}) (U_{g_2 f_2} U_{g_3 f_3}^* (\gamma^\mu P_L)_{s_3 s_2} \\ - U_{g_2 f_3} U_{g_3 f_2}^* (\gamma^\mu P_R)_{s_3 s_2}) - C_{g_1 g_2 g_3 g_4}^{ll} (U_{g_2 f_2} U_{g_1 f_1}^* (\gamma^\mu P_L)_{s_1 s_2} \\ - U_{g_2 f_1} U_{g_1 f_2}^* (\gamma^\mu P_R)_{s_1 s_2}) (U_{g_4 f_4} U_{g_3 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} \\ \left. - U_{g_4 f_3} U_{g_3 f_4}^* (\gamma^\mu P_R)_{s_3 s_4}) \right)$$

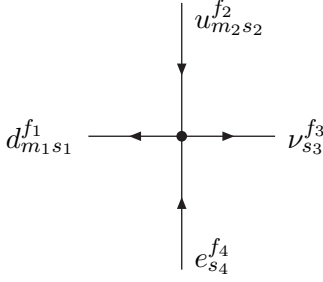
A.11 Two quark–two lepton vertices



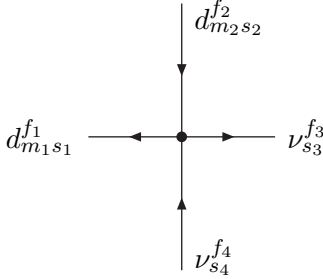
$$+iC_{f_1 f_2 f_3 f_4}^{eu} (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \\ - i \left((P_L)_{s_1 s_2} (P_L)_{s_3 s_4} K_{f_4 g_1}^* C_{f_2 f_1 g_1 f_3}^{lequ1*} \right. \\ \left. + (P_R)_{s_1 s_2} (P_R)_{s_3 s_4} K_{f_3 g_1} C_{f_1 f_2 g_1 f_4}^{lequ1} \right) \\ - i \left(K_{f_4 g_1}^* (\sigma^{\mu\nu} P_L)_{s_1 s_2} (\sigma_{\mu\nu} P_L)_{s_3 s_4} C_{f_2 f_1 g_1 f_3}^{lequ3*} \right. \\ \left. + K_{f_3 g_1} C_{f_1 f_2 g_1 f_4}^{lequ3} (\sigma^{\mu\nu} P_R)_{s_1 s_2} (\sigma_{\mu\nu} P_R)_{s_3 s_4} \right) \\ + iK_{f_3 g_1} K_{f_4 g_2}^* (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} C_{f_1 f_2 g_1 g_2}^{lq1} \\ - iK_{f_3 g_1} K_{f_4 g_2}^* (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} C_{f_1 f_2 g_1 g_2}^{lq3} \\ + iC_{f_1 f_2 f_3 f_4}^{lu} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \\ + iK_{f_3 g_2} K_{f_4 g_1}^* (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} C_{g_2 g_1 f_1 f_2}^{qe}$$



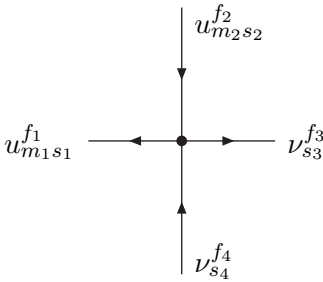
$$\begin{aligned}
& + i C_{f_3 f_4 f_1 f_2}^{ed} (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} + i C_{f_3 f_4 f_1 f_2}^{ld} (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} \\
& + i \left((P_L)_{s_3 s_4} (P_R)_{s_1 s_2} C_{f_4 f_3 f_2 f_1}^{ledq*} + (P_L)_{s_1 s_2} (P_R)_{s_3 s_4} C_{f_3 f_4 f_1 f_2}^{ledq} \right) \\
& + i C_{f_3 f_4 f_1 f_2}^{lq1} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} + i C_{f_3 f_4 f_1 f_2}^{lq3} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} \\
& + i C_{f_1 f_2 f_3 f_4}^{qe} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4}
\end{aligned}$$



$$\begin{aligned}
& + i (P_L)_{s_1 s_2} (P_R)_{s_3 s_4} U_{g_1 f_3}^* K_{f_2 g_2}^* C_{g_1 f_4 f_1 g_2}^{ledq} \\
& + i (P_R)_{s_1 s_2} (P_R)_{s_3 s_4} U_{g_1 f_3}^* C_{g_1 f_4 f_1 f_2}^{lequ1} \\
& + i U_{g_1 f_3}^* C_{g_1 f_4 f_1 f_2}^{lequ3} (\sigma^{\mu\nu} P_R)_{s_1 s_2} (\sigma_{\mu\nu} P_R)_{s_3 s_4} \\
& + 2i U_{g_1 f_3}^* K_{f_2 g_2}^* (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} C_{g_1 f_4 f_1 g_2}^{lq3}
\end{aligned}$$

