

Minimal-Dirac-Gaugino-SSM with UV completion  
Superpotential, Rotations and Interactions for eigenstates 'EWSB'  
including Renormalization Group Equations  
including one-loop Self-Energies

SARAH 4.6.0

November 18, 2015

This file was automatically generated by SARAH version 4.6.0.

References: [arXiv: 1309.7223](#) , [Comput.Phys.Commun.184:1792-1809,2011 \(1207.0906\)](#) , [Comput.Phys.Commun.182:833,2011 \(1002.0840\)](#) , [Comput.Phys.Commun.181:1077-1086,2010 \(0909.2863\)](#) , [arXiv: 0806.0538](#)

Package Homepage: [projects.hepforge.org/sarah/](http://projects.hepforge.org/sarah/)

by **Florian Staub**, [florian.staub@cern.ch](mailto:florian.staub@cern.ch)

# Contents

<b>1 Superfields</b>	<b>3</b>
1.1 Vector Superfields . . . . .	3
1.2 Chiral Superfields . . . . .	3
<b>2 Superpotential and Lagrangian</b>	<b>3</b>
2.1 Superpotential . . . . .	3
2.2 Softbreaking terms . . . . .	4
2.3 Gauge fixing terms . . . . .	4
2.3.1 Gauge fixing terms for eigenstates 'GaugeES' . . . . .	4
2.3.2 Gauge fixing terms for eigenstates 'EWSB' . . . . .	4
2.4 Fields integrated out . . . . .	4
<b>3 Renormalization Group Equations</b>	<b>4</b>
3.1 Anomalous Dimensions . . . . .	4
3.2 Gauge Couplings . . . . .	8
3.3 Trilinear Superpotential Parameters . . . . .	9
3.4 Bilinear Superpotential Parameters . . . . .	15
3.5 Bilinear Soft-Breaking Parameters . . . . .	17
3.6 Fayet-Iliopoulos $D$ -terms . . . . .	19
3.7 Soft-Breaking Scalar Masses . . . . .	20
3.8 Vacuum expectation values . . . . .	34
<b>4 Field Rotations</b>	<b>36</b>
4.1 Rotations in gauge sector for eigenstates 'EWSB' . . . . .	36
4.2 Rotations in Mass sector for eigenstates 'EWSB' . . . . .	36
4.2.1 Mass Matrices for Scalars . . . . .	36
4.2.2 Mass Matrices for Fermions . . . . .	44
<b>5 Vacuum Expectation Values</b>	<b>46</b>
<b>6 Tadpole Equations</b>	<b>47</b>
<b>7 Particle content for eigenstates 'EWSB'</b>	<b>47</b>
<b>8 One Loop Self-Energy and One Loop Tadpoles for eigenstates 'EWSB'</b>	<b>48</b>
8.1 One Loop Self-Energy . . . . .	48
8.2 Tadpoles . . . . .	69
<b>9 Interactions for eigenstates 'EWSB'</b>	<b>70</b>
9.1 Three Scalar-Interaction . . . . .	70
9.2 Two Scalar-One Vector Boson-Interaction . . . . .	102
9.3 One Scalar-Two Vector Boson-Interaction . . . . .	110
9.4 Two Fermion-One Vector Boson-Interaction . . . . .	112
9.5 Two Fermion-One Scalar Boson-Interaction . . . . .	119
9.6 Three Vector Boson-Interaction . . . . .	137

9.7	Four Scalar-Interaction . . . . .	138
9.8	Two Scalar-Two Vector Boson-Interaction . . . . .	202
9.9	Four Vector Boson-Interaction . . . . .	220
9.10	Two Ghosts-One Vector Boson-Interaction . . . . .	222
9.11	Two Ghosts-One Scalar-Interaction . . . . .	226
<b>10</b>	<b>Clebsch-Gordan Coefficients</b>	<b>230</b>

# 1 Superfields

## 1.1 Vector Superfields

SF	Spin $\frac{1}{2}$	Spin 1	$SU(N)$	Coupling	Name
$\hat{B}$	$\lambda_{\hat{B}}$	$B$	$U(1)$	$g_1$	hypercharge
$\hat{W}$	$\lambda_{\hat{W}}$	$W$	$SU(2)$	$g_2$	left
$\hat{g}$	$\lambda_{\hat{g}}$	$g$	$SU(3)$	$g_3$	color

## 1.2 Chiral Superfields

SF	Spin 0	Spin $\frac{1}{2}$	Generations	$(U(1) \otimes SU(2) \otimes SU(3))$
$\hat{q}$	$\tilde{q}$	$q$	3	$(\frac{1}{6}, \mathbf{2}, \mathbf{3})$
$\hat{l}$	$\tilde{l}$	$l$	3	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1})$
$\hat{H}_d$	$H_d$	$\tilde{H}_d$	1	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1})$
$\hat{H}_u$	$H_u$	$\tilde{H}_u$	1	$(\frac{1}{2}, \mathbf{2}, \mathbf{1})$
$\hat{d}$	$\tilde{d}_R^*$	$d_R^*$	3	$(\frac{1}{3}, \mathbf{1}, \bar{\mathbf{3}})$
$\hat{u}$	$\tilde{u}_R^*$	$u_R^*$	3	$(-\frac{2}{3}, \mathbf{1}, \bar{\mathbf{3}})$
$\hat{e}$	$\tilde{e}_R^*$	$e_R^*$	3	$(1, \mathbf{1}, \mathbf{1})$
$\hat{S}$	$S$	$\tilde{S}$	1	$(0, \mathbf{1}, \mathbf{1})$
$\hat{T}$	$T$	$\tilde{T}$	1	$(0, \mathbf{3}, \mathbf{1})$
$\hat{oc}$	$O$	$\tilde{O}$	1	$(0, \mathbf{1}, \mathbf{8})$
$\hat{R}_u$	$R_d$	$\tilde{R}_d$	1	$(-\frac{1}{2}, \mathbf{2}, \mathbf{1})$
$\hat{R}_d$	$R_d$	$\tilde{R}_d$	1	$(\frac{1}{2}, \mathbf{2}, \mathbf{1})$
$\hat{E}$	$\tilde{E}^*$	$E^*$	2	$(1, \mathbf{1}, \mathbf{1})$
$\hat{\bar{E}}$	$\tilde{\bar{E}}^*$	$\bar{E}^*$	2	$(-1, \mathbf{1}, \mathbf{1})$

# 2 Superpotential and Lagrangian

## 2.1 Superpotential

$$\begin{aligned}
W = & \mu_E \hat{E} \hat{\bar{E}} + \mu \hat{H}_u \hat{H}_d + \mu_R \hat{R}_u \hat{R}_d + \frac{1}{2} M_S \hat{S} \hat{S} - Y_d \hat{d} \hat{q} \hat{H}_d - Y_e \hat{e} \hat{l} \hat{H}_d + \Lambda_T \hat{H}_d \hat{T} \hat{H}_u \\
& + Y_L \hat{l} \hat{H}_d \hat{E} + Y_{B\hat{u}rE} \hat{R}_d \hat{H}_u \hat{\bar{E}} + Y_{\hat{E}} \hat{R}_u \hat{H}_d \hat{E} + \lambda_{TR} \hat{R}_u \hat{T} \hat{R}_d + \lambda_{SE} \hat{S} \hat{E} \hat{\bar{E}} + \lambda \hat{S} \hat{H}_d \hat{H}_u + \lambda_{SR} \hat{S} \hat{R}_u \hat{R}_d \quad (1) \\
& + \frac{1}{2} \lambda_T \hat{S} \hat{T} \hat{T} + Y_u \hat{u} \hat{q} \hat{H}_u \quad (2)
\end{aligned}$$

## 2.2 Softbreaking terms

$$-L_{SB,W} = \frac{1}{2}S^2 B_S - H_d^0 H_u^0 B_\mu + H_d^- H_u^+ B_\mu + R_d^0 R_u^0 B_R - R_d^+ R_u^+ B_R + \tilde{E}_i^* \tilde{E}_j^* B_{E,ij} + \text{h.c.} \quad (3)$$

$$\begin{aligned} -L_{SB,\phi} = & + m_{H_d}^2 |H_d^0|^2 + m_{H_d}^2 |H_d^-|^2 + m_{H_u}^2 |H_u^0|^2 + m_{H_u}^2 |H_u^+|^2 + m_{R_d}^2 |R_d^0|^2 + m_{R_d}^2 |R_d^+|^2 + m_{R_u}^2 |R_u^0|^2 \\ & + m_{R_u}^2 |R_u^+|^2 + m_{\tilde{S}}^2 |S|^2 + m_{\tilde{T}}^2 |T^0|^2 + m_{\tilde{T}}^2 |T^-|^2 + m_{\tilde{T}}^2 |T^+|^2 + \tilde{d}_{L,i\alpha}^* \delta_{\alpha\beta} m_{q,ij}^2 \tilde{d}_{L,j\beta} \\ & + \tilde{d}_{R,i\alpha}^* \delta_{\alpha\beta} m_{d,ij}^2 \tilde{d}_{R,j\beta} + \tilde{e}_{L,i}^* m_{l,ij}^2 \tilde{e}_{L,j} + \tilde{e}_{R,i}^* m_{e,ij}^2 \tilde{e}_{R,j} + \tilde{E}_i^* m_{\tilde{E},ij}^2 \tilde{E}_j + \tilde{E}_i^* m_{B\hat{a}rE,ij}^2 \tilde{E}_j \\ & + m_{\tilde{O}}^2 O_\alpha^* \delta_{\alpha\beta} O_\beta + \tilde{u}_{L,i\alpha}^* \delta_{\alpha\beta} m_{q,ij}^2 \tilde{u}_{L,j\beta} + \tilde{u}_{R,i\alpha}^* \delta_{\alpha\beta} m_{u,ij}^2 \tilde{u}_{R,j\beta} + \tilde{\nu}_{L,i}^* m_{l,ij}^2 \tilde{\nu}_{L,j} \end{aligned} \quad (4)$$

$$-L_{SB,\lambda} = \frac{1}{2}(0 + \text{h.c.}) \quad (5)$$

$$\begin{aligned} -L_{SB,DG} = & \frac{1}{2} \left( 4\lambda_{\tilde{B}} \tilde{S} M_D^B + 2M_D^O \delta_{\alpha\beta} \lambda_{\tilde{g},\beta} \tilde{O}_\alpha + 2M_D^O \delta_{\alpha\beta} \lambda_{\tilde{g},\alpha} \tilde{O}_\beta + 2\sqrt{2}\tilde{T}^- M_D^W \lambda_{\tilde{W},1} + 2\sqrt{2}\tilde{T}^+ M_D^W \lambda_{\tilde{W},1} \right. \\ & \left. - 2i\sqrt{2}\tilde{T}^- M_D^W \lambda_{\tilde{W},2} + 2i\sqrt{2}\tilde{T}^+ M_D^W \lambda_{\tilde{W},2} + 4\tilde{T}^0 M_D^W \lambda_{\tilde{W},3} \right) \end{aligned} \quad (6)$$

## 2.3 Gauge fixing terms

### 2.3.1 Gauge fixing terms for eigenstates 'GaugeES'

$$L_{GF} = -\frac{1}{2}|\partial_\mu B|^2 \xi_B^{-1} - \frac{1}{2}|\partial_\mu g|^2 \xi_g^{-1} - \frac{1}{2}|\partial_\mu W|^2 \xi_W^{-1} \quad (7)$$

### 2.3.2 Gauge fixing terms for eigenstates 'EWSB'

$$\begin{aligned} L_{GF} = & -\frac{1}{2}|\partial_\mu g|^2 \xi_g^{-1} - \frac{1}{2}|\partial_\mu \gamma|^2 \xi_\gamma^{-1} \\ & - \left| \frac{1}{2} \left( 2\partial_\mu W^- - ig_2 \left( H_d^- v_d + \sqrt{2}T^- v_T + \sqrt{2}v_T T^{+,*} - v_u H_u^{+,*} \right) \xi_{W^-} \right) \right|^2 \xi_{W^-}^{-1} \\ & - \frac{1}{2} \left| \frac{1}{2} \left( 2\partial_\mu Z + \left( \sigma_d v_d - \sigma_u v_u \right) \xi_Z \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \right) \right|^2 \xi_Z^{-1} \end{aligned} \quad (8)$$

## 2.4 Fields integrated out

None

# 3 Renormalization Group Equations

## 3.1 Anomalous Dimensions

$$\gamma_{\hat{q}}^{(1)} = -\frac{1}{30} \left( 45g_2^2 + 80g_3^2 + g_1^2 \right) \mathbf{1} + Y_d^\dagger Y_d + Y_u^\dagger Y_u \quad (9)$$

$$\gamma_{\hat{q}}^{(2)} = + \left( 8g_2^2 g_3^2 + \frac{1}{90} g_1^2 \left( 16g_3^2 + 9g_2^2 \right) + \frac{289}{900} g_1^4 + \frac{33}{4} g_2^4 + \frac{64}{9} g_3^4 \right) \mathbf{1} + \frac{4}{5} g_1^2 Y_u^\dagger Y_u - \frac{3}{2} |\Lambda_T|^2 Y_u^\dagger Y_u$$

$$\begin{aligned}
& -|\lambda|^2 Y_u^\dagger Y_u - 2Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_u^\dagger Y_u Y_u^\dagger Y_u - Y_u^\dagger Y_u \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) \\
& + Y_d^\dagger Y_d \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 - \frac{3}{2}|\Lambda_T|^2 - |\lambda|^2 - \text{Tr}(Y_e Y_e^\dagger) - \text{Tr}(Y_L Y_L^\dagger) - (Y_{\hat{E}} Y_{\hat{E}}^*) \right) \\
& - 3Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger)
\end{aligned} \tag{10}$$

$$\gamma_{\hat{I}}^{(1)} = -\frac{3}{10} \left( 5g_2^2 + g_1^2 \right) \mathbf{1} + Y_e^\dagger Y_e + Y_L^* Y_L^T \tag{11}$$

$$\begin{aligned}
\gamma_{\hat{I}}^{(2)} = & +\frac{3}{100} \left( 275g_2^4 + 30g_1^2 g_2^2 + 99g_1^4 \right) \mathbf{1} + \frac{6}{5}g_1^2 Y_L^* Y_L^T - \frac{3}{2}|\Lambda_T|^2 Y_L^* Y_L^T - |\lambda|^2 Y_L^* Y_L^T \\
& - 2Y_e^\dagger Y_e Y_e^\dagger Y_e - 2Y_e^\dagger Y_e Y_L^* Y_L^T - Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_L^T - 2Y_L^* Y_L^T Y_e^\dagger Y_e \\
& - 2Y_L^* Y_L^T Y_L^* Y_L^T - Y_L^* Y_L^T \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) - 3Y_L^* Y_L^T \text{Tr}(Y_d Y_d^\dagger) - Y_L^* Y_L^T \text{Tr}(Y_e Y_e^\dagger) \\
& + Y_e^\dagger Y_e \left( -3\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{2}|\Lambda_T|^2 + \frac{6}{5}g_1^2 - |\lambda|^2 - \text{Tr}(Y_e Y_e^\dagger) - \text{Tr}(Y_L Y_L^\dagger) - (Y_{\hat{E}} Y_{\hat{E}}^*) \right) \\
& - Y_L^* Y_L^T \text{Tr}(Y_L Y_L^\dagger) - 2 \left( Y_L Y_{\hat{E}}^* \right)_{i_2} \left( Y_L^* Y_{\hat{E}} \right)_{i_1}
\end{aligned} \tag{12}$$

$$\gamma_{\hat{I}, \hat{R}_u}^{(1)} = \left( Y_L^* Y_{\hat{E}} \right)_{i_1} \tag{13}$$

$$\begin{aligned}
\gamma_{\hat{I}, \hat{R}_u}^{(2)} = & + \left( -3\text{Tr}(Y_d Y_d^\dagger) - 3(Y_{\hat{E}} Y_{\hat{E}}^*) - \frac{3}{2}|\Lambda_T|^2 + \frac{6}{5}g_1^2 - |\lambda|^2 - \text{Tr}(Y_e Y_e^\dagger) - \text{Tr}(Y_L Y_L^\dagger) \right) \left( Y_L^* Y_{\hat{E}} \right)_{i_1} \\
& - 2 \left( Y_e^\dagger Y_e Y_L^* Y_{\hat{E}} \right)_{i_1} - \left( Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}} \right)_{i_1} - 2 \left( Y_L^* Y_L^T Y_L^* Y_{\hat{E}} \right)_{i_1}
\end{aligned} \tag{14}$$

$$\gamma_{\hat{H}_d}^{(1)} = 3\text{Tr}(Y_d Y_d^\dagger) - \frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + \frac{3}{2}|\Lambda_T|^2 + |\lambda|^2 + (Y_{\hat{E}} Y_{\hat{E}}^*) + \text{Tr}(Y_e Y_e^\dagger) + \text{Tr}(Y_L Y_L^\dagger) \tag{15}$$