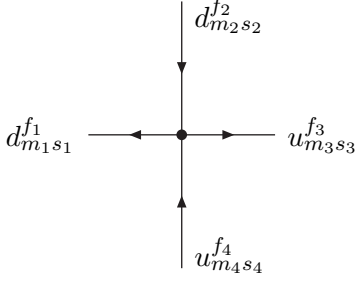


$$\begin{aligned}
& + i (\gamma^\mu P_R)_{s_1 s_2} C_{g_1 g_2 f_1 f_2}^{ld} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4}) \\
& + i (\gamma^\mu P_L)_{s_1 s_2} C_{g_1 g_2 f_1 f_2}^{lq1} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4}) \\
& - i (\gamma^\mu P_L)_{s_1 s_2} C_{g_1 g_2 f_1 f_2}^{lq3} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4})
\end{aligned}$$

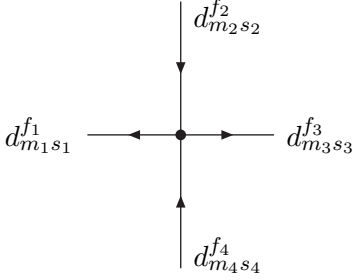


$$\begin{aligned}
& + i K_{f_1 g_3} K_{f_2 g_4}^* (\gamma^\mu P_L)_{s_1 s_2} C_{g_1 g_2 g_3 g_4}^{lq1} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} \\
& - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4}) \\
& + i K_{f_1 g_3} K_{f_2 g_4}^* (\gamma^\mu P_L)_{s_1 s_2} C_{g_1 g_2 g_3 g_4}^{lq3} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} \\
& - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4}) \\
& + i (\gamma^\mu P_R)_{s_1 s_2} C_{g_1 g_2 f_1 f_2}^{lu} (U_{g_2 f_4} U_{g_1 f_3}^* (\gamma^\mu P_L)_{s_3 s_4} \\
& - U_{g_2 f_3} U_{g_1 f_4}^* (\gamma^\mu P_R)_{s_3 s_4})
\end{aligned}$$

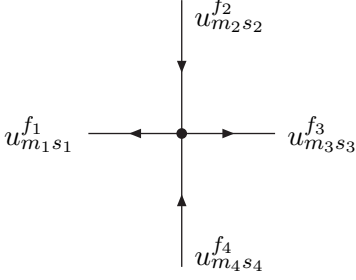
A.12 Four quark vertices



$$\begin{aligned}
& + i\delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_3 g_2} K_{f_4 g_1}^* (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} C_{g_2 g_1 f_1 f_2}^{qd1} \\
& + \frac{i}{6} (3\delta_{m_1 m_4} \delta_{m_2 m_3} - \delta_{m_1 m_2} \delta_{m_3 m_4}) K_{f_3 g_2} K_{f_4 g_1}^* (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} C_{g_2 g_1 f_1 f_2}^{qd8} \\
& + 2i\delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_3 g_2} K_{f_4 g_1}^* (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} C_{f_1 f_2 g_2 g_1}^{qq1} \\
& - 2iK_{f_3 g_2} K_{f_4 g_1}^* \left(2\delta_{m_1 m_4} \delta_{m_2 m_3} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} C_{f_1 g_1 g_2 f_2}^{qq3} \right. \\
& \left. + \delta_{m_1 m_2} \delta_{m_3 m_4} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} C_{f_1 f_2 g_2 g_1}^{qq3} \right) \\
& + i\delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{qu1} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \\
& + \frac{i}{6} (3\delta_{m_1 m_4} \delta_{m_2 m_3} - \delta_{m_1 m_2} \delta_{m_3 m_4}) C_{f_1 f_2 f_3 f_4}^{qu8} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \\
& + i \left(\delta_{m_1 m_4} \delta_{m_2 m_3} (P_L)_{s_1 s_4} (P_L)_{s_3 s_2} K_{f_4 g_1}^* C_{f_2 f_3 g_1 f_1}^{quqd1*} \right. \\
& + \delta_{m_1 m_2} \delta_{m_3 m_4} (P_L)_{s_1 s_2} (P_L)_{s_3 s_4} K_{f_4 g_1}^* C_{g_1 f_3 f_2 f_1}^{quqd1*} \\
& + K_{f_3 g_1} \left(\delta_{m_1 m_4} \delta_{m_2 m_3} (P_R)_{s_1 s_4} (P_R)_{s_3 s_2} C_{f_1 f_4 g_1 f_2}^{quqd1} \right. \\
& \left. + \delta_{m_1 m_2} \delta_{m_3 m_4} (P_R)_{s_1 s_2} (P_R)_{s_3 s_4} C_{g_1 f_4 f_1 f_2}^{quqd1} \right) \Big) \\
& - \frac{i}{6} \left((\delta_{m_1 m_4} \delta_{m_2 m_3} - 3\delta_{m_1 m_2} \delta_{m_3 m_4}) (P_L)_{s_1 s_4} (P_L)_{s_3 s_2} K_{f_4 g_1}^* C_{f_2 f_3 g_1 f_1}^{quqd8*} \right. \\
& + (\delta_{m_1 m_2} \delta_{m_3 m_4} - 3\delta_{m_1 m_4} \delta_{m_2 m_3}) (P_L)_{s_1 s_2} (P_L)_{s_3 s_4} K_{f_4 g_1}^* C_{g_1 f_3 f_2 f_1}^{quqd8*} \\
& + K_{f_3 g_1} \left((\delta_{m_1 m_4} \delta_{m_2 m_3} - 3\delta_{m_1 m_2} \delta_{m_3 m_4}) (P_R)_{s_1 s_4} (P_R)_{s_3 s_2} C_{f_1 f_4 g_1 f_2}^{quqd8} \right. \\
& \left. + (\delta_{m_1 m_2} \delta_{m_3 m_4} - 3\delta_{m_1 m_4} \delta_{m_2 m_3}) (P_R)_{s_1 s_2} (P_R)_{s_3 s_4} C_{g_1 f_4 f_1 f_2}^{quqd8} \right) \Big) \\
& + i\delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_3 f_4 f_1 f_2}^{ud1} (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \\
& + \frac{i}{6} (3\delta_{m_1 m_4} \delta_{m_2 m_3} - \delta_{m_1 m_2} \delta_{m_3 m_4}) C_{f_3 f_4 f_1 f_2}^{ud8} (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4}
\end{aligned}$$

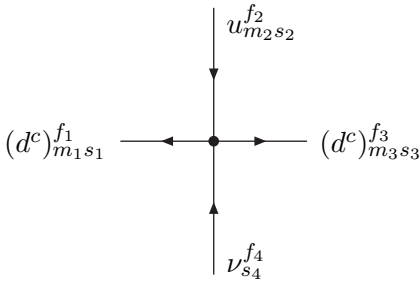


$$\begin{aligned}
& -2i \left(\delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_4 f_3 f_2}^{dd} (\gamma^\mu P_R)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} \right. \\
& \quad \left. - \delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{dd} (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \right) \\
& + i \left(\delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_3 f_4 f_1 f_2}^{qd1} (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} \right. \\
& \quad - \delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_3 f_2 f_1 f_4}^{qd1} (\gamma^\mu P_L)_{s_3 s_2} (\gamma_\mu P_R)_{s_1 s_4} \\
& \quad - \delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_4 f_3 f_2}^{qd1} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} \\
& \quad \left. + \delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{qd1} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \right) \\
& + \frac{i}{6} \left((3\delta_{m_1 m_4} \delta_{m_2 m_3} \right. \\
& \quad - \delta_{m_1 m_2} \delta_{m_3 m_4}) C_{f_3 f_4 f_1 f_2}^{qd8} (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} \\
& \quad + (\delta_{m_1 m_4} \delta_{m_2 m_3} \\
& \quad - 3\delta_{m_1 m_2} \delta_{m_3 m_4}) C_{f_3 f_2 f_1 f_4}^{qd8} (\gamma^\mu P_L)_{s_3 s_2} (\gamma_\mu P_R)_{s_1 s_4} \\
& \quad + \delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_4 f_3 f_2}^{qd8} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} \\
& \quad - 3\delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_4 f_3 f_2}^{qd8} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} \\
& \quad + 3\delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_2 f_3 f_4}^{qd8} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \\
& \quad \left. - \delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{qd8} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} \right) \\
& - 2i \left(\delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_4 f_3 f_2}^{qq1} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \right. \\
& \quad \left. - \delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{qq1} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} \right) \\
& - 2i \left(\delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_4 f_3 f_2}^{qq3} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \right. \\
& \quad \left. - \delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{qq3} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4} \right)
\end{aligned}$$