$$\begin{aligned}
\gamma_{\hat{H}_d}^{(2)} = & +\frac{297}{100}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{33}{4}g_2^4 - \frac{15}{4}\Lambda_T^2 \Lambda_T^{*,2} - \frac{3}{2}\lambda|\lambda_T|^2 \lambda^* - 3\lambda^2 \lambda^{*,2} + \frac{6}{5}g_1^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& - \frac{3}{2}|\lambda_{TR}|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 3 \left( (Y_{\hat{E}} Y_{\hat{E}}^*) \right)^2 - |\lambda_{SR}|^2 \left( 2\lambda\lambda^* + (Y_{\hat{E}} Y_{\hat{E}}^*) \right) - 6(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*) - |\lambda|^2 (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) \\
& - \left( \lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^* \right) - |\lambda|^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) - \frac{2}{5}g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 16g_3^2 \text{Tr}(Y_d Y_d^\dagger) \\
& + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_L Y_L^\dagger) \\
& + \frac{3}{2}|\Lambda_T|^2 \left( -2\lambda\lambda^* - 3\text{Tr}(Y_u Y_u^\dagger) + 4g_2^2 - \lambda_T \lambda_T^* - \lambda_{TR} \lambda_{TR}^* - (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) \right) - 3|\lambda|^2 \text{Tr}(Y_u Y_u^\dagger) \\
& - \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \\
& - 3\text{Tr}(Y_L Y_L^\dagger Y_L Y_L^\dagger) - 6\text{Tr}(Y_L Y_L^\dagger Y_e^T Y_e^*)
\end{aligned} \tag{16}$$

$$\gamma_{\hat{H}_u}^{(1)} = 3\text{Tr}(Y_u Y_u^\dagger) - \frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + \frac{3}{2}|\Lambda_T|^2 + |\lambda|^2 + (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) \tag{17}$$

$$\begin{aligned}
\gamma_{\hat{H}_u}^{(2)} = & +\frac{297}{100}g_1^4 + \frac{9}{10}g_1^2 g_2^2 + \frac{33}{4}g_2^4 - \frac{15}{4}\Lambda_T^2 \Lambda_T^{*,2} - \frac{3}{2}\lambda|\lambda_T|^2 \lambda^* - 3\lambda^2 \lambda^{*,2} - |\lambda|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& + \frac{6}{5}g_1^2 (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) - \frac{3}{2}|\lambda_{TR}|^2 (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) - 3 \left( (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) \right)^2 - |\lambda_{SR}|^2 \left( 2\lambda\lambda^* + (Y_{B\hat{a}rE} Y_{B\hat{a}rE}^*) \right) - (Y_{B\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{B\hat{a}rE}^*) \\
& - |\lambda|^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) - 3|\lambda|^2 \text{Tr}(Y_d Y_d^\dagger) - |\lambda|^2 \text{Tr}(Y_e Y_e^\dagger)
\end{aligned}$$

$$\begin{aligned}
& + \frac{3}{2}|\Lambda_T|^2 \left( -2\lambda\lambda^* - 3\text{Tr}(Y_d Y_d^\dagger) + 4g_2^2 - \lambda_T \lambda_T^* - \lambda_{TR} \lambda_{TR}^* - \text{Tr}(Y_e Y_e^\dagger) - \text{Tr}(Y_L Y_L^\dagger) - (Y_{\hat{E}} Y_{\hat{E}}^*) \right) \\
& - |\lambda|^2 \text{Tr}(Y_L Y_L^\dagger) + \frac{4}{5}g_1^2 \text{Tr}(Y_u Y_u^\dagger) + 16g_3^2 \text{Tr}(Y_u Y_u^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger)
\end{aligned} \tag{18}$$

$$\gamma_{\hat{d}}^{(1)} = 2Y_d^* Y_d^T - \frac{2}{15}(20g_3^2 + g_1^2)\mathbf{1} \tag{19}$$

$$\begin{aligned}
\gamma_{\hat{d}}^{(2)} = & + \frac{4}{225}(400g_3^4 + 40g_1^2 g_3^2 + 73g_1^4)\mathbf{1} - 2(Y_d^* Y_d^T Y_d^* Y_d^T + Y_d^* Y_u^T Y_u^* Y_d^T) \\
& + Y_d^* Y_d^T \left( -2|\lambda|^2 - 2\text{Tr}(Y_e Y_e^\dagger) - 2\text{Tr}(Y_L Y_L^\dagger) - 2(Y_{\hat{E}} Y_{\hat{E}}^*) - 3|\Lambda_T|^2 + 6g_2^2 - 6\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 \right)
\end{aligned} \tag{20}$$

$$\gamma_{\hat{u}}^{(1)} = 2Y_u^* Y_u^T - \frac{8}{15}(5g_3^2 + g_1^2)\mathbf{1} \tag{21}$$

$$\begin{aligned}
\gamma_{\hat{u}}^{(2)} = & + \frac{64}{225}(10g_1^2 g_3^2 + 19g_1^4 + 25g_3^4)\mathbf{1} - 2(Y_u^* Y_d^T Y_d^* Y_u^T + Y_u^* Y_u^T Y_u^* Y_u^T) \\
& + Y_u^* Y_u^T \left( -2|\lambda|^2 - 2(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 3|\Lambda_T|^2 + 6g_2^2 - 6\text{Tr}(Y_u Y_u^\dagger) - \frac{2}{5}g_1^2 \right)
\end{aligned} \tag{22}$$

$$\gamma_{\hat{e}}^{(1)} = 2Y_e^* Y_e^T - \frac{6}{5}g_1^2 \mathbf{1} \tag{23}$$

$$\begin{aligned}
\gamma_{\hat{e}}^{(2)} = & + \frac{324}{25}g_1^4 \mathbf{1} - 2(Y_e^* Y_L Y_L^\dagger Y_e^T + Y_e^* Y_e^T Y_e^* Y_e^T) \\
& + Y_e^* Y_e^T \left( -2|\lambda|^2 - 2\text{Tr}(Y_e Y_e^\dagger) - 2\text{Tr}(Y_L Y_L^\dagger) - 2(Y_{\hat{E}} Y_{\hat{E}}^*) - 3|\Lambda_T|^2 + 6g_2^2 - 6\text{Tr}(Y_d Y_d^\dagger) - \frac{6}{5}g_1^2 \right)
\end{aligned} \tag{24}$$

$$\gamma_{\hat{e},\hat{E}}^{(1)} = -2Y_e^* Y_L \tag{25}$$

$$\begin{aligned}
\gamma_{\hat{e},\hat{E}}^{(2)} = & + Y_e^* Y_L \left( 2|\lambda|^2 + 2\text{Tr}(Y_e Y_e^\dagger) + 2\text{Tr}(Y_L Y_L^\dagger) + 2(Y_{\hat{E}} Y_{\hat{E}}^*) + 3|\Lambda_T|^2 - 6g_2^2 + 6\text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \right) \\
& + 2(Y_{\hat{E},i_2} (Y_e^* Y_L Y_{\hat{E}}^*)_{i_1} + Y_e^* Y_L Y_L^\dagger Y_L + Y_e^* Y_e^T Y_e^* Y_L)
\end{aligned} \tag{26}$$

$$\gamma_{\hat{S}}^{(1)} = 2|\lambda|^2 + 2|\lambda_{SR}|^2 + \frac{3}{2}|\lambda_T|^2 + \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \tag{27}$$

$$\begin{aligned}
\gamma_{\hat{S}}^{(2)} = & + \frac{6}{5}g_1^2 |\lambda|^2 + 6g_2^2 |\lambda|^2 - 4\lambda_{SR}^2 \lambda_{SR}^{*,2} - 3\lambda_T^2 \lambda_T^{*,2} + 3|\lambda_T|^2 (4g_2^2 - \Lambda_T \Lambda_T^* - \lambda_{TR} \lambda_{TR}^*) \\
& - 6\lambda |\Lambda_T|^2 \lambda^* - 4\lambda^2 \lambda^{*,2} - 2|\lambda|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& + \frac{2}{5}|\lambda_{SR}|^2 (15g_2^2 - 15\lambda_{TR} \lambda_{TR}^* + 3g_1^2 - 5(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 5(Y_{\hat{E}} Y_{\hat{E}}^*)) - 2|\lambda|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 2(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*) \\
& - 2(\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*) + \frac{12}{5}g_1^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) - 6|\lambda|^2 \text{Tr}(Y_d Y_d^\dagger) - 2|\lambda|^2 \text{Tr}(Y_e Y_e^\dagger) \\
& - 2|\lambda|^2 \text{Tr}(Y_L Y_L^\dagger) - 6|\lambda|^2 \text{Tr}(Y_u Y_u^\dagger) - 2\text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger) - 2\text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*)
\end{aligned} \tag{28}$$

$$\gamma_{\hat{T}}^{(1)} = -4g_2^2 + |\lambda_{TR}|^2 + |\lambda_T|^2 + |\Lambda_T|^2 \tag{29}$$

$$\gamma_{\hat{T}}^{(2)} = +32g_2^4 + \frac{3}{5}g_1^2 |\Lambda_T|^2 - g_2^2 |\Lambda_T|^2 - 3\lambda_{TR}^2 \lambda_{TR}^{*,2} - 2\lambda_T |\lambda_{SR}|^2 \lambda_T^* - \frac{5}{2}\lambda_T^2 \lambda_T^{*,2} - \Lambda_T |\lambda_T|^2 \Lambda_T^*$$

$$\begin{aligned}
& -3\Lambda_T^2\Lambda_T^{*2} - 2\lambda|\lambda_T|^2\lambda^* - 2\lambda|\Lambda_T|^2\lambda^* - |\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\
& + \frac{1}{5}|\lambda_{TR}|^2\left(-10\lambda_{SR}\lambda_{SR}^* + 3g_1^2 - 5g_2^2 - 5\lambda_T\lambda_T^* - 5\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 5\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right) - |\Lambda_T|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& - |\lambda_T|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - 3|\Lambda_T|^2\text{Tr}\left(Y_dY_d^\dagger\right) - |\Lambda_T|^2\text{Tr}\left(Y_eY_e^\dagger\right) - |\Lambda_T|^2\text{Tr}\left(Y_LY_L^\dagger\right) \\
& - 3|\Lambda_T|^2\text{Tr}\left(Y_uY_u^\dagger\right) \tag{30}
\end{aligned}$$

$$\gamma_{\hat{oc}}^{(1)} = -6g_3^2 \tag{31}$$

$$\gamma_{\hat{oc}}^{(2)} = 36g_3^4 \tag{32}$$

$$\gamma_{\hat{R}u,\hat{l}}^{(1)} = \left(Y_LY_{\hat{E}}^*\right)_{i_2} \tag{33}$$

$$\begin{aligned}
\gamma_{\hat{R}u,\hat{l}}^{(2)} = & \left(-3\text{Tr}\left(Y_dY_d^\dagger\right) - 3\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - \frac{3}{2}|\Lambda_T|^2 + \frac{6}{5}g_1^2 - |\lambda|^2 - \text{Tr}\left(Y_eY_e^\dagger\right) - \text{Tr}\left(Y_LY_L^\dagger\right)\right)\left(Y_LY_{\hat{E}}^*\right)_{i_2} \\
& - 2\left(Y_LY_L^\dagger Y_LY_{\hat{E}}^*\right)_{i_2} - \left(Y_L\lambda_{SE}^*\lambda_{SE}^TY_{\hat{E}}^*\right)_{i_2} - 2\left(Y_e^TY_e^*Y_LY_{\hat{E}}^*\right)_{i_2} \tag{34}
\end{aligned}$$

$$\gamma_{\hat{R}u}^{(1)} = -\frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + \frac{3}{2}|\lambda_{TR}|^2 + |\lambda_{SR}|^2 + \left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \tag{35}$$

$$\begin{aligned}
\gamma_{\hat{R}u}^{(2)} = & +\frac{297}{100}g_1^4 + \frac{9}{10}g_1^2g_2^2 + \frac{33}{4}g_2^4 - 3\lambda_{SR}^2\lambda_{SR}^{*2} - \frac{15}{4}\lambda_{TR}^2\lambda_{TR}^{*2} + \frac{6}{5}g_1^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - \frac{3}{2}|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\
& - |\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 3\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 - 2\left(Y_{\hat{E}}Y_L^\dagger Y_LY_{\hat{E}}^*\right) \\
& + \frac{3}{2}|\lambda_{TR}|^2\left(4g_2^2 - \lambda_T\lambda_T^* - \Lambda_T\Lambda_T^* - \left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right)\right) - \left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^TY_{\hat{E}}^*\right) \\
& - \frac{1}{2}|\lambda_{SR}|^2\left(2\left(2\lambda\lambda^* + \left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + \text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right)\right) + 3\lambda_T\lambda_T^* + 6\lambda_{TR}\lambda_{TR}^*\right) - 3\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_dY_d^\dagger\right) \\
& - \left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_eY_e^\dagger\right) - \left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_LY_L^\dagger\right) \tag{36}
\end{aligned}$$

$$\gamma_{\hat{R}d}^{(1)} = -\frac{3}{10}g_1^2 - \frac{3}{2}g_2^2 + \frac{3}{2}|\lambda_{TR}|^2 + |\lambda_{SR}|^2 + \left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \tag{37}$$

$$\begin{aligned}
\gamma_{\hat{R}d}^{(2)} = & +\frac{297}{100}g_1^4 + \frac{9}{10}g_1^2g_2^2 + \frac{33}{4}g_2^4 - 3\lambda_{SR}^2\lambda_{SR}^{*2} - \frac{15}{4}\lambda_{TR}^2\lambda_{TR}^{*2} \\
& + \frac{3}{2}|\lambda_{TR}|^2\left(4g_2^2 - \lambda_T\lambda_T^* - \Lambda_T\Lambda_T^* - \left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right) + \frac{6}{5}g_1^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - \frac{3}{2}|\Lambda_T|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& - |\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 3\left(\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 - \left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}^TY_{\hat{B}\hat{a}rE}^*\right) \\
& - \frac{1}{2}|\lambda_{SR}|^2\left(2\left(2\lambda\lambda^* + \left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + \text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right)\right) + 3\lambda_T\lambda_T^* + 6\lambda_{TR}\lambda_{TR}^*\right) - 3\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right)\text{Tr}\left(Y_uY_u^\dagger\right) \tag{38}
\end{aligned}$$

$$\gamma_{\hat{E},\hat{e}}^{(1)} = -2Y_L^\dagger Y_e^T \tag{39}$$

$$\begin{aligned}
\gamma_{\hat{E},\hat{e}}^{(2)} = & +Y_L^\dagger Y_e^T\left(2|\lambda|^2 + 2\text{Tr}\left(Y_eY_e^\dagger\right) + 2\text{Tr}\left(Y_LY_L^\dagger\right) + 2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 3|\Lambda_T|^2 - 6g_2^2 + 6\text{Tr}\left(Y_dY_d^\dagger\right) + \frac{6}{5}g_1^2\right) \\
& + 2\left(Y_{\hat{E},i_1}^*\left(Y_eY_LY_{\hat{E}}\right)_{i_2} + Y_L^\dagger Y_LY_L^\dagger Y_e^T + Y_L^\dagger Y_e^TY_e^*Y_e^T\right) \tag{40}
\end{aligned}$$

$$\gamma_{\hat{E}}^{(1)} = 2Y_{\hat{E},i_1}^*Y_{\hat{E},i_2} + 2Y_L^\dagger Y_L - \frac{6}{5}g_1^2\mathbf{1} + \lambda_{SE}^*\lambda_{SE}^T \tag{41}$$



$$\begin{aligned}
\gamma_{\hat{E}}^{(2)} = & + \frac{324}{25} g_1^4 \mathbf{1} - \frac{6}{5} g_1^2 Y_L^\dagger Y_L + 6g_2^2 Y_L^\dagger Y_L - 3|\Lambda_T|^2 Y_L^\dagger Y_L - 2|\lambda|^2 Y_L^\dagger Y_L \\
& - 2|\lambda_{SR}|^2 \lambda_{SE}^* \lambda_{SE}^T - \frac{3}{2} |\lambda_T|^2 \lambda_{SE}^* \lambda_{SE}^T - 2|\lambda|^2 \lambda_{SE}^* \lambda_{SE}^T - 2Y_L^\dagger Y_L Y_L^\dagger Y_L \\
& - 2Y_L^\dagger Y_e^T Y_e^* Y_L - \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T - 2Y_L^\dagger Y_L (Y_{\hat{E}} Y_{\hat{E}}^*) - \lambda_{SE}^* \lambda_{SE}^T \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \\
& - 6Y_L^\dagger Y_L \text{Tr}(Y_d Y_d^\dagger) - 2Y_L^\dagger Y_L \text{Tr}(Y_e Y_e^\dagger) - 2Y_L^\dagger Y_L \text{Tr}(Y_L Y_L^\dagger) - 2(\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*)_{i_2} (\lambda_{SE}^* Y_{\hat{B}\hat{a}rE})_{i_1} \\
& - 2Y_{\hat{E},i_2} (Y_L^\dagger Y_L Y_{\hat{E}}^*)_{i_1} \\
& - \frac{1}{5} Y_{\hat{E},i_1}^* \left( (6g_1^2 - 30g_2^2 + 10|\lambda_{SR}|^2 + 15|\lambda_{TR}|^2 + 15|\Lambda_T|^2 + 10|\lambda|^2 + 20(Y_{\hat{E}} Y_{\hat{E}}^*) + 30\text{Tr}(Y_d Y_d^\dagger) + 10\text{Tr}(Y_e Y_e^\dagger) \right. \\
& \left. + 10\text{Tr}(Y_L Y_L^\dagger) \right) Y_{\hat{E},i_2} \\
& \left. + 10(Y_L^T Y_L^* Y_{\hat{E}})_{i_2} \right) \tag{42}
\end{aligned}$$

$$\gamma_{\hat{E}}^{(1)} = 2Y_{\hat{B}\hat{a}rE,i_1}^* Y_{\hat{B}\hat{a}rE,i_2} - \frac{6}{5} g_1^2 \mathbf{1} + \lambda_{SE}^\dagger \lambda_{SE} \tag{43}$$

$$\begin{aligned}
\gamma_{\hat{E}}^{(2)} = & + \frac{324}{25} g_1^4 \mathbf{1} - 2|\lambda_{SR}|^2 \lambda_{SE}^\dagger \lambda_{SE} - \frac{3}{2} |\lambda_T|^2 \lambda_{SE}^\dagger \lambda_{SE} - 2|\lambda|^2 \lambda_{SE}^\dagger \lambda_{SE} - \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \\
& - 2\lambda_{SE}^\dagger Y_L^T Y_L^* \lambda_{SE} - \lambda_{SE}^\dagger \lambda_{SE} \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \\
& - \frac{1}{5} Y_{\hat{B}\hat{a}rE,i_1}^* \left( 10|\lambda|^2 + 10|\lambda_{SR}|^2 + 15|\Lambda_T|^2 + 15|\lambda_{TR}|^2 + 20(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 30g_2^2 + 30\text{Tr}(Y_u Y_u^\dagger) + 6g_1^2 \right) Y_{\hat{B}\hat{a}rE,i_2} \\
& - 2(\lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} (\lambda_{SE}^T Y_{\hat{E}}^*)_{i_2} \tag{44}
\end{aligned}$$

### 3.2 Gauge Couplings

$$\beta_{g_1}^{(1)} = \frac{48}{5} g_1^3 \tag{45}$$

$$\begin{aligned}
\beta_{g_1}^{(2)} = & \frac{1}{25} g_1^3 (352g_1^2 + 180g_2^2 + 440g_3^2 - 30|\lambda_{SR}|^2 - 45|\lambda_{TR}|^2 - 45|\Lambda_T|^2 - 30|\lambda|^2 - 90(Y_{\hat{E}} Y_{\hat{E}}^*) - 90(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\
& - 60\text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) - 70\text{Tr}(Y_d Y_d^\dagger) - 90\text{Tr}(Y_e Y_e^\dagger) - 90\text{Tr}(Y_L Y_L^\dagger) - 130\text{Tr}(Y_u Y_u^\dagger)) \tag{46}
\end{aligned}$$

$$\beta_{g_2}^{(1)} = 4g_2^3 \tag{47}$$

$$\begin{aligned}
\beta_{g_2}^{(2)} = & \frac{1}{5} g_2^3 (12g_1^2 + 280g_2^2 + 120g_3^2 - 10|\lambda_{SR}|^2 - 35|\lambda_{TR}|^2 - 20|\lambda_T|^2 - 35|\Lambda_T|^2 - 10|\lambda|^2 - 10(Y_{\hat{E}} Y_{\hat{E}}^*) \\
& - 10(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 30\text{Tr}(Y_d Y_d^\dagger) - 10\text{Tr}(Y_e Y_e^\dagger) - 10\text{Tr}(Y_L Y_L^\dagger) - 30\text{Tr}(Y_u Y_u^\dagger)) \tag{48}
\end{aligned}$$

$$\beta_{g_3}^{(1)} = 0 \tag{49}$$

$$\beta_{g_3}^{(2)} = \frac{1}{5} g_3^3 (11g_1^2 - 20\text{Tr}(Y_d Y_d^\dagger) - 20\text{Tr}(Y_u Y_u^\dagger) + 340g_2^2 + 45g_2^2) \tag{50}$$

### 3.3 Trilinear Superpotential Parameters

$$\begin{aligned} \beta_{Y_d}^{(1)} &= +3Y_d Y_d^\dagger Y_d + Y_d Y_u^\dagger Y_u \\ &+ Y_d \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) - \frac{16}{3}g_3^2 + \frac{3}{2}|\Lambda_T|^2 - \frac{7}{15}g_1^2 + |\lambda|^2 + (Y_{\hat{E}} Y_{\hat{E}}^*) + \text{Tr}(Y_e Y_e^\dagger) + \text{Tr}(Y_L Y_L^\dagger) \right) \end{aligned} \quad (51)$$

$$\begin{aligned} \beta_{Y_d}^{(2)} &= +\frac{4}{5}g_1^2 Y_d Y_u^\dagger Y_u - \frac{3}{2}|\Lambda_T|^2 Y_d Y_u^\dagger Y_u - |\lambda|^2 Y_d Y_u^\dagger Y_u - 4Y_d Y_d^\dagger Y_d Y_d^\dagger Y_d \\ &- 2Y_d Y_u^\dagger Y_u Y_d^\dagger Y_d - 2Y_d Y_u^\dagger Y_u Y_u^\dagger Y_u - Y_d Y_u^\dagger Y_u (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\ &+ Y_d Y_d^\dagger Y_d \left( -3|\lambda|^2 - 3\text{Tr}(Y_e Y_e^\dagger) - 3\text{Tr}(Y_L Y_L^\dagger) - 3(Y_{\hat{E}} Y_{\hat{E}}^*) + 6g_2^2 - 9\text{Tr}(Y_d Y_d^\dagger) + \frac{4}{5}g_1^2 - \frac{9}{2}|\Lambda_T|^2 \right) \\ &- 3Y_d Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) \\ &+ Y_d \left( \frac{413}{90}g_1^4 + g_1^2 g_2^2 + \frac{33}{2}g_2^4 + \frac{8}{9}g_1^2 g_3^2 + 8g_2^2 g_3^2 + \frac{128}{9}g_3^4 - \frac{15}{4}\Lambda_T^2 \Lambda_T^{*,2} - \frac{3}{2}\lambda|\lambda_T|^2 \lambda^* - 3\lambda^2 \lambda^{*,2} \right. \\ &+ \frac{6}{5}g_1^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - \frac{3}{2}|\lambda_{TR}|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 3\left( (Y_{\hat{E}} Y_{\hat{E}}^*) \right)^2 - |\lambda_{SR}|^2 (2\lambda\lambda^* + (Y_{\hat{E}} Y_{\hat{E}}^*)) - 6(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*) \\ &- |\lambda|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - (\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*) - |\lambda|^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) - \frac{2}{5}g_1^2 \text{Tr}(Y_d Y_d^\dagger) \\ &+ 16g_3^2 \text{Tr}(Y_d Y_d^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_e Y_e^\dagger) + \frac{6}{5}g_1^2 \text{Tr}(Y_L Y_L^\dagger) \\ &+ \frac{3}{2}|\Lambda_T|^2 \left( -2\lambda\lambda^* - 3\text{Tr}(Y_u Y_u^\dagger) + 4g_2^2 - \lambda_T \lambda_T^* - \lambda_{TR} \lambda_{TR}^* - (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \right) - 3|\lambda|^2 \text{Tr}(Y_u Y_u^\dagger) \\ &- \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*) - 9\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 3\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \\ &- 3\text{Tr}(Y_L Y_L^\dagger Y_L Y_L^\dagger) - 6\text{Tr}(Y_L Y_L^\dagger Y_e^T Y_e^*) \end{aligned} \quad (52)$$

$$\begin{aligned} \beta_{Y_e}^{(1)} &= +3(Y_e Y_e^\dagger Y_e + Y_e Y_L^* Y_L^T) \\ &+ Y_e \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) + \frac{3}{2}|\Lambda_T|^2 - \frac{9}{5}g_1^2 + |\lambda|^2 + (Y_{\hat{E}} Y_{\hat{E}}^*) + \text{Tr}(Y_e Y_e^\dagger) + \text{Tr}(Y_L Y_L^\dagger) \right) \end{aligned} \quad (53)$$

$$\begin{aligned} \beta_{Y_e}^{(2)} &= +6g_2^2 Y_e Y_L^* Y_L^T - \frac{9}{2}|\Lambda_T|^2 Y_e Y_L^* Y_L^T - 3|\lambda|^2 Y_e Y_L^* Y_L^T - 4Y_e Y_e^\dagger Y_e Y_e^\dagger Y_e \\ &- 4Y_e Y_e^\dagger Y_e Y_L^* Y_L^T - Y_e Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_L^T - 4Y_e Y_L^* Y_L^T Y_e^\dagger Y_e - 4Y_e Y_L^* Y_L^T Y_L^* Y_L^T \\ &- 3Y_e Y_L^* Y_L^T (Y_{\hat{E}} Y_{\hat{E}}^*) - 9Y_e Y_L^* Y_L^T \text{Tr}(Y_d Y_d^\dagger) - 3Y_e Y_L^* Y_L^T \text{Tr}(Y_e Y_e^\dagger) \\ &+ Y_e Y_e^\dagger Y_e \left( -3|\lambda|^2 - 3\text{Tr}(Y_e Y_e^\dagger) - 3\text{Tr}(Y_L Y_L^\dagger) - 3(Y_{\hat{E}} Y_{\hat{E}}^*) + 6g_2^2 - 9\text{Tr}(Y_d Y_d^\dagger) - \frac{9}{2}|\Lambda_T|^2 \right) \\ &- 3Y_e Y_L^* Y_L^T \text{Tr}(Y_L Y_L^\dagger) \\ &- \frac{1}{20}Y_e \left( 75\Lambda_T^2 \Lambda_T^{*,2} - 30|\Lambda_T|^2 \left( -2\lambda\lambda^* - 3\text{Tr}(Y_u Y_u^\dagger) + 4g_2^2 - \lambda_T \lambda_T^* - \lambda_{TR} \lambda_{TR}^* - (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \right) \right. \\ &+ 2 \left( -189g_1^4 - 18g_1^2 g_2^2 - 165g_2^4 + 15\lambda|\lambda_T|^2 \lambda^* + 30\lambda^2 \lambda^{*,2} - 12g_1^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + 15|\lambda_{TR}|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \right. \\ &\left. \left. + 30\left( (Y_{\hat{E}} Y_{\hat{E}}^*) \right)^2 + 10|\lambda_{SR}|^2 (2\lambda\lambda^* + (Y_{\hat{E}} Y_{\hat{E}}^*)) + 60(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*) + 10|\lambda|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \right) \right) \end{aligned}$$

$$\begin{aligned}
& + 10\left(\lambda_{SE}^\dagger Y_{\hat{E}} Y_{SE}^T Y_{\hat{E}}^*\right) + 10|\lambda|^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) + 4g_1^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 160g_3^2 \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 12g_1^2 \text{Tr}\left(Y_e Y_e^\dagger\right) - 12g_1^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 30|\lambda|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 10 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*\right) \\
& + 90 \text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) + 30 \text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) + 30 \text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) + 30 \text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger\right) \\
& + 60 \text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^*\right) \\
& - 4\left(Y_L Y_{\hat{E}}^*\right)_{i_2} \left(Y_e Y_L^* Y_{\hat{E}}\right)_{i_1}
\end{aligned} \tag{54}$$

$$\begin{aligned}
\beta_{\Lambda_T}^{(1)} & = -\frac{3}{5}g_1^2 \Lambda_T - 7g_2^2 \Lambda_T + \Lambda_T |\lambda_{TR}|^2 + \Lambda_T |\lambda_T|^2 + 2\Lambda_T |\lambda|^2 + 4\Lambda_T^2 \Lambda_T^* + \Lambda_T \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + \Lambda_T \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 3\Lambda_T \text{Tr}\left(Y_d Y_d^\dagger\right) + \Lambda_T \text{Tr}\left(Y_e Y_e^\dagger\right) + \Lambda_T \text{Tr}\left(Y_L Y_L^\dagger\right) + 3\Lambda_T \text{Tr}\left(Y_u Y_u^\dagger\right)
\end{aligned} \tag{55}$$

$$\begin{aligned}
\beta_{\Lambda_T}^{(2)} & = -\frac{1}{50} \Lambda_T \left(-297g_1^4 - 90g_1^2 g_2^2 - 2425g_2^4 - 30g_1^2 |\Lambda_T|^2 - 550g_2^2 |\Lambda_T|^2 + 150\lambda_{TR}^2 \lambda_{TR}^{*2} + 125\lambda_T^2 \lambda_T^{*2}\right. \\
& + 200\Lambda_T |\lambda_T|^2 \Lambda_T^* + 525\Lambda_T^2 \Lambda_T^{*2} + 250\lambda |\lambda_T|^2 \lambda^* + 400\lambda |\Lambda_T|^2 \lambda^* + 300\lambda^2 \lambda^{*2} - 60g_1^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& + 125|\Lambda_T|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 50|\lambda|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 150\left(\left(Y_{\hat{E}} Y_{\hat{E}}^*\right)\right)^2 + 300\left(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*\right) - 60g_1^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 125|\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 50|\lambda|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 150\left(\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 + 50|\lambda_{SR}|^2 \left(2\lambda_T \lambda_T^* + 4\lambda \lambda^* + \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\right) \\
& + 5|\lambda_{TR}|^2 \left(10g_2^2 + 10\lambda_T \lambda_T^* + 20\lambda_{SR} \lambda_{SR}^* + 25\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 25\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 30\Lambda_T \Lambda_T^* - 6g_1^2\right) + 50\left(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 50\left(\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*\right) + 50|\lambda_T|^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) + 100|\lambda|^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) + 20g_1^2 \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 800g_3^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 375|\Lambda_T|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 150|\lambda|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 60g_1^2 \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + 125|\Lambda_T|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 50|\lambda|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) - 60g_1^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 125|\Lambda_T|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) \\
& + 50|\lambda|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) - 40g_1^2 \text{Tr}\left(Y_u Y_u^\dagger\right) - 800g_3^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 375|\Lambda_T|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 150|\lambda|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 50 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*\right) + 450 \text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) + 300 \text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) \\
& + 150 \text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) + 150 \text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger\right) + 300 \text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^*\right) + 450 \text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right)
\end{aligned} \tag{56}$$

$$\begin{aligned}
\beta_{Y_L}^{(1)} & = +3Y_L Y_L^\dagger Y_L + Y_L \lambda_{SE}^* \lambda_{SE}^T + 3Y_e^T Y_e^* Y_L \\
& + Y_L \left(-3g_2^2 + 3 \text{Tr}\left(Y_d Y_d^\dagger\right) + \frac{3}{2} |\Lambda_T|^2 - \frac{9}{5} g_1^2 + |\lambda|^2 + \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + \text{Tr}\left(Y_e Y_e^\dagger\right) + \text{Tr}\left(Y_L Y_L^\dagger\right)\right) + 3Y_{\hat{E},i_2} \left(Y_L Y_{\hat{E}}^*\right)_{i_1}
\end{aligned} \tag{57}$$

$$\begin{aligned}
\beta_{Y_L}^{(2)} & = -\frac{1}{20} Y_L \left(75\Lambda_T^2 \Lambda_T^{*2} - 30|\Lambda_T|^2 \left(-2\lambda \lambda^* - 3 \text{Tr}\left(Y_u Y_u^\dagger\right) + 4g_2^2 - \lambda_T \lambda_T^* - \lambda_{TR} \lambda_{TR}^* - \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\right)\right) \\
& + 2\left(-189g_1^4 - 18g_1^2 g_2^2 - 165g_2^4 + 15\lambda |\lambda_T|^2 \lambda^* + 30\lambda^2 \lambda^{*2} - 12g_1^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 15|\lambda_{TR}|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right)\right) \\
& + 30\left(\left(Y_{\hat{E}} Y_{\hat{E}}^*\right)\right)^2 + 10|\lambda_{SR}|^2 \left(2\lambda \lambda^* + \left(Y_{\hat{E}} Y_{\hat{E}}^*\right)\right) + 60\left(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*\right) + 10|\lambda|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 10\left(\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*\right) + 10|\lambda|^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) + 4g_1^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 160g_3^2 \text{Tr}\left(Y_d Y_d^\dagger\right)
\end{aligned}$$