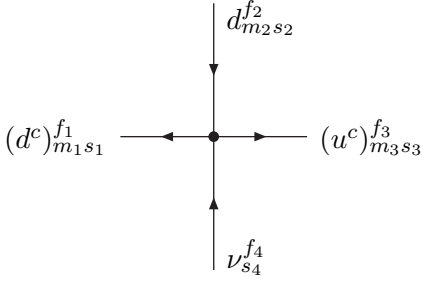


$$\begin{aligned}
& -iK_{f_2 g_1}^* K_{f_4 g_2}^* (C_{g_4 g_1 g_3 g_2}^{qq1} (\delta_{m_1 m_4} \delta_{m_2 m_3} K_{f_1 g_3} K_{f_3 g_4} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \\
& - \delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_3 g_3} K_{f_1 g_4} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4}) \\
& + C_{g_3 g_1 g_4 g_2}^{qq1} (\delta_{m_1 m_4} \delta_{m_2 m_3} K_{f_3 g_3} K_{f_1 g_4} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \\
& - \delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_1 g_3} K_{f_3 g_4} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4}) \\
& - iK_{f_2 g_1}^* K_{f_4 g_2}^* (C_{g_4 g_1 g_3 g_2}^{qq3} (\delta_{m_1 m_4} \delta_{m_2 m_3} K_{f_1 g_3} K_{f_3 g_4} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \\
& - \delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_3 g_3} K_{f_1 g_4} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4}) \\
& + C_{g_3 g_1 g_4 g_2}^{qq3} (\delta_{m_1 m_4} \delta_{m_2 m_3} K_{f_3 g_3} K_{f_1 g_4} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_L)_{s_3 s_2} \\
& - \delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_1 g_3} K_{f_3 g_4} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_L)_{s_3 s_4}) \\
& + i \left(K_{f_4 g_1}^* \left(\delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_3 g_2} (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} C_{g_2 g_1 f_1 f_2}^{qu1} \right. \right. \\
& - \delta_{m_1 m_4} \delta_{m_2 m_3} K_{f_1 g_2} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} C_{g_2 g_1 f_3 f_2}^{qu1} \\
& + K_{f_2 g_1}^* \left(\delta_{m_1 m_2} \delta_{m_3 m_4} K_{f_1 g_2} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} C_{g_2 g_1 f_3 f_4}^{qu1} \right. \\
& - \delta_{m_1 m_4} \delta_{m_2 m_3} K_{f_3 g_2} (\gamma^\mu P_L)_{s_3 s_2} (\gamma_\mu P_R)_{s_1 s_4} C_{g_2 g_1 f_1 f_4}^{qu1} \left. \left. \right) \right) \\
& + \frac{i}{6} \left(K_{f_4 g_1}^* \left((3\delta_{m_1 m_4} \delta_{m_2 m_3} - \delta_{m_1 m_2} \delta_{m_3 m_4}) K_{f_3 g_2} (\gamma^\mu P_L)_{s_3 s_4} (\gamma_\mu P_R)_{s_1 s_2} C_{g_2 g_1 f_1 f_2}^{qu8} \right. \right. \\
& + (\delta_{m_1 m_4} \delta_{m_2 m_3} - 3\delta_{m_1 m_2} \delta_{m_3 m_4}) K_{f_1 g_2} (\gamma^\mu P_L)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} C_{g_2 g_1 f_3 f_2}^{qu8} \\
& + K_{f_2 g_1}^* \left((\delta_{m_1 m_4} \delta_{m_2 m_3} - 3\delta_{m_1 m_2} \delta_{m_3 m_4}) K_{f_3 g_2} (\gamma^\mu P_L)_{s_3 s_2} (\gamma_\mu P_R)_{s_1 s_4} C_{g_2 g_1 f_1 f_4}^{qu8} \right. \\
& + (3\delta_{m_1 m_4} \delta_{m_2 m_3} - \delta_{m_1 m_2} \delta_{m_3 m_4}) K_{f_1 g_2} (\gamma^\mu P_L)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4} C_{g_2 g_1 f_3 f_4}^{qu8} \left. \left. \right) \right) \\
& - 2i (\delta_{m_1 m_4} \delta_{m_2 m_3} C_{f_1 f_4 f_3 f_2}^{uu} (\gamma^\mu P_R)_{s_1 s_4} (\gamma_\mu P_R)_{s_3 s_2} \\
& - \delta_{m_1 m_2} \delta_{m_3 m_4} C_{f_1 f_2 f_3 f_4}^{uu} (\gamma^\mu P_R)_{s_1 s_2} (\gamma_\mu P_R)_{s_3 s_4})
\end{aligned}$$