$$\begin{aligned}
& -12g_1^2\text{Tr}\left(Y_e Y_e^\dagger\right) - 12g_1^2\text{Tr}\left(Y_L Y_L^\dagger\right) + 30|\lambda|^2\text{Tr}\left(Y_u Y_u^\dagger\right) + 10\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*\right) \\
& + 90\text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) + 30\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) + 30\text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) + 30\text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger\right) \\
& + 60\text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^*\right) \\
& + \frac{1}{2}\left(-4|\lambda_{SR}|^2 Y_L \lambda_{SE}^* \lambda_{SE}^T - 3|\lambda_T|^2 Y_L \lambda_{SE}^* \lambda_{SE}^T - 4|\lambda|^2 Y_L \lambda_{SE}^* \lambda_{SE}^T + 12g_2^2 Y_e^T Y_e^* Y_L \right. \\
& - 9|\Lambda_T|^2 Y_e^T Y_e^* Y_L - 6|\lambda|^2 Y_e^T Y_e^* Y_L - 8Y_L Y_L^\dagger Y_L Y_L^\dagger Y_L - 8Y_L Y_L^\dagger Y_e^T Y_e^* Y_L \\
& - 2Y_L \lambda_{SE}^* \lambda_{SE}^T Y_L^\dagger Y_L - 2Y_L \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T - 8Y_e^T Y_e^* Y_L Y_L^\dagger Y_L - 8Y_e^T Y_e^* Y_e^T Y_e^* Y_L \\
& - 6Y_e^T Y_e^* Y_L \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 2Y_L \lambda_{SE}^* \lambda_{SE}^T \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) - 18Y_e^T Y_e^* Y_L \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 6Y_e^T Y_e^* Y_L \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + 3Y_L Y_L^\dagger Y_L \left(-2|\lambda|^2 - 2\text{Tr}\left(Y_e Y_e^\dagger\right) - 2\text{Tr}\left(Y_L Y_L^\dagger\right) - 2\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 3|\Lambda_T|^2 + 4g_2^2 - 6\text{Tr}\left(Y_d Y_d^\dagger\right)\right) \\
& - 6Y_e^T Y_e^* Y_L \text{Tr}\left(Y_L Y_L^\dagger\right) - 4\left(\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} \left(Y_L \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} - 8\left(Y_L Y_{\hat{E}}^*\right)_{i_1} \left(Y_L^T Y_L^* Y_{\hat{E}}\right)_{i_2} \\
& + Y_{\hat{E},i_2} \left(\left(12g_2^2 - 4|\lambda_{SR}|^2 - 6|\lambda_{TR}|^2 - 9|\Lambda_T|^2 - 6|\lambda|^2 - 14\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 18\text{Tr}\left(Y_d Y_d^\dagger\right) - 6\text{Tr}\left(Y_e Y_e^\dagger\right) \right. \right. \\
& \left. \left. - 6\text{Tr}\left(Y_L Y_L^\dagger\right)\right)\right) \left(Y_L Y_{\hat{E}}^*\right)_{i_1} \\
& - 2\left(4\left(Y_e^T Y_e^* Y_L Y_{\hat{E}}^*\right)_{i_1} + 4\left(Y_L Y_L^\dagger Y_L Y_{\hat{E}}^*\right)_{i_1} + \left(Y_L \lambda_{SE}^* \lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1}\right) \tag{58}
\end{aligned}$$

$$\beta_{Y_{\hat{B}\hat{a}rE},i_1}^{(1)} = \left(-3g_2^2 + 3\text{Tr}\left(Y_u Y_u^\dagger\right) + 4\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + \frac{3}{2}|\Lambda_T|^2 + \frac{3}{2}|\lambda_{TR}|^2 - \frac{9}{5}g_1^2 + |\lambda_{SR}|^2 + |\lambda|^2\right) Y_{\hat{B}\hat{a}rE,i_1} + \left(\lambda_{SE}^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} \tag{59}$$

$$\begin{aligned}
\beta_{Y_{\hat{B}\hat{a}rE},i_1}^{(2)} & = +\frac{1}{20}\left(378g_1^4 + 36g_1^2 g_2^2 + 330g_2^4 + 120g_2^2 |\Lambda_T|^2 - 60\lambda_{SR}^2 \lambda_{SR}^{*2} - 75\lambda_{TR}^2 \lambda_{TR}^{*2} - 30\Lambda_T |\lambda_T|^2 \Lambda_T^* \right. \\
& - 75\Lambda_T^2 \Lambda_T^{*2} - 30|\lambda_T|^2 \lambda^* - 60|\Lambda_T|^2 \lambda^* - 60\lambda^2 \lambda^{*2} - 30|\Lambda_T|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 20|\lambda|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& + 30|\lambda_{TR}|^2 \left(-2\Lambda_T \Lambda_T^* - 3\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 4g_2^2 - \lambda_T \lambda_T^* - \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 24g_1^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 120g_2^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 90|\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 60|\lambda|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 200\left(\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 - 40\left(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) - 20|\lambda|^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) \\
& - 10|\lambda_{SR}|^2 \left(2\left(3\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 4\lambda\lambda^* + \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right)\right) + 3\lambda_T \lambda_T^* + 6\lambda_{TR} \lambda_{TR}^*\right) - 90|\Lambda_T|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 60|\lambda|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 30|\Lambda_T|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) - 20|\lambda|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) - 30|\Lambda_T|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) \\
& - 20|\lambda|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 16g_1^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 320g_3^2 \text{Tr}\left(Y_u Y_u^\dagger\right) - 180\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 60\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 180\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right)\big) Y_{\hat{B}\hat{a}rE,i_1} \\
& - 2\left(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger Y_{\hat{E}}\right) \left(\lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1} - 2|\lambda_{SR}|^2 \left(\lambda_{SE}^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} - \frac{3}{2}|\lambda_T|^2 \left(\lambda_{SE}^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} - 2|\lambda|^2 \left(\lambda_{SE}^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} \\
& - \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) \left(\lambda_{SE}^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} - 2\left(\lambda_{SE}^T Y_L^\dagger Y_L \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} - \left(\lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_1} \tag{60}
\end{aligned}$$

$$\begin{aligned}
\beta_{Y_{\hat{E},i_1}}^{(1)} &= + \left( -3g_2^2 + 3\text{Tr}(Y_d Y_d^\dagger) + 4(Y_{\hat{E}} Y_{\hat{E}}^*) + \frac{3}{2}|\Lambda_T|^2 + \frac{3}{2}|\lambda_{TR}|^2 - \frac{9}{5}g_1^2 + |\lambda_{SR}|^2 + |\lambda|^2 + \text{Tr}(Y_e Y_e^\dagger) + \text{Tr}(Y_L Y_L^\dagger) \right) Y_{\hat{E},i_1} \\
&+ \left( \lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}} \right)_{i_1} + 3 \left( Y_L^T Y_L^* Y_{\hat{E}} \right)_{i_1} \tag{61}
\end{aligned}$$

$$\begin{aligned}
\beta_{Y_{\hat{E},i_1}}^{(2)} &= + \frac{1}{20} \left( 378g_1^4 + 36g_1^2 g_2^2 + 330g_2^4 + 120g_2^2 |\Lambda_T|^2 - 60\lambda_{SR}^2 \lambda_{SR}^{*2} - 75\lambda_{TR}^2 \lambda_{TR}^{*2} - 30\Lambda_T |\lambda_T|^2 \Lambda_T^* \right. \\
&- 75\Lambda_T^2 \Lambda_T^{*2} - 30\lambda |\lambda_T|^2 \lambda^* - 60\lambda |\Lambda_T|^2 \lambda^* - 60\lambda^2 \lambda^{*2} + 24g_1^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + 120g_2^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \\
&- 90|\Lambda_T|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 60|\lambda|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 200 \left( (Y_{\hat{E}} Y_{\hat{E}}^*) \right)^2 - 200 (Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*) \\
&+ 30|\lambda_{TR}|^2 \left( -2\Lambda_T \Lambda_T^* - 3(Y_{\hat{E}} Y_{\hat{E}}^*) + 4g_2^2 - \lambda_T \lambda_T^* - (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \right) - 30|\Lambda_T|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 20|\lambda|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\
&- 40 \left( \lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^* \right) - 20|\lambda|^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \\
&- 10|\lambda_{SR}|^2 \left( 2 \left( 3(Y_{\hat{E}} Y_{\hat{E}}^*) + 4\lambda\lambda^* + (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \right) + 3\lambda_T \lambda_T^* + 6\lambda_{TR} \lambda_{TR}^* \right) - 8g_1^2 \text{Tr}(Y_d Y_d^\dagger) \\
&+ 320g_3^2 \text{Tr}(Y_d Y_d^\dagger) - 180(Y_{\hat{E}} Y_{\hat{E}}^*) \text{Tr}(Y_d Y_d^\dagger) + 24g_1^2 \text{Tr}(Y_e Y_e^\dagger) - 60(Y_{\hat{E}} Y_{\hat{E}}^*) \text{Tr}(Y_e Y_e^\dagger) \\
&+ 24g_1^2 \text{Tr}(Y_L Y_L^\dagger) - 60(Y_{\hat{E}} Y_{\hat{E}}^*) \text{Tr}(Y_L Y_L^\dagger) - 90|\Lambda_T|^2 \text{Tr}(Y_u Y_u^\dagger) - 60|\lambda|^2 \text{Tr}(Y_u Y_u^\dagger) \\
&- 20\text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*) - 180\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) - 60\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 60\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) \\
&- 60\text{Tr}(Y_L Y_L^\dagger Y_L Y_L^\dagger) - 120\text{Tr}(Y_L Y_L^\dagger Y_e^T Y_e^*) Y_{\hat{E},i_1} \\
&- 2(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger Y_{\hat{E}}) (\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*)_{i_1} - 2|\lambda_{SR}|^2 (\lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} - \frac{3}{2}|\lambda_T|^2 (\lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} - 2|\lambda|^2 (\lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} \\
&- \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) (\lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} + 6g_2^2 (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - \frac{9}{2}|\Lambda_T|^2 (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - 3|\lambda|^2 (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - 7(Y_{\hat{E}} Y_{\hat{E}}^*) (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} \\
&- 9\text{Tr}(Y_d Y_d^\dagger) (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - 3\text{Tr}(Y_e Y_e^\dagger) (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - 3\text{Tr}(Y_L Y_L^\dagger) (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - (\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} - 4(Y_L^T Y_e^\dagger Y_{\hat{E}})_{i_1} \\
&- 4(Y_L^T Y_L^* Y_L^T Y_L^* Y_{\hat{E}})_{i_1} \tag{62}
\end{aligned}$$

$$\beta_{\lambda_{TR}}^{(1)} = 2\lambda_{TR} |\lambda_{SR}|^2 + 4\lambda_{TR}^2 \lambda_{TR}^* - 7g_2^2 \lambda_{TR} - \frac{3}{5}g_1^2 \lambda_{TR} + \lambda_{TR} |\lambda_T|^2 + \lambda_{TR} |\Lambda_T|^2 + \lambda_{TR} (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + \lambda_{TR} (Y_{\hat{E}} Y_{\hat{E}}^*) \tag{63}$$

$$\begin{aligned}
\beta_{\lambda_{TR}}^{(2)} &= -\frac{1}{50} \lambda_{TR} \left( -297g_1^4 - 90g_1^2 g_2^2 - 2425g_2^4 - 30g_1^2 |\Lambda_T|^2 + 50g_2^2 |\Lambda_T|^2 + 300\lambda_{SR}^2 \lambda_{SR}^{*2} + 525\lambda_{TR}^2 \lambda_{TR}^{*2} \right. \\
&+ 125\lambda_T^2 \lambda_T^{*2} + 50\Lambda_T |\lambda_T|^2 \Lambda_T^* + 150\Lambda_T^2 \Lambda_T^{*2} + 100\lambda |\lambda_T|^2 \lambda^* + 100\lambda |\Lambda_T|^2 \lambda^* - 60g_1^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \\
&+ 125|\Lambda_T|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + 50|\lambda|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + 150 \left( (Y_{\hat{E}} Y_{\hat{E}}^*) \right)^2 + 100(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*) \\
&- 5|\lambda_{TR}|^2 \left( 110g_2^2 - 25(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 25(Y_{\hat{E}} Y_{\hat{E}}^*) - 30\Lambda_T \Lambda_T^* - 40\lambda_T \lambda_T^* + 6g_1^2 \right) - 60g_1^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\
&+ 125|\Lambda_T|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 50|\lambda|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 150 \left( (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \right)^2 + 50(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*) \\
&+ 50 \left( \lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^* \right) + 50|\lambda_T|^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \tag{63}
\end{aligned}$$

$$\begin{aligned}
& + 50|\lambda_{SR}|^2 \left( 2\text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) + 4\lambda\lambda^* + 5\lambda_T \lambda_T^* + 8\lambda_{TR} \lambda_{TR}^* + \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + \left( Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^* \right) \right) + 150|\Lambda_T|^2 \text{Tr} \left( Y_d Y_d^\dagger \right) \\
& + 150 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \text{Tr} \left( Y_d Y_d^\dagger \right) + 50|\Lambda_T|^2 \text{Tr} \left( Y_e Y_e^\dagger \right) + 50 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \text{Tr} \left( Y_e Y_e^\dagger \right) + 50|\Lambda_T|^2 \text{Tr} \left( Y_L Y_L^\dagger \right) \\
& + 50 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \text{Tr} \left( Y_L Y_L^\dagger \right) + 150|\Lambda_T|^2 \text{Tr} \left( Y_u Y_u^\dagger \right) + 150 \left( Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^* \right) \text{Tr} \left( Y_u Y_u^\dagger \right) \tag{64}
\end{aligned}$$

$$\begin{aligned}
\beta_{\lambda_{SE}}^{(1)} & = +\lambda_{SE} \left( 2|\lambda|^2 + 2|\lambda_{SR}|^2 - \frac{12}{5}g_1^2 + \frac{3}{2}|\lambda_T|^2 + \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) \right) \\
& + 2 \left( Y_{\hat{B}\hat{a}rE, i_2} \left( \lambda_{SE} Y_{\hat{B}\hat{a}rE}^* \right)_{i_1} + Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} + \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} + Y_L^T Y_L^* \lambda_{SE} \right) \tag{65}
\end{aligned}$$

$$\begin{aligned}
\beta_{\lambda_{SE}}^{(2)} & = -4|\lambda_{SR}|^2 \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} - 3|\lambda_T|^2 \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} - 4|\lambda|^2 \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} - \frac{6}{5}g_1^2 Y_L^T Y_L^* \lambda_{SE} \\
& + 6g_2^2 Y_L^T Y_L^* \lambda_{SE} - 3|\Lambda_T|^2 Y_L^T Y_L^* \lambda_{SE} - 2|\lambda|^2 Y_L^T Y_L^* \lambda_{SE} - 2\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \\
& - 2\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^* \lambda_{SE} - 2Y_L^T Y_e^\dagger Y_e Y_L^* \lambda_{SE} - 2Y_L^T Y_L^* Y_L^T Y_L^* \lambda_{SE} - 2Y_L^T Y_L^* \lambda_{SE} \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \\
& - 2\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) - 6Y_L^T Y_L^* \lambda_{SE} \text{Tr} \left( Y_d Y_d^\dagger \right) - 2Y_L^T Y_L^* \lambda_{SE} \text{Tr} \left( Y_e Y_e^\dagger \right) \\
& - 2Y_L^T Y_L^* \lambda_{SE} \text{Tr} \left( Y_L Y_L^\dagger \right) \\
& - \frac{1}{25} \lambda_{SE} \left( 100\lambda_{SR}^2 \lambda_{SR}^{*2} + 75\lambda_T^2 \lambda_T^{*2} - 75|\lambda_T|^2 \left( 4g_2^2 - \Lambda_T \Lambda_T^* - \lambda_{TR} \lambda_{TR}^* \right) \right. \\
& \left. - 10|\lambda_{SR}|^2 \left( 15g_2^2 - 15\lambda_{TR} \lambda_{TR}^* + 3g_1^2 - 5 \left( Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^* \right) - 5 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \right) \right. \\
& \left. + 2 \left( -324g_1^4 + 50\lambda^2 \lambda^{*2} + 25 \left( Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^* \right) + 25 \left( \lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^* \right) - 30g_1^2 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) \right) \right. \\
& \left. + 5|\lambda|^2 \left( -3g_1^2 - 15g_2^2 + 15\Lambda_T \Lambda_T^* + 5 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + 5 \left( Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^* \right) + 15\text{Tr} \left( Y_d Y_d^\dagger \right) + 5\text{Tr} \left( Y_e Y_e^\dagger \right) + 5\text{Tr} \left( Y_L Y_L^\dagger \right) \right) \right. \\
& \left. + 15\text{Tr} \left( Y_u Y_u^\dagger \right) \right) \\
& + 25\text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger \right) + 25\text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^* \right) \\
& - \frac{1}{5} \left( 10|\lambda|^2 + 10|\lambda_{SR}|^2 + 15|\Lambda_T|^2 + 15|\lambda_{TR}|^2 + 20 \left( Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^* \right) - 30g_2^2 + 30\text{Tr} \left( Y_u Y_u^\dagger \right) + 6g_1^2 \right) Y_{\hat{B}\hat{a}rE, i_2} \left( \lambda_{SE} Y_{\hat{B}\hat{a}rE}^* \right)_{i_1} \\
& - \frac{6}{5}g_1^2 Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} + 6g_2^2 Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 2|\lambda_{SR}|^2 Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 3|\lambda_{TR}|^2 Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} \\
& - 3|\Lambda_T|^2 Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 2|\lambda|^2 Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 4 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 6\text{Tr} \left( Y_d Y_d^\dagger \right) Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} \\
& - 2\text{Tr} \left( Y_e Y_e^\dagger \right) Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 2\text{Tr} \left( Y_L Y_L^\dagger \right) Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} - 2 \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} \left( \lambda_{SE} \lambda_{SE}^\dagger Y_{\hat{E}} \right)_{i_1} - 2 \left( \lambda_{SE} Y_{\hat{B}\hat{a}rE}^* \right)_{i_1} \left( \lambda_{SE}^T \lambda_{SE}^* Y_{\hat{E}} \right)_{i_2} \\
& - 2 \left( \lambda_{SE}^T Y_{\hat{E}}^* \right)_{i_2} \left( Y_L^T Y_L^* Y_{\hat{E}} \right)_{i_1} - 2Y_{\hat{E}, i_1} \left( \lambda_{SE}^T Y_L^\dagger Y_L Y_{\hat{E}}^* \right)_{i_2} \tag{66}
\end{aligned}$$

$$\beta_\lambda^{(1)} = -\frac{3}{5}g_1^2 \lambda - 3g_2^2 \lambda + 2\lambda|\lambda_{SR}|^2 + \frac{3}{2}\lambda|\lambda_T|^2 + 3\lambda|\Lambda_T|^2 + 4\lambda^2 \lambda^* + \lambda \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + \lambda \left( Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^* \right)$$

$$+ \lambda \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) + 3\lambda \text{Tr} \left( Y_d Y_d^\dagger \right) + \lambda \text{Tr} \left( Y_e Y_e^\dagger \right) + \lambda \text{Tr} \left( Y_L Y_L^\dagger \right) + 3\lambda \text{Tr} \left( Y_u Y_u^\dagger \right) \tag{67}$$

$$\beta_\lambda^{(2)} = -\frac{1}{50} \lambda \left( -297g_1^4 - 90g_1^2 g_2^2 - 825g_2^4 - 600g_2^2 |\Lambda_T|^2 - 60g_1^2 |\lambda|^2 - 300g_2^2 |\lambda|^2 + 200\lambda_{SR}^2 \lambda_{SR}^{*2} \right)$$

$$\begin{aligned}
& + 150\lambda_T^2\lambda_T^{*,2} + 150\Lambda_T|\lambda_{TR}|^2\Lambda_T^* + 375\Lambda_T^2\Lambda_T^{*,2} + 600\lambda|\Lambda_T|^2\lambda^* + 500\lambda^2\lambda^{*,2} \\
& - 150|\lambda_T|^2\left(-2\Lambda_T\Lambda_T^* + 4g_2^2 - \lambda\lambda^* - \lambda_{TR}\lambda_{TR}^*\right) - 60g_1^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 75|\lambda_{TR}|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\
& + 75|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 150|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 150\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 + 300\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) \\
& - 10|\lambda_{SR}|^2\left(-15\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 15\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 20\lambda\lambda^* + 30g_2^2 - 30\lambda_{TR}\lambda_{TR}^* + 6g_1^2\right) - 60g_1^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 75|\lambda_{TR}|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + 75|\Lambda_T|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + 150|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + 150\left(\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 + 150\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 150\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) - 120g_1^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 100|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 20g_1^2\text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 800g_3^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 225|\Lambda_T|^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 450|\lambda|^2\text{Tr}\left(Y_d Y_d^\dagger\right) - 60g_1^2\text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + 75|\Lambda_T|^2\text{Tr}\left(Y_e Y_e^\dagger\right) + 150|\lambda|^2\text{Tr}\left(Y_e Y_e^\dagger\right) - 60g_1^2\text{Tr}\left(Y_L Y_L^\dagger\right) + 75|\Lambda_T|^2\text{Tr}\left(Y_L Y_L^\dagger\right) \\
& + 150|\lambda|^2\text{Tr}\left(Y_L Y_L^\dagger\right) - 40g_1^2\text{Tr}\left(Y_u Y_u^\dagger\right) - 800g_3^2\text{Tr}\left(Y_u Y_u^\dagger\right) + 225|\Lambda_T|^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 450|\lambda|^2\text{Tr}\left(Y_u Y_u^\dagger\right) + 100\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger\right) + 150\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*\right) + 450\text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) \\
& + 300\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) + 150\text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) + 150\text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger\right) + 300\text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^*\right) \\
& + 450\text{Tr}\left(Y_u Y_u^\dagger Y_u Y_u^\dagger\right)
\end{aligned} \tag{68}$$

$$\begin{aligned}
\beta_{\lambda_{SR}}^{(1)} &= -\frac{3}{5}g_1^2\lambda_{SR} - 3g_2^2\lambda_{SR} + 3\lambda_{SR}|\lambda_{TR}|^2 + \frac{3}{2}\lambda_{SR}|\lambda_T|^2 + 2\lambda_{SR}|\lambda|^2 + 4\lambda_{SR}^2\lambda_{SR}^* + \lambda_{SR}\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + \lambda_{SR}\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& + \lambda_{SR}\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right)
\end{aligned} \tag{69}$$

$$\begin{aligned}
\beta_{\lambda_{SR}}^{(2)} &= -\frac{1}{50}\lambda_{SR}\left(-297g_1^4 - 90g_1^2g_2^2 - 825g_2^4 - 600g_2^2|\lambda_T|^2 - 60g_1^2|\lambda|^2 - 300g_2^2|\lambda|^2 + 500\lambda_{SR}^2\lambda_{SR}^{*,2}\right) \\
& + 375\lambda_{TR}^2\lambda_{TR}^{*,2} + 150\lambda_T^2\lambda_T^{*,2} + 150\Lambda_T|\lambda_T|^2\Lambda_T^* + 300\lambda|\Lambda_T|^2\lambda^* + 200\lambda^2\lambda^{*,2} - 60g_1^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\
& + 75|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 150|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 150\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 + 100\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) \\
& - 75|\lambda_{TR}|^2\left(-2\Lambda_T\Lambda_T^* - 4\lambda_T\lambda_T^* + 8g_2^2 - \left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - \left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right) - 60g_1^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + 75|\Lambda_T|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 150|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + 150\left(\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 + 150\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*\right) + 150\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) \\
& - 10|\lambda_{SR}|^2\left(-10\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - 15\lambda_T\lambda_T^* - 15\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 15\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 20\lambda\lambda^* + 30g_2^2 - 60\lambda_{TR}\lambda_{TR}^* + 6g_1^2\right) \\
& - 120g_1^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 300|\lambda|^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 150\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_d Y_d^\dagger\right) + 100|\lambda|^2\text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + 50\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_e Y_e^\dagger\right) + 100|\lambda|^2\text{Tr}\left(Y_L Y_L^\dagger\right) + 50\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L Y_L^\dagger\right) + 300|\lambda|^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 150\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right)\text{Tr}\left(Y_u Y_u^\dagger\right) + 100\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger\right) + 100\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*\right)
\end{aligned} \tag{70}$$

$$\beta_{\lambda_T}^{(1)} = \frac{1}{2}\lambda_T\left(-16g_2^2 + 2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 4|\lambda|^2 + 4|\lambda_{SR}|^2 + 4|\Lambda_T|^2 + 4|\lambda_{TR}|^2 + 7|\lambda_T|^2\right) \tag{71}$$

$$\begin{aligned}
\beta_{\lambda_T}^{(2)} = & -\frac{1}{5}\lambda_T \left( -320g_2^4 - 60g_2^2|\lambda_T|^2 - 6g_1^2|\Lambda_T|^2 + 10g_2^2|\Lambda_T|^2 - 6g_1^2|\lambda|^2 - 30g_2^2|\lambda|^2 + 20\lambda_{SR}^2\lambda_{SR}^{*2} \right. \\
& + 30\lambda_{TR}^2\lambda_{TR}^{*2} + 40\lambda_T^2\lambda_T^{*2} + 25\Lambda_T|\lambda_T|^2\Lambda_T^* + 30\Lambda_T^2\Lambda_T^{*2} + 20\lambda|\lambda_T|^2\lambda^* + 50\lambda|\Lambda_T|^2\lambda^* \\
& + 20\lambda^2\lambda^{*2} + 10|\Lambda_T|^2(Y_{\hat{E}}Y_{\hat{E}}^*) + 10|\lambda|^2(Y_{\hat{E}}Y_{\hat{E}}^*) + 10|\Lambda_T|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 10|\lambda|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \\
& + 2|\lambda_{SR}|^2(10\lambda_T\lambda_T^* - 15g_2^2 + 25\lambda_{TR}\lambda_{TR}^* - 3g_1^2 + 5(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 5(Y_{\hat{E}}Y_{\hat{E}}^*)) \\
& + |\lambda_{TR}|^2(10g_2^2 + 10(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 10(Y_{\hat{E}}Y_{\hat{E}}^*) + 25\lambda_T\lambda_T^* - 6g_1^2) + 10(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) \\
& + 10(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*) - 12g_1^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) + 10|\lambda_T|^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) + 30|\Lambda_T|^2\text{Tr}(Y_d Y_d^\dagger) \\
& + 30|\lambda|^2\text{Tr}(Y_d Y_d^\dagger) + 10|\Lambda_T|^2\text{Tr}(Y_e Y_e^\dagger) + 10|\lambda|^2\text{Tr}(Y_e Y_e^\dagger) + 10|\Lambda_T|^2\text{Tr}(Y_L Y_L^\dagger) \\
& + 10|\lambda|^2\text{Tr}(Y_L Y_L^\dagger) + 30|\Lambda_T|^2\text{Tr}(Y_u Y_u^\dagger) + 30|\lambda|^2\text{Tr}(Y_u Y_u^\dagger) + 10\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger) \\
& + 10\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*) \Big) \tag{72}
\end{aligned}$$

$$\beta_{Y_u}^{(1)} = 3Y_u Y_u^\dagger Y_u + Y_u \left( -3g_2^2 + 3\text{Tr}(Y_u Y_u^\dagger) - \frac{13}{15}g_1^2 - \frac{16}{3}g_3^2 + \frac{3}{2}|\Lambda_T|^2 + |\lambda|^2 + (Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \right) + Y_u Y_d^\dagger Y_d \tag{73}$$

$$\begin{aligned}
\beta_{Y_u}^{(2)} = & +\frac{2}{5}g_1^2 Y_u Y_u^\dagger Y_u + 6g_2^2 Y_u Y_u^\dagger Y_u - \frac{9}{2}|\Lambda_T|^2 Y_u Y_u^\dagger Y_u - 3|\lambda|^2 Y_u Y_u^\dagger Y_u \\
& - 2Y_u Y_d^\dagger Y_d Y_d^\dagger Y_d - 2Y_u Y_d^\dagger Y_d Y_u^\dagger Y_u - 4Y_u Y_u^\dagger Y_u Y_u^\dagger Y_u - 3Y_u Y_u^\dagger Y_u (Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \\
& + Y_u Y_d^\dagger Y_d \left( -3\text{Tr}(Y_d Y_d^\dagger) + \frac{2}{5}g_1^2 - \frac{3}{2}|\Lambda_T|^2 - |\lambda|^2 - \text{Tr}(Y_e Y_e^\dagger) - \text{Tr}(Y_L Y_L^\dagger) - (Y_{\hat{E}}Y_{\hat{E}}^*) \right) \\
& - 9Y_u Y_u^\dagger Y_u \text{Tr}(Y_u Y_u^\dagger) \\
& + Y_u \left( \frac{3913}{450}g_1^4 + g_1^2 g_2^2 + \frac{33}{2}g_2^4 + \frac{136}{45}g_1^2 g_3^2 + 8g_2^2 g_3^2 + \frac{128}{9}g_3^4 - \frac{15}{4}\Lambda_T^2 \Lambda_T^{*2} - \frac{3}{2}\lambda|\lambda_T|^2\lambda^* - 3\lambda^2\lambda^{*2} \right. \\
& - |\lambda|^2(Y_{\hat{E}}Y_{\hat{E}}^*) + \frac{6}{5}g_1^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - \frac{3}{2}|\lambda_{TR}|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 3((Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*))^2 - |\lambda_{SR}|^2(2\lambda\lambda^* + (Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*)) \\
& - (Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) - |\lambda|^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) - 3|\lambda|^2\text{Tr}(Y_d Y_d^\dagger) - |\lambda|^2\text{Tr}(Y_e Y_e^\dagger) \\
& + \frac{3}{2}|\Lambda_T|^2(-2\lambda\lambda^* - 3\text{Tr}(Y_d Y_d^\dagger) + 4g_2^2 - \lambda_T\lambda_T^* - \lambda_{TR}\lambda_{TR}^* - \text{Tr}(Y_e Y_e^\dagger) - \text{Tr}(Y_L Y_L^\dagger) - (Y_{\hat{E}}Y_{\hat{E}}^*)) \\
& - |\lambda|^2\text{Tr}(Y_L Y_L^\dagger) + \frac{4}{5}g_1^2\text{Tr}(Y_u Y_u^\dagger) + 16g_3^2\text{Tr}(Y_u Y_u^\dagger) - 3\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& \left. - 9\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) \right) \tag{74}
\end{aligned}$$

### 3.4 Bilinear Superpotential Parameters

$$\begin{aligned}
\beta_{\mu_E}^{(1)} = & 2Y_{B\hat{a}rE, i_2}(\mu_E Y_{B\hat{a}rE}^*)_{i_1} + 2Y_{\hat{E}, i_1}(\mu_E^T Y_{\hat{E}}^*)_{i_2} + 2Y_L^T Y_L^* \mu_E - \frac{12}{5}g_1^2 \mu_E + \lambda_{SE}\lambda_{SE}^\dagger \mu_E + \mu_E \lambda_{SE}^\dagger \lambda_{SE} \tag{75} \\
\beta_{\mu_E}^{(2)} = & +\frac{648}{25}g_1^4 \mu_E - 2|\lambda_{SR}|^2 \lambda_{SE}\lambda_{SE}^\dagger \mu_E - \frac{3}{2}|\lambda_T|^2 \lambda_{SE}\lambda_{SE}^\dagger \mu_E - 2|\lambda|^2 \lambda_{SE}\lambda_{SE}^\dagger \mu_E
\end{aligned}$$



$$\begin{aligned}
& -2|\lambda_{SR}|^2\mu_E\lambda_{SE}^\dagger\lambda_{SE} - \frac{3}{2}|\lambda_T|^2\mu_E\lambda_{SE}^\dagger\lambda_{SE} - 2|\lambda|^2\mu_E\lambda_{SE}^\dagger\lambda_{SE} - \frac{6}{5}g_1^2Y_L^TY_L^*\mu_E \\
& + 6g_2^2Y_L^TY_L^*\mu_E - 3|\Lambda_T|^2Y_L^TY_L^*\mu_E - 2|\lambda|^2Y_L^TY_L^*\mu_E - \lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger\mu_E \\
& - \mu_E\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE} - 2\mu_E\lambda_{SE}^\dagger Y_L^TY_L^*\lambda_{SE} - 2Y_L^TY_e^\dagger Y_e Y_L^*\mu_E - 2Y_L^TY_L^*Y_L^TY_L^*\mu_E \\
& - 2Y_L^TY_L^*\mu_E(Y_{\hat{E}}Y_{\hat{E}}^*) - \lambda_{SE}\lambda_{SE}^\dagger\mu_E\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) - \mu_E\lambda_{SE}^\dagger\lambda_{SE}\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) \\
& - 6Y_L^TY_L^*\mu_E\text{Tr}(Y_dY_d^\dagger) - 2Y_L^TY_L^*\mu_E\text{Tr}(Y_eY_e^\dagger) - 2Y_L^TY_L^*\mu_E\text{Tr}(Y_LY_L^\dagger) \\
& - \frac{1}{5}(10|\lambda|^2 + 10|\lambda_{SR}|^2 + 15|\Lambda_T|^2 + 15|\lambda_{TR}|^2 + 20(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - 30g_2^2 + 30\text{Tr}(Y_uY_u^\dagger) + 6g_1^2)Y_{\hat{B}\hat{a}rE,i_2}(\mu_EY_{\hat{B}\hat{a}rE}^*)_{i_1} \\
& - \frac{6}{5}g_1^2Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} + 6g_2^2Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 2|\lambda_{SR}|^2Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 3|\lambda_{TR}|^2Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} \\
& - 3|\Lambda_T|^2Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 2|\lambda|^2Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 4(Y_{\hat{E}}Y_{\hat{E}}^*)Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 6\text{Tr}(Y_dY_d^\dagger)Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} \\
& - 2\text{Tr}(Y_eY_e^\dagger)Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 2\text{Tr}(Y_LY_L^\dagger)Y_{\hat{E},i_1}(\mu_E^TY_{\hat{E}}^*)_{i_2} - 2(\lambda_{SE}^TY_{\hat{E}}^*)_{i_2}(\mu_E\lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} - 2(\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*)_{i_1}(\mu_E^T\lambda_{SE}^*Y_{\hat{B}\hat{a}rE})_{i_2} \\
& - 2(\mu_E^TY_{\hat{E}}^*)_{i_2}(Y_L^TY_L^*Y_{\hat{E}})_{i_1} - 2Y_{\hat{E},i_1}(\mu_E^TY_L^\dagger Y_L Y_{\hat{E}}^*)_{i_2} \tag{76}
\end{aligned}$$

$$\begin{aligned}
\beta_\mu^{(1)} &= -\frac{3}{5}g_1^2\mu - 3g_2^2\mu + 3\mu|\Lambda_T|^2 + 2\mu|\lambda|^2 + \mu(Y_{\hat{E}}Y_{\hat{E}}^*) + \mu(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) + 3\mu\text{Tr}(Y_dY_d^\dagger) + \mu\text{Tr}(Y_eY_e^\dagger) \\
& + \mu\text{Tr}(Y_LY_L^\dagger) + 3\mu\text{Tr}(Y_uY_u^\dagger) \tag{77}
\end{aligned}$$