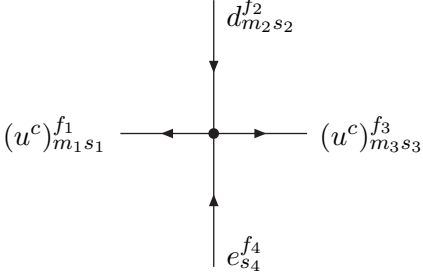
A.13 Baryon and lepton number violating four fermion vertices



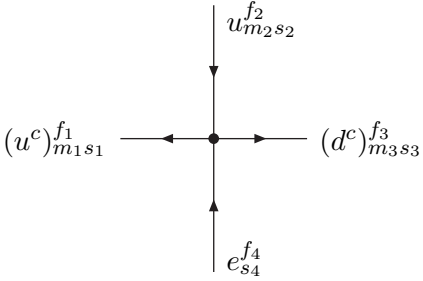
$$\begin{aligned}
& -i\epsilon_{m_1 m_2 m_3} U_{g_4 f_4} \left((P_L)_{s_3 s_4} (P_R)_{s_1 s_2} C_{f_1 f_2 f_3 g_4}^{duq} \right. \\
& + (P_L)_{s_1 s_4} (P_R)_{s_3 s_2} C_{f_3 f_2 f_1 g_4}^{duq} \\
& - i\epsilon_{m_1 m_2 m_3} U_{g_4 f_4} K_{f_2 g_2}^* \left((P_L)_{s_1 s_4} (P_L)_{s_3 s_2} C_{f_3 g_2 f_1 g_4}^{qqq} \right. \\
& + (P_L)_{s_1 s_2} (P_L)_{s_3 s_4} C_{f_1 g_2 f_3 g_4}^{qqq} \left. \right)
\end{aligned}$$



$$+i\epsilon_{m_1 m_2 m_3} (P_L)_{s_1 s_2} (P_L)_{s_3 s_4} U_{g_4 f_4} K_{f_3 g_3}^* \left(C_{f_1 f_2 g_3 g_4}^{qqq} - C_{f_2 f_1 g_3 g_4}^{qqq} \right)$$



$$\begin{aligned} & -i\epsilon_{m_1 m_2 m_3} \left((P_L)_{s_1 s_4} (P_R)_{s_3 s_2} K_{f_1 g_1}^* C_{f_2 f_3 g_1 f_4}^{duq} \right. \\ & \quad \left. + (P_L)_{s_3 s_4} (P_R)_{s_1 s_2} K_{f_3 g_3}^* C_{f_2 f_1 g_3 f_4}^{duq} \right) \\ & - i\epsilon_{m_1 m_2 m_3} \left((P_R)_{s_1 s_4} (P_R)_{s_3 s_2} C_{f_2 f_3 f_1 f_4}^{duu} \right. \\ & \quad \left. + (P_R)_{s_1 s_2} (P_R)_{s_3 s_4} C_{f_2 f_1 f_3 f_4}^{duu} \right) \\ & - i\epsilon_{m_1 m_2 m_3} K_{f_1 g_1}^* K_{f_3 g_3}^* \left((P_L)_{s_1 s_4} (P_L)_{s_3 s_2} C_{g_3 f_2 g_1 f_4}^{qqq} \right. \\ & \quad \left. + (P_L)_{s_1 s_2} (P_L)_{s_3 s_4} C_{g_1 f_2 g_3 f_4}^{qqq} \right) \\ & + 2i\epsilon_{m_1 m_2 m_3} \left((P_L)_{s_1 s_2} (P_R)_{s_3 s_4} K_{f_1 g_1}^* C_{g_1 f_2 f_3 f_4}^{qqu} \right. \\ & \quad \left. + (P_L)_{s_3 s_2} (P_R)_{s_1 s_4} K_{f_3 g_3}^* C_{g_3 f_2 f_1 f_4}^{qqu} \right) \end{aligned}$$



$$+i\epsilon_{m_1 m_2 m_3} (P_L)_{s_1 s_2} (P_L)_{s_3 s_4} K_{f_1 g_1}^* K_{f_2 g_2}^* \left(C_{g_1 g_2 f_3 f_4}^{qqq} - C_{g_2 g_1 f_3 f_4}^{qqq} \right)$$