$$\begin{aligned}
\beta_\mu^{(2)} &= \frac{1}{50}\mu(297g_1^4 + 90g_1^2g_2^2 + 825g_2^4 - 375\Lambda_T^2\Lambda_T^{*,2} - 150\lambda|\lambda_T|^2\lambda^* - 300\lambda^2\lambda^{*,2} + 60g_1^2(Y_{\hat{E}}Y_{\hat{E}}^*) \\
& - 75|\lambda_{TR}|^2(Y_{\hat{E}}Y_{\hat{E}}^*) - 50|\lambda|^2(Y_{\hat{E}}Y_{\hat{E}}^*) - 150((Y_{\hat{E}}Y_{\hat{E}}^*))^2 - 300(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*) + 60g_1^2(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) \\
& - 75|\lambda_{TR}|^2(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - 50|\lambda|^2(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - 150((Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*))^2 - 50|\lambda_{SR}|^2(4\lambda\lambda^* + (Y_{\hat{E}}Y_{\hat{E}}^*) + (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*)) \\
& - 50(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*) - 50(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^TY_{\hat{E}}^*) - 100|\lambda|^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) - 20g_1^2\text{Tr}(Y_dY_d^\dagger) \\
& + 800g_3^2\text{Tr}(Y_dY_d^\dagger) - 150|\lambda|^2\text{Tr}(Y_dY_d^\dagger) + 60g_2^2\text{Tr}(Y_eY_e^\dagger) - 50|\lambda|^2\text{Tr}(Y_eY_e^\dagger) \\
& + 60g_1^2\text{Tr}(Y_LY_L^\dagger) - 50|\lambda|^2\text{Tr}(Y_LY_L^\dagger) \\
& + 75|\Lambda_T|^2(8g_2^2 - 2\lambda_{TR}\lambda_{TR}^* - 2\lambda_T\lambda_T^* - 4\lambda\lambda^* - (Y_{\hat{E}}Y_{\hat{E}}^*) - (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - 3\text{Tr}(Y_dY_d^\dagger) - \text{Tr}(Y_eY_e^\dagger) \\
& - \text{Tr}(Y_LY_L^\dagger) - 3\text{Tr}(Y_uY_u^\dagger)) \\
& + 40g_1^2\text{Tr}(Y_uY_u^\dagger) + 800g_3^2\text{Tr}(Y_uY_u^\dagger) - 150|\lambda|^2\text{Tr}(Y_uY_u^\dagger) - 50\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger Y_L^TY_L^*) \\
& - 450\text{Tr}(Y_dY_d^\dagger Y_dY_d^\dagger) - 300\text{Tr}(Y_dY_u^\dagger Y_u Y_d^\dagger) - 150\text{Tr}(Y_eY_e^\dagger Y_eY_e^\dagger) - 150\text{Tr}(Y_LY_L^\dagger Y_LY_L^\dagger) \\
& - 300\text{Tr}(Y_LY_L^\dagger Y_e^TY_e^*) - 450\text{Tr}(Y_uY_u^\dagger Y_uY_u^\dagger) \tag{78}
\end{aligned}$$

$$\beta_{\mu_R}^{(1)} = 2\mu_R|\lambda_{SR}|^2 - 3g_2^2\mu_R + 3\mu_R|\lambda_{TR}|^2 - \frac{3}{5}g_1^2\mu_R + \mu_R(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) + \mu_R(Y_{\hat{E}}Y_{\hat{E}}^*) \tag{79}$$

$$\begin{aligned}
\beta_{\mu_R}^{(2)} = & \frac{1}{50}\mu_R\left(297g_1^4 + 90g_1^2g_2^2 + 825g_2^4 - 300\lambda_{SR}^2\lambda_{SR}^{*2} - 375\lambda_{TR}^2\lambda_{TR}^{*2} + 60g_1^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 75|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right. \\
& - 50|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 150\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 - 100\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) \\
& + 75|\lambda_{TR}|^2\left(-2\lambda_T\lambda_T^* - 2\Lambda_T\Lambda_T^* + 8g_2^2 - \left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) - \left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right) + 60g_1^2\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) - 75|\Lambda_T|^2\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) \\
& - 50|\lambda|^2\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) - 150\left(\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right)\right)^2 - 50\left(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*\right) - 50\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) \\
& - 50|\lambda_{SR}|^2\left(2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 3\lambda_T\lambda_T^* + 4\lambda\lambda^* + 6\lambda_{TR}\lambda_{TR}^* + \left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + \left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right)\right) - 150\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 50\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_e Y_e^\dagger\right) - 50\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L Y_L^\dagger\right) - 150\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right)\text{Tr}\left(Y_u Y_u^\dagger\right) \tag{80}
\end{aligned}$$

$$\beta_{M_S}^{(1)} = M_S\left(2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 3|\lambda_T|^2 + 4|\lambda|^2 + 4|\lambda_{SR}|^2\right) \tag{81}$$

$$\begin{aligned}
\beta_{M_S}^{(2)} = & -\frac{2}{5}M_S\left(20\lambda_{SR}^2\lambda_{SR}^{*2} + 15\lambda_T^2\lambda_T^{*2} + 15|\lambda_T|^2\left(-4g_2^2 + \Lambda_T\Lambda_T^* + \lambda_{TR}\lambda_{TR}^*\right)\right. \\
& + 2|\lambda_{SR}|^2\left(-15g_2^2 + 15\lambda_{TR}\lambda_{TR}^* - 3g_1^2 + 5\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) + 5\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right) \\
& + 2\left(10\lambda^2\lambda^{*2} + 5\left(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*\right) + 5\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) - 6g_1^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right)\right) \\
& + |\lambda|^2\left(-3g_1^2 - 15g_2^2 + 15\Lambda_T\Lambda_T^* + 5\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 5\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) + 15\text{Tr}\left(Y_d Y_d^\dagger\right) + 5\text{Tr}\left(Y_e Y_e^\dagger\right) + 5\text{Tr}\left(Y_L Y_L^\dagger\right)\right. \\
& \left.+ 15\text{Tr}\left(Y_u Y_u^\dagger\right)\right) \\
& + 5\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger\right) + 5\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*\right) \tag{82}
\end{aligned}$$

### 3.5 Bilinear Soft-Breaking Parameters

$$\begin{aligned}
\beta_{B_E}^{(1)} = & -\frac{12}{5}g_1^2 B_E + 4\lambda_{SE}B_R\lambda_{SR}^* - 4\lambda_{SE}B_\mu\lambda^* + \lambda_{SE}\lambda_{SE}^\dagger B_E + B_E\lambda_{SE}^\dagger\lambda_{SE} + 2Y_L^T Y_L^* B_E + 2\lambda_{SE}\text{Tr}\left(\lambda_{SE}^\dagger B_E\right) \\
& + 2Y_{B\hat{a}rE,i_2}\left(B_E Y_{B\hat{a}rE}^*\right)_{i_1} + 2Y_{\hat{E},i_1}\left(B_E^T Y_{\hat{E}}^*\right)_{i_2} \tag{83}
\end{aligned}$$

$$\begin{aligned}
\beta_{B_E}^{(2)} = & +\frac{648}{25}g_1^4 B_E - 2|\lambda_{SR}|^2\lambda_{SE}\lambda_{SE}^\dagger B_E - \frac{3}{2}|\lambda_T|^2\lambda_{SE}\lambda_{SE}^\dagger B_E - 2|\lambda|^2\lambda_{SE}\lambda_{SE}^\dagger B_E \\
& - 2|\lambda_{SR}|^2 B_E\lambda_{SE}^\dagger\lambda_{SE} - \frac{3}{2}|\lambda_T|^2 B_E\lambda_{SE}^\dagger\lambda_{SE} - 2|\lambda|^2 B_E\lambda_{SE}^\dagger\lambda_{SE} - \frac{6}{5}g_1^2 Y_L^T Y_L^* B_E \\
& + 6g_2^2 Y_L^T Y_L^* B_E - 3|\Lambda_T|^2 Y_L^T Y_L^* B_E - 2|\lambda|^2 Y_L^T Y_L^* B_E - \lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger B_E \\
& - B_E\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE} - 2B_E\lambda_{SE}^\dagger Y_L^T Y_L^* \lambda_{SE} - 2Y_L^T Y_e^\dagger Y_e Y_L^* B_E - 2Y_L^T Y_L^* Y_L^T Y_L^* B_E \\
& - 2Y_L^T Y_L^* B_E\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - \frac{4}{5}\lambda_{SE}B_R\lambda_{SR}^*\left(10|\lambda_{SR}|^2 + 15|\lambda_{TR}|^2 - 45g_2^2 + 5\left(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*\right) + 5\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 9g_1^2\right) \\
& - 4\lambda_{SE}\left(Y_{B\hat{a}rE}\lambda_{SE}^\dagger B_E Y_{B\hat{a}rE}^*\right) - 4\lambda_{SE}\left(\lambda_{SE}^\dagger Y_{\hat{E}} B_E^T Y_{\hat{E}}^*\right) - \lambda_{SE}\lambda_{SE}^\dagger B_E\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) \\
& - B_E\lambda_{SE}^\dagger\lambda_{SE}\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - 6Y_L^T Y_L^* B_E\text{Tr}\left(Y_d Y_d^\dagger\right) - 2Y_L^T Y_L^* B_E\text{Tr}\left(Y_e Y_e^\dagger\right)
\end{aligned}$$

$$\begin{aligned}
& -2Y_L^T Y_L^* B_E \text{Tr}(Y_L Y_L^\dagger) \\
& + \frac{4}{5} \lambda_{SE} B_\mu \lambda^* \left( -9g_1^2 - 45g_2^2 + 15|\Lambda_T|^2 + 10|\lambda|^2 + 5(Y_{\hat{E}} Y_{\hat{E}}^*) + 5(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 15\text{Tr}(Y_d Y_d^\dagger) + 5\text{Tr}(Y_e Y_e^\dagger) + 5\text{Tr}(Y_L Y_L^\dagger) \right. \\
& \left. + 15\text{Tr}(Y_u Y_u^\dagger) \right) \\
& + \frac{72}{5} g_1^2 \lambda_{SE} \text{Tr}(\lambda_{SE}^\dagger B_E) - 4\lambda_{SE} \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger B_E \lambda_{SE}^\dagger) - 4\lambda_{SE} \text{Tr}(\lambda_{SE}^\dagger Y_L^T Y_L^* B_E) - \frac{6}{5} g_1^2 Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} \\
& + 6g_2^2 Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} - 2|\lambda_{SR}|^2 Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} - 3|\lambda_{TR}|^2 Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} - 3|\Lambda_T|^2 Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} \\
& - 2|\lambda|^2 Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} - 4(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*)_{i_2} Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} - 6\text{Tr}(Y_u Y_u^\dagger) Y_{\hat{B}\hat{a}rE, i_2} (B_E Y_{\hat{B}\hat{a}rE}^*)_{i_1} - \frac{6}{5} g_1^2 Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} \\
& + 6g_2^2 Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 2|\lambda_{SR}|^2 Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 3|\lambda_{TR}|^2 Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 3|\Lambda_T|^2 Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} \\
& - 2|\lambda|^2 Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 4(Y_{\hat{E}} Y_{\hat{E}}^*)_{i_2} Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 6\text{Tr}(Y_d Y_d^\dagger) Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 2\text{Tr}(Y_e Y_e^\dagger) Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} \\
& - 2\text{Tr}(Y_L Y_L^\dagger) Y_{\hat{E}, i_1} (B_E^T Y_{\hat{E}}^*)_{i_2} - 2(\lambda_{SE}^T Y_{\hat{E}}^*)_{i_2} (B_E \lambda_{SE}^\dagger Y_{\hat{E}})_{i_1} - 2(B_E^T Y_{\hat{E}}^*)_{i_2} (Y_L^T Y_L^* Y_{\hat{E}})_{i_1} - 2(\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*)_{i_1} (B_E^T \lambda_{SE}^* Y_{\hat{B}\hat{a}rE})_{i_2} - \\
& \hspace{15em} (84)
\end{aligned}$$

$$\begin{aligned}
\beta_{B_\mu}^{(1)} = & +B_\mu \left( -\frac{3}{5} g_1^2 - 3g_2^2 + 3|\Lambda_T|^2 + 6|\lambda|^2 + (Y_{\hat{E}} Y_{\hat{E}}^*) + (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 3\text{Tr}(Y_d Y_d^\dagger) + \text{Tr}(Y_e Y_e^\dagger) + \text{Tr}(Y_L Y_L^\dagger) \right. \\
& \left. + 3\text{Tr}(Y_u Y_u^\dagger) \right) \\
& - 2\lambda \left( 2B_R \lambda_{SR}^* + \text{Tr}(\lambda_{SE}^\dagger B_E) \right) \hspace{15em} (85)
\end{aligned}$$

$$\begin{aligned}
\beta_{B_\mu}^{(2)} = & +\frac{1}{50} B_\mu \left( 297g_1^4 + 90g_1^2 g_2^2 + 825g_2^4 - 375\Lambda_T^2 \Lambda_T^{*2} - 700\lambda^2 \lambda^{*2} + 60g_1^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 50|\lambda_{SR}|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \right. \\
& - 75|\lambda_{TR}|^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 150 \left( (Y_{\hat{E}} Y_{\hat{E}}^*) \right)^2 - 300(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*) + 60g_1^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 50|\lambda_{SR}|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\
& - 75|\lambda_{TR}|^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 150 \left( (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \right)^2 - 50(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*) - 50(\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*) \\
& - 20g_1^2 \text{Tr}(Y_d Y_d^\dagger) + 800g_3^2 \text{Tr}(Y_d Y_d^\dagger) + 60g_1^2 \text{Tr}(Y_e Y_e^\dagger) + 60g_1^2 \text{Tr}(Y_L Y_L^\dagger) \\
& + 10|\lambda|^2 (36g_1^2 + 180g_2^2 - 20\lambda_{SR} \lambda_{SR}^* - 15\lambda_T \lambda_T^* - 25(Y_{\hat{E}} Y_{\hat{E}}^*) - 25(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 10\text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) - 75\text{Tr}(Y_d Y_d^\dagger) \\
& - 25\text{Tr}(Y_e Y_e^\dagger) - 25\text{Tr}(Y_L Y_L^\dagger) - 75\text{Tr}(Y_u Y_u^\dagger)) \\
& + 75|\Lambda_T|^2 (8g_2^2 - 2\lambda_{TR} \lambda_{TR}^* - 2\lambda_T \lambda_T^* - 12\lambda \lambda^* - (Y_{\hat{E}} Y_{\hat{E}}^*) - (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 3\text{Tr}(Y_d Y_d^\dagger) - \text{Tr}(Y_e Y_e^\dagger) \\
& - \text{Tr}(Y_L Y_L^\dagger) - 3\text{Tr}(Y_u Y_u^\dagger)) \\
& + 40g_1^2 \text{Tr}(Y_u Y_u^\dagger) + 800g_3^2 \text{Tr}(Y_u Y_u^\dagger) - 50\text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*) - 450\text{Tr}(Y_d Y_d^\dagger Y_d Y_d^\dagger) \\
& - 300\text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 150\text{Tr}(Y_e Y_e^\dagger Y_e Y_e^\dagger) - 150\text{Tr}(Y_L Y_L^\dagger Y_L Y_L^\dagger) - 300\text{Tr}(Y_L Y_L^\dagger Y_e^T Y_e^*) \\
& - 450\text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger)
\end{aligned}$$

$$\begin{aligned}
& + \frac{4}{5} \lambda \left( B_R \lambda_{SR}^* \left( 10 |\lambda_{SR}|^2 + 15 |\lambda_{TR}|^2 - 45 g_2^2 + 5 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) + 5 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) - 9 g_1^2 \right) + 5 \left( Y_{B\hat{a}rE} \lambda_{SE}^\dagger B_E Y_{B\hat{a}rE}^* \right) \right. \\
& \left. + 5 \left( \lambda_{SE}^\dagger Y_{\hat{E}} B_E^T Y_{\hat{E}}^* \right) - 18 g_1^2 \text{Tr} \left( \lambda_{SE}^\dagger B_E \right) + 5 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger B_E \lambda_{SE}^\dagger \right) + 5 \text{Tr} \left( \lambda_{SE}^\dagger Y_L^T Y_L^* B_E \right) \right) \quad (86)
\end{aligned}$$

$$\beta_{B_R}^{(1)} = 2 \lambda_{SR} \left( -2 B_\mu \lambda^* + \text{Tr} \left( \lambda_{SE}^\dagger B_E \right) \right) + B_R \left( -3 g_2^2 + 3 |\lambda_{TR}|^2 + 6 |\lambda_{SR}|^2 - \frac{3}{5} g_1^2 + \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) \right) \quad (87)$$

$$\begin{aligned}
\beta_{B_R}^{(2)} = & + \frac{1}{50} B_R \left( 297 g_1^4 + 90 g_1^2 g_2^2 + 825 g_2^4 - 700 \lambda_{SR}^2 \lambda_{SR}^{*,2} - 375 \lambda_{TR}^2 \lambda_{TR}^{*,2} + 60 g_1^2 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) - 75 |\Lambda_T|^2 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \right. \\
& - 50 |\lambda|^2 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) - 150 \left( \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \right)^2 - 100 \left( Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^* \right) \\
& + 75 |\lambda_{TR}|^2 \left( -2 \lambda_T \lambda_T^* - 2 \Lambda_T \Lambda_T^* + 8 g_2^2 - \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) - \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \right) + 60 g_1^2 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) - 75 |\Lambda_T|^2 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) \\
& - 50 |\lambda|^2 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) - 150 \left( \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) \right)^2 - 50 \left( Y_{B\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{B\hat{a}rE}^* \right) - 50 \left( \lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^* \right) \\
& + 10 |\lambda_{SR}|^2 \left( -10 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) - 15 \lambda_T \lambda_T^* + 180 g_2^2 - 20 \lambda \lambda^* - 25 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) - 25 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + 36 g_1^2 - 90 \lambda_{TR} \lambda_{TR}^* \right) \\
& - 150 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \text{Tr} \left( Y_d Y_d^\dagger \right) - 50 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \text{Tr} \left( Y_e Y_e^\dagger \right) - 50 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \text{Tr} \left( Y_L Y_L^\dagger \right) - 150 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - \frac{4}{5} \lambda_{SR} \left( 5 \left( Y_{B\hat{a}rE} \lambda_{SE}^\dagger B_E Y_{B\hat{a}rE}^* \right) + 5 \left( \lambda_{SE}^\dagger Y_{\hat{E}} B_E^T Y_{\hat{E}}^* \right) \right. \\
& - B_\mu \lambda^* \left( -9 g_1^2 - 45 g_2^2 + 15 |\Lambda_T|^2 + 10 |\lambda|^2 + 5 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + 5 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) + 15 \text{Tr} \left( Y_d Y_d^\dagger \right) + 5 \text{Tr} \left( Y_e Y_e^\dagger \right) + 5 \text{Tr} \left( Y_L Y_L^\dagger \right) \right. \\
& \left. + 15 \text{Tr} \left( Y_u Y_u^\dagger \right) \right) \\
& - 18 g_1^2 \text{Tr} \left( \lambda_{SE}^\dagger B_E \right) + 5 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger B_E \lambda_{SE}^\dagger \right) + 5 \text{Tr} \left( \lambda_{SE}^\dagger Y_L^T Y_L^* B_E \right) \quad (88)
\end{aligned}$$

$$\beta_{B_S}^{(1)} = B_S \left( 2 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) + 3 |\lambda_T|^2 + 4 |\lambda|^2 + 4 |\lambda_{SR}|^2 \right) \quad (89)$$

$$\begin{aligned}
\beta_{B_S}^{(2)} = & - \frac{2}{5} B_S \left( 20 \lambda_{SR}^2 \lambda_{SR}^{*,2} + 15 \lambda_T^2 \lambda_T^{*,2} + 15 |\lambda_T|^2 \left( -4 g_2^2 + \Lambda_T \Lambda_T^* + \lambda_{TR} \lambda_{TR}^* \right) \right. \\
& + 2 |\lambda_{SR}|^2 \left( -15 g_2^2 + 15 \lambda_{TR} \lambda_{TR}^* - 3 g_1^2 + 5 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) + 5 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \right) \\
& + 2 \left( 10 \lambda^2 \lambda^{*,2} + 5 \left( Y_{B\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{B\hat{a}rE}^* \right) + 5 \left( \lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^* \right) - 6 g_1^2 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) \right. \\
& + |\lambda|^2 \left( -3 g_1^2 - 15 g_2^2 + 15 \Lambda_T \Lambda_T^* + 5 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + 5 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) + 15 \text{Tr} \left( Y_d Y_d^\dagger \right) + 5 \text{Tr} \left( Y_e Y_e^\dagger \right) + 5 \text{Tr} \left( Y_L Y_L^\dagger \right) \right. \\
& \left. + 15 \text{Tr} \left( Y_u Y_u^\dagger \right) \right) \\
& \left. + 5 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger \right) + 5 \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^* \right) \right) \quad (90)
\end{aligned}$$

### 3.6 Fayet-Iliopoulos $D$ -terms

$$\beta_{M_D^B}^{(1)} = 2 M_D^B |\lambda|^2 + 2 M_D^B |\lambda_{SR}|^2 + \frac{3}{2} M_D^B |\lambda_T|^2 + \frac{48}{5} g_1^2 M_D^B + M_D^B \text{Tr} \left( \lambda_{SE} \lambda_{SE}^\dagger \right) \quad (91)$$

$$\begin{aligned}
\beta_{M_B^B}^{(2)} = & \frac{1}{25} M_D^B \left( 352g_1^4 + 180g_1^2g_2^2 + 440g_1^2g_3^2 + 300g_2^2|\lambda_T|^2 - 45g_1^2|\Lambda_T|^2 + 150g_2^2|\lambda|^2 - 100\lambda_{SR}^2\lambda_{SR}^{*,2} \right. \\
& - 75\lambda_T^2\lambda_T^{*,2} - 15|\lambda_{TR}|^2 \left( 3g_1^2 + 5\lambda_T\lambda_T^* \right) - 75\Lambda_T|\lambda_T|^2\Lambda_T^* - 150\lambda|\Lambda_T|^2\lambda^* - 100\lambda^2\lambda^{*,2} \\
& - 90g_1^2 \left( Y_{\hat{E}}Y_{\hat{E}}^* \right) - 50|\lambda|^2 \left( Y_{\hat{E}}Y_{\hat{E}}^* \right) + 50|\lambda_{SR}|^2 \left( 3g_2^2 - 3\lambda_{TR}\lambda_{TR}^* - \left( Y_{B\hat{a}rE}Y_{B\hat{a}rE}^* \right) - \left( Y_{\hat{E}}Y_{\hat{E}}^* \right) \right) \\
& - 90g_1^2 \left( Y_{B\hat{a}rE}Y_{B\hat{a}rE}^* \right) - 50|\lambda|^2 \left( Y_{B\hat{a}rE}Y_{B\hat{a}rE}^* \right) - 50 \left( Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^* \right) - 50 \left( \lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^* \right) \\
& - 70g_1^2 \text{Tr} \left( Y_d Y_d^\dagger \right) - 150|\lambda|^2 \text{Tr} \left( Y_d Y_d^\dagger \right) - 90g_1^2 \text{Tr} \left( Y_e Y_e^\dagger \right) - 50|\lambda|^2 \text{Tr} \left( Y_e Y_e^\dagger \right) \\
& - 90g_1^2 \text{Tr} \left( Y_L Y_L^\dagger \right) - 50|\lambda|^2 \text{Tr} \left( Y_L Y_L^\dagger \right) - 130g_1^2 \text{Tr} \left( Y_u Y_u^\dagger \right) - 150|\lambda|^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - 50 \text{Tr} \left( \lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger \right) - 50 \text{Tr} \left( \lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^* \right) \tag{92}
\end{aligned}$$

$$\beta_{M_D^W}^{(1)} = M_D^W \left( |\lambda_{TR}|^2 + |\lambda_T|^2 + |\Lambda_T|^2 \right) \tag{93}$$

$$\begin{aligned}
\beta_{M_D^B}^{(2)} = & \frac{1}{10} M_D^W \left( 24g_1^2g_2^2 + 880g_2^4 + 240g_2^2g_3^2 - 40g_2^2|\lambda_T|^2 + 6g_1^2|\Lambda_T|^2 - 80g_2^2|\Lambda_T|^2 - 20g_2^2|\lambda|^2 \right. \\
& - 30\lambda_{TR}^2\lambda_{TR}^{*,2} - 25\lambda_T^2\lambda_T^{*,2} - 20|\lambda_{SR}|^2 \left( \lambda_T\lambda_T^* + \lambda_{TR}\lambda_{TR}^* + g_2^2 \right) - 10\Lambda_T|\lambda_T|^2\Lambda_T^* - 30\Lambda_T^2\Lambda_T^{*,2} \\
& - 20\lambda|\lambda_T|^2\lambda^* - 20\lambda|\Lambda_T|^2\lambda^* - 20g_2^2 \left( Y_{\hat{E}}Y_{\hat{E}}^* \right) - 10|\Lambda_T|^2 \left( Y_{\hat{E}}Y_{\hat{E}}^* \right) \\
& + 2|\lambda_{TR}|^2 \left( 3g_1^2 - 40g_2^2 - 5\lambda_T\lambda_T^* - 5 \left( Y_{B\hat{a}rE}Y_{B\hat{a}rE}^* \right) - 5 \left( Y_{\hat{E}}Y_{\hat{E}}^* \right) \right) - 20g_2^2 \left( Y_{B\hat{a}rE}Y_{B\hat{a}rE}^* \right) - 10|\Lambda_T|^2 \left( Y_{B\hat{a}rE}Y_{B\hat{a}rE}^* \right) \\
& - 10|\lambda_T|^2 \text{Tr} \left( \lambda_{SE}\lambda_{SE}^\dagger \right) - 60g_2^2 \text{Tr} \left( Y_d Y_d^\dagger \right) - 30|\Lambda_T|^2 \text{Tr} \left( Y_d Y_d^\dagger \right) - 20g_2^2 \text{Tr} \left( Y_e Y_e^\dagger \right) \\
& - 10|\Lambda_T|^2 \text{Tr} \left( Y_e Y_e^\dagger \right) - 20g_2^2 \text{Tr} \left( Y_L Y_L^\dagger \right) - 10|\Lambda_T|^2 \text{Tr} \left( Y_L Y_L^\dagger \right) - 60g_2^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - 30|\Lambda_T|^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \tag{94}
\end{aligned}$$

$$\beta_{M_D^O}^{(1)} = -6g_3^2 M_D^O \tag{95}$$

$$\beta_{M_D^O}^{(2)} = \frac{1}{5} g_3^2 M_D^O \left( 11g_1^2 - 20 \text{Tr} \left( Y_d Y_d^\dagger \right) - 20 \text{Tr} \left( Y_u Y_u^\dagger \right) + 45g_2^2 + 520g_3^2 \right) \tag{96}$$

### 3.7 Soft-Breaking Scalar Masses

$$\sigma_{1,1} = \sqrt{\frac{3}{5}} g_1 \left( -2 \text{Tr} \left( m_u^2 \right) - \text{Tr} \left( m_{B\hat{a}rE}^2 \right) - \text{Tr} \left( m_l^2 \right) - m_{H_d}^2 - m_{R_u}^2 + m_{H_u}^2 + m_{R_d}^2 + \text{Tr} \left( m_d^2 \right) + \text{Tr} \left( m_e^2 \right) + \text{Tr} \left( m_{\hat{E}}^2 \right) + \text{Tr} \left( m_q^2 \right) \right) \tag{97}$$

$$\sigma_{2,11} = \frac{1}{10} g_1^2 \left( 2 \text{Tr} \left( m_d^2 \right) + 3 \text{Tr} \left( m_l^2 \right) + 3m_{H_d}^2 + 3m_{H_u}^2 + 3m_{R_d}^2 + 3m_{R_u}^2 + 6 \text{Tr} \left( m_e^2 \right) + 6 \text{Tr} \left( m_{B\hat{a}rE}^2 \right) + 6 \text{Tr} \left( m_{\hat{E}}^2 \right) + 8 \text{Tr} \left( m_u^2 \right) + \text{Tr} \left( m_q^2 \right) \right) \tag{98}$$

$$\begin{aligned}
\sigma_{3,1} = & \frac{1}{20} \frac{1}{\sqrt{15}} g_1 \left( -9g_1^2 m_{H_d}^2 - 45g_2^2 m_{H_d}^2 + 9g_1^2 m_{H_u}^2 + 45g_2^2 m_{H_u}^2 + 9g_1^2 m_{R_d}^2 + 45g_2^2 m_{R_d}^2 - 9g_1^2 m_{R_u}^2 - 45g_2^2 m_{R_u}^2 \right. \\
& \left. - 30 \left( -m_{R_u}^2 + m_{R_d}^2 \right) |\lambda_{SR}|^2 - 45 \left( -m_{R_u}^2 + m_{R_d}^2 \right) |\lambda_{TR}|^2 + 45m_{H_d}^2 |\Lambda_T|^2 - 45m_{H_u}^2 |\Lambda_T|^2 + 30m_{H_d}^2 |\lambda|^2 \right)
\end{aligned}$$

$$\begin{aligned}
& -30m_{H_u}^2|\lambda|^2 - 60Y_{\hat{E}}m_{\hat{E}}^2Y_{\hat{E}}^* + 60Y_{\hat{B}\hat{a}rE}m_{\hat{B}\hat{a}rE}^2Y_{\hat{B}\hat{a}rE}^* + 30m_{H_d}^2(Y_{\hat{E}}Y_{\hat{E}}^*) + 30m_{R_u}^2(Y_{\hat{E}}Y_{\hat{E}}^*) - 30m_{H_u}^2(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) \\
& - 30m_{R_d}^2(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) + 4g_1^2\text{Tr}(m_d^2) + 80g_3^2\text{Tr}(m_d^2) + 36g_1^2\text{Tr}(m_e^2) + 36g_1^2\text{Tr}(m_{\hat{E}}^2) - 36g_1^2\text{Tr}(m_{\hat{B}\hat{a}rE}^2) \\
& - 9g_1^2\text{Tr}(m_l^2) - 45g_2^2\text{Tr}(m_l^2) + g_1^2\text{Tr}(m_q^2) + 45g_2^2\text{Tr}(m_q^2) + 80g_3^2\text{Tr}(m_q^2) - 32g_1^2\text{Tr}(m_u^2) \\
& - 160g_3^2\text{Tr}(m_u^2) + 90m_{H_d}^2\text{Tr}(Y_dY_d^\dagger) + 30m_{H_d}^2\text{Tr}(Y_eY_e^\dagger) + 30m_{H_d}^2\text{Tr}(Y_LY_L^\dagger) - 90m_{H_u}^2\text{Tr}(Y_uY_u^\dagger) \\
& + 30\text{Tr}(\lambda_{SE}m_{\hat{B}\hat{a}rE}^2\lambda_{SE}^\dagger) - 30\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2) - 60\text{Tr}(m_{\hat{E}}^2Y_L^\dagger Y_L) + 30\text{Tr}(m_l^2Y_LY_L^\dagger) - 60\text{Tr}(Y_dY_d^\dagger m_d^{2*}) \\
& - 30\text{Tr}(Y_d m_q^{2*} Y_d^\dagger) - 60\text{Tr}(Y_e Y_e^\dagger m_e^{2*}) + 30\text{Tr}(Y_e m_l^{2*} Y_e^\dagger) + 120\text{Tr}(Y_u Y_u^\dagger m_u^{2*}) \\
& - 30\text{Tr}(Y_u m_q^{2*} Y_u^\dagger)
\end{aligned} \tag{99}$$

$$\sigma_{2,2} = \frac{1}{2}(3\text{Tr}(m_q^2) + 4m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2 + \text{Tr}(m_l^2)) \tag{100}$$

$$\sigma_{2,3} = \frac{1}{2}(2\text{Tr}(m_q^2) + 6m_O^2 + \text{Tr}(m_d^2) + \text{Tr}(m_u^2)) \tag{101}$$

$$\begin{aligned}
\beta_{m_q^2}^{(1)} & = +2m_{H_d}^2 Y_d^\dagger Y_d + 2m_{H_u}^2 Y_u^\dagger Y_u + m_q^2 Y_d^\dagger Y_d + m_q^2 Y_u^\dagger Y_u + 2Y_d^\dagger m_d^2 Y_d \\
& + Y_d^\dagger Y_d m_q^2 + 2Y_u^\dagger m_u^2 Y_u + Y_u^\dagger Y_u m_q^2 + \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1}
\end{aligned} \tag{102}$$

$$\begin{aligned}
\beta_{m_q^2}^{(2)} & = +\frac{8}{5}g_1^2 m_{H_u}^2 Y_u^\dagger Y_u - 3m_{H_d}^2 |\Lambda_T|^2 Y_u^\dagger Y_u - 6m_{H_u}^2 |\Lambda_T|^2 Y_u^\dagger Y_u \\
& - 3m_t^2 |\Lambda_T|^2 Y_u^\dagger Y_u - 2m_{H_d}^2 |\lambda|^2 Y_u^\dagger Y_u - 4m_{H_u}^2 |\lambda|^2 Y_u^\dagger Y_u \\
& - 2m_S^2 |\lambda|^2 Y_u^\dagger Y_u + \frac{2}{5}g_1^2 m_q^2 Y_d^\dagger Y_d - \frac{3}{2}|\Lambda_T|^2 m_q^2 Y_d^\dagger Y_d - |\lambda|^2 m_q^2 Y_d^\dagger Y_d \\
& + \frac{4}{5}g_1^2 m_q^2 Y_u^\dagger Y_u - \frac{3}{2}|\Lambda_T|^2 m_q^2 Y_u^\dagger Y_u - |\lambda|^2 m_q^2 Y_u^\dagger Y_u + \frac{4}{5}g_1^2 Y_d^\dagger m_d^2 Y_d \\
& - 3|\Lambda_T|^2 Y_d^\dagger m_d^2 Y_d - 2|\lambda|^2 Y_d^\dagger m_d^2 Y_d + \frac{2}{5}g_1^2 Y_d^\dagger Y_d m_q^2 - \frac{3}{2}|\Lambda_T|^2 Y_d^\dagger Y_d m_q^2 \\
& - |\lambda|^2 Y_d^\dagger Y_d m_q^2 + \frac{8}{5}g_1^2 Y_u^\dagger m_u^2 Y_u - 3|\Lambda_T|^2 Y_u^\dagger m_u^2 Y_u - 2|\lambda|^2 Y_u^\dagger m_u^2 Y_u \\
& + \frac{4}{5}g_1^2 Y_u^\dagger Y_u m_q^2 - \frac{3}{2}|\Lambda_T|^2 Y_u^\dagger Y_u m_q^2 - |\lambda|^2 Y_u^\dagger Y_u m_q^2 - 8m_{H_d}^2 Y_d^\dagger Y_d Y_d^\dagger Y_d \\
& - 8m_{H_u}^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 2m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d - 2m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u - 4Y_d^\dagger m_d^2 Y_d Y_d^\dagger Y_d \\
& - 4Y_d^\dagger Y_d m_q^2 Y_d^\dagger Y_d - 4Y_d^\dagger Y_d Y_d^\dagger m_d^2 Y_d - 2Y_d^\dagger Y_d Y_d^\dagger Y_d m_q^2 - 4Y_u^\dagger m_u^2 Y_u Y_u^\dagger Y_u \\
& - 4Y_u^\dagger Y_u m_q^2 Y_u^\dagger Y_u - 4Y_u^\dagger Y_u Y_u^\dagger m_u^2 Y_u - 2Y_u^\dagger Y_u Y_u^\dagger Y_u m_q^2 - m_q^2 Y_d^\dagger Y_d (Y_{\hat{E}}Y_{\hat{E}}^*) \\
& - 2Y_d^\dagger m_d^2 Y_d (Y_{\hat{E}}Y_{\hat{E}}^*) - Y_d^\dagger Y_d m_q^2 (Y_{\hat{E}}Y_{\hat{E}}^*) - 4m_{H_u}^2 Y_u^\dagger Y_u (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) \\
& - 2m_{R_d}^2 Y_u^\dagger Y_u (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - m_q^2 Y_u^\dagger Y_u (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - 2Y_u^\dagger m_u^2 Y_u (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) \\
& - Y_u^\dagger Y_u m_q^2 (Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*) - 2Y_u^\dagger Y_u (Y_{\hat{B}\hat{a}rE}m_{\hat{B}\hat{a}rE}^{2*}Y_{\hat{B}\hat{a}rE}^*)
\end{aligned}$$

$$\begin{aligned}
& + \frac{2}{15} \mathbf{1} \left( 45g_2^4 \sigma_{2,2} + 80g_3^4 \sigma_{2,3} + g_1 \left( 2\sqrt{15} \sigma_{3,1} + g_1 \sigma_{2,11} \right) \right) - 3m_q^2 Y_d^\dagger Y_d \text{Tr} \left( Y_d Y_d^\dagger \right) \\
& - 6Y_d^\dagger m_d^2 Y_d \text{Tr} \left( Y_d Y_d^\dagger \right) - 3Y_d^\dagger Y_d m_q^2 \text{Tr} \left( Y_d Y_d^\dagger \right) - m_q^2 Y_d^\dagger Y_d \text{Tr} \left( Y_e Y_e^\dagger \right) \\
& - 2Y_d^\dagger m_d^2 Y_d \text{Tr} \left( Y_e Y_e^\dagger \right) - Y_d^\dagger Y_d m_q^2 \text{Tr} \left( Y_e Y_e^\dagger \right) - m_q^2 Y_d^\dagger Y_d \text{Tr} \left( Y_L Y_L^\dagger \right) \\
& - 2Y_d^\dagger m_d^2 Y_d \text{Tr} \left( Y_L Y_L^\dagger \right) - Y_d^\dagger Y_d m_q^2 \text{Tr} \left( Y_L Y_L^\dagger \right) - 12m_{H_u}^2 Y_u^\dagger Y_u \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - 3m_q^2 Y_u^\dagger Y_u \text{Tr} \left( Y_u Y_u^\dagger \right) - 6Y_u^\dagger m_u^2 Y_u \text{Tr} \left( Y_u Y_u^\dagger \right) - 3Y_u^\dagger Y_u m_q^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - 6Y_u^\dagger Y_u \text{Tr} \left( m_q^2 Y_u^\dagger Y_u \right) - 6Y_u^\dagger Y_u \text{Tr} \left( m_u^2 Y_u Y_u^\dagger \right) \\
& - \frac{1}{5} Y_d^\dagger Y_d \left( 15 \left( 2m_{H_d}^2 + m_{H_u}^2 + m_t^2 \right) |\Lambda_T|^2 \right. \\
& + 2 \left( -2g_1^2 m_{H_d}^2 + 5 \left( 2m_{H_d}^2 + m_{H_u}^2 + m_S^2 \right) |\lambda|^2 + 5 \left( 2m_{H_d}^2 + m_{R_u}^2 \right) \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + 5 \left( Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^* \right) + 30m_{H_d}^2 \text{Tr} \left( Y_d Y_d^\dagger \right) \right. \\
& + 10m_{H_d}^2 \text{Tr} \left( Y_e Y_e^\dagger \right) + 10m_{H_d}^2 \text{Tr} \left( Y_L Y_L^\dagger \right) + 15 \text{Tr} \left( m_d^2 Y_d Y_d^\dagger \right) + 5 \text{Tr} \left( m_e^2 Y_e Y_e^\dagger \right) + 5 \text{Tr} \left( m_l^2 Y_e^\dagger Y_e \right) \\
& \left. + 15 \text{Tr} \left( m_q^2 Y_d^\dagger Y_d \right) + 5 \text{Tr} \left( Y_L Y_L^\dagger m_l^{2*} \right) + 5 \text{Tr} \left( Y_L m_{\hat{E}}^{2*} Y_L^\dagger \right) \right) \quad (103)
\end{aligned}$$

$$\begin{aligned}
\beta_{m_l^2}^{(1)} & = +2m_{H_d}^2 Y_e^\dagger Y_e + 2m_{H_d}^2 Y_L^* Y_L^T + m_l^2 Y_e^\dagger Y_e + m_l^2 Y_L^* Y_L^T + 2Y_e^\dagger m_e^2 Y_e \\
& + Y_e^\dagger Y_e m_l^2 + 2Y_L^* m_{\hat{E}}^2 Y_L^T + Y_L^* Y_L^T m_l^2 - \sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{1,1} \quad (104)
\end{aligned}$$

$$\begin{aligned}
\beta_{m_l^2}^{(2)} & = + \frac{12}{5} g_1^2 m_{H_d}^2 Y_L^* Y_L^T - 6m_{H_d}^2 |\Lambda_T|^2 Y_L^* Y_L^T - 3m_{H_u}^2 |\Lambda_T|^2 Y_L^* Y_L^T \\
& - 3m_l^2 |\Lambda_T|^2 Y_L^* Y_L^T - 4m_{H_d}^2 |\lambda|^2 Y_L^* Y_L^T - 2m_{H_u}^2 |\lambda|^2 Y_L^* Y_L^T \\
& - 2m_S^2 |\lambda|^2 Y_L^* Y_L^T + \frac{6}{5} g_1^2 m_l^2 Y_e^\dagger Y_e - \frac{3}{2} |\Lambda_T|^2 m_l^2 Y_e^\dagger Y_e - |\lambda|^2 m_l^2 Y_e^\dagger Y_e \\
& + \frac{6}{5} g_1^2 m_l^2 Y_L^* Y_L^T - \frac{3}{2} |\Lambda_T|^2 m_l^2 Y_L^* Y_L^T - |\lambda|^2 m_l^2 Y_L^* Y_L^T + \frac{12}{5} g_1^2 Y_e^\dagger m_e^2 Y_e \\
& - 3|\Lambda_T|^2 Y_e^\dagger m_e^2 Y_e - 2|\lambda|^2 Y_e^\dagger m_e^2 Y_e + \frac{6}{5} g_1^2 Y_e^\dagger Y_e m_l^2 - \frac{3}{2} |\Lambda_T|^2 Y_e^\dagger Y_e m_l^2 \\
& - |\lambda|^2 Y_e^\dagger Y_e m_l^2 + \frac{12}{5} g_1^2 Y_L^* m_{\hat{E}}^2 Y_L^T - 3|\Lambda_T|^2 Y_L^* m_{\hat{E}}^2 Y_L^T - 2|\lambda|^2 Y_L^* m_{\hat{E}}^2 Y_L^T \\
& + \frac{6}{5} g_1^2 Y_L^* Y_L^T m_l^2 - \frac{3}{2} |\Lambda_T|^2 Y_L^* Y_L^T m_l^2 - |\lambda|^2 Y_L^* Y_L^T m_l^2 - 8m_{H_d}^2 Y_e^\dagger Y_e Y_e^\dagger Y_e \\
& - 8m_{H_d}^2 Y_e^\dagger Y_e Y_L^* Y_L^T - 2m_{H_d}^2 Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_L^T - 2m_S^2 Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_L^T \\
& - 8m_{H_d}^2 Y_L^* Y_L^T Y_e^\dagger Y_e - 8m_{H_d}^2 Y_L^* Y_L^T Y_L^* Y_L^T - 2m_l^2 Y_e^\dagger Y_e Y_e^\dagger Y_e - 2m_l^2 Y_e^\dagger Y_e Y_L^* Y_L^T \\
& - m_l^2 Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_L^T - 2m_l^2 Y_L^* Y_L^T Y_e^\dagger Y_e - 2m_l^2 Y_L^* Y_L^T Y_L^* Y_L^T - 4Y_e^\dagger m_e^2 Y_e Y_e^\dagger Y_e \\
& - 4Y_e^\dagger m_e^2 Y_e Y_L^* Y_L^T - 4Y_e^\dagger Y_e m_l^2 Y_e^\dagger Y_e - 4Y_e^\dagger Y_e m_l^2 Y_L^* Y_L^T - 4Y_e^\dagger Y_e Y_e^\dagger m_e^2 Y_e \\
& - 2Y_e^\dagger Y_e Y_e^\dagger Y_e m_l^2 - 4Y_e^\dagger Y_e Y_L^* m_{\hat{E}}^2 Y_L^T - 2Y_e^\dagger Y_e Y_L^* Y_L^T m_l^2 \\
& - 2Y_L^* \lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2 Y_L^T - Y_L^* \lambda_{SE} \lambda_{SE}^\dagger Y_L^T m_l^2 - 2Y_L^* \lambda_{SE} m_{\hat{B}arE}^{2*} \lambda_{SE}^\dagger Y_L^T \\
& - 2Y_L^* m_{\hat{E}}^2 \lambda_{SE} \lambda_{SE}^\dagger Y_L^T - 4Y_L^* m_{\hat{E}}^2 Y_L^T Y_e^\dagger Y_e - 4Y_L^* m_{\hat{E}}^2 Y_L^T Y_L^* Y_L^T
\end{aligned}$$

$$\begin{aligned}
& -4Y_L^*Y_L^T m_l^2 Y_e^\dagger Y_e - 4Y_L^*Y_L^T m_l^2 Y_L^* Y_L^T - 4Y_L^*Y_L^T Y_e^\dagger m_e^2 Y_e \\
& -2Y_L^*Y_L^T Y_e^\dagger Y_e m_l^2 - 4Y_L^*Y_L^T Y_L^* m_{\hat{E}}^2 Y_L^T - 2Y_L^*Y_L^T Y_L^* Y_L^T m_l^2 - 4m_{H_d}^2 Y_L^* Y_L^T (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& -2m_{R_u}^2 Y_L^* Y_L^T (Y_{\hat{E}} Y_{\hat{E}}^*) - m_l^2 Y_e^\dagger Y_e (Y_{\hat{E}} Y_{\hat{E}}^*) - m_l^2 Y_L^* Y_L^T (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& -2Y_e^\dagger m_e^2 Y_e (Y_{\hat{E}} Y_{\hat{E}}^*) - Y_e^\dagger Y_e m_l^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 2Y_L^* m_{\hat{E}}^2 Y_L^T (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& -Y_L^* Y_L^T m_l^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - 2Y_L^* Y_L^T (Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) + \mathbf{1} \left( 6g_2^4 \sigma_{2,2} + \frac{2}{5} g_1 \left( -2\sqrt{15} \sigma_{3,1} + 3g_1 \sigma_{2,11} \right) \right) \\
& -12m_{H_d}^2 Y_L^* Y_L^T \text{Tr}(Y_d Y_d^\dagger) - 3m_l^2 Y_e^\dagger Y_e \text{Tr}(Y_d Y_d^\dagger) - 3m_l^2 Y_L^* Y_L^T \text{Tr}(Y_d Y_d^\dagger) \\
& -6Y_e^\dagger m_e^2 Y_e \text{Tr}(Y_d Y_d^\dagger) - 3Y_e^\dagger Y_e m_l^2 \text{Tr}(Y_d Y_d^\dagger) - 6Y_L^* m_{\hat{E}}^2 Y_L^T \text{Tr}(Y_d Y_d^\dagger) \\
& -3Y_L^* Y_L^T m_l^2 \text{Tr}(Y_d Y_d^\dagger) - 4m_{H_d}^2 Y_L^* Y_L^T \text{Tr}(Y_e Y_e^\dagger) - m_l^2 Y_e^\dagger Y_e \text{Tr}(Y_e Y_e^\dagger) \\
& -m_l^2 Y_L^* Y_L^T \text{Tr}(Y_e Y_e^\dagger) - 2Y_e^\dagger m_e^2 Y_e \text{Tr}(Y_e Y_e^\dagger) - Y_e^\dagger Y_e m_l^2 \text{Tr}(Y_e Y_e^\dagger) \\
& -2Y_L^* m_{\hat{E}}^2 Y_L^T \text{Tr}(Y_e Y_e^\dagger) - Y_L^* Y_L^T m_l^2 \text{Tr}(Y_e Y_e^\dagger) - 4m_{H_d}^2 Y_L^* Y_L^T \text{Tr}(Y_L Y_L^\dagger) \\
& -m_l^2 Y_e^\dagger Y_e \text{Tr}(Y_L Y_L^\dagger) - m_l^2 Y_L^* Y_L^T \text{Tr}(Y_L Y_L^\dagger) - 2Y_e^\dagger m_e^2 Y_e \text{Tr}(Y_L Y_L^\dagger) \\
& -Y_e^\dagger Y_e m_l^2 \text{Tr}(Y_L Y_L^\dagger) - 2Y_L^* m_{\hat{E}}^2 Y_L^T \text{Tr}(Y_L Y_L^\dagger) - Y_L^* Y_L^T m_l^2 \text{Tr}(Y_L Y_L^\dagger) \\
& -6Y_L^* Y_L^T \text{Tr}(m_d^2 Y_d Y_d^\dagger) - 2Y_L^* Y_L^T \text{Tr}(m_e^2 Y_e Y_e^\dagger) - 2Y_L^* Y_L^T \text{Tr}(m_l^2 Y_e^\dagger Y_e) \\
& -6Y_L^* Y_L^T \text{Tr}(m_q^2 Y_d^\dagger Y_d) - 2Y_L^* Y_L^T \text{Tr}(Y_L Y_L^\dagger m_l^{2*}) - 2Y_L^* Y_L^T \text{Tr}(Y_L m_{\hat{E}}^{2*} Y_L^\dagger) \\
& -\frac{1}{5} Y_e^\dagger Y_e \left( 15(2m_{H_d}^2 + m_{H_u}^2 + m_t^2) |\Lambda_T|^2 \right. \\
& + 2 \left( -6g_1^2 m_{H_d}^2 + 5(2m_{H_d}^2 + m_{H_u}^2 + m_S^2) |\lambda|^2 + 5(2m_{H_d}^2 + m_{R_u}^2) (Y_{\hat{E}} Y_{\hat{E}}^*) + 5(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) + 30m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) \right. \\
& + 10m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 10m_{H_d}^2 \text{Tr}(Y_L Y_L^\dagger) + 15\text{Tr}(m_d^2 Y_d Y_d^\dagger) + 5\text{Tr}(m_e^2 Y_e Y_e^\dagger) + 5\text{Tr}(m_l^2 Y_e^\dagger Y_e) \\
& \left. \left. + 15\text{Tr}(m_q^2 Y_d^\dagger Y_d) + 5\text{Tr}(Y_L Y_L^\dagger m_l^{2*}) + 5\text{Tr}(Y_L m_{\hat{E}}^{2*} Y_L^\dagger) \right) \right) \\
& -8m_{H_d}^2 (Y_L Y_{\hat{E}}^*)_{i_2} (Y_L^* Y_{\hat{E}})_{i_1} - 4m_{R_u}^2 (Y_L Y_{\hat{E}}^*)_{i_2} (Y_L^* Y_{\hat{E}})_{i_1} - 2(Y_L Y_{\hat{E}}^*)_{i_2} (m_l^2 Y_L^* Y_{\hat{E}})_{i_1} - 4(Y_L^* Y_{\hat{E}})_{i_1} (Y_L m_{\hat{E}}^{2*} Y_{\hat{E}}^*)_{i_2} - 2(Y_L^* Y_{\hat{E}})_{i_1} \\
& -4(Y_L Y_{\hat{E}}^*)_{i_2} (Y_L^* m_{\hat{E}}^2 Y_{\hat{E}})_{i_1} \tag{105}
\end{aligned}$$

$$\begin{aligned}
\beta_{m_{H_d}^2}^{(1)} & = +3(m_{H_d}^2 + m_{H_u}^2 + m_t^2) |\Lambda_T|^2 + 2(m_{H_d}^2 + m_{H_u}^2 + m_S^2) |\lambda|^2 + 2m_{H_d}^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + 2m_{R_u}^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + 2(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) \\
& - \sqrt{\frac{3}{5}} g_1 \sigma_{1,1} + 6m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) + 2m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 2m_{H_d}^2 \text{Tr}(Y_L Y_L^\dagger) + 6\text{Tr}(m_d^2 Y_d Y_d^\dagger) \\
& + 2\text{Tr}(m_e^2 Y_e Y_e^\dagger) + 2\text{Tr}(m_l^2 Y_e^\dagger Y_e) + 6\text{Tr}(m_q^2 Y_d^\dagger Y_d) + 2\text{Tr}(Y_L Y_L^\dagger m_l^{2*}) + 2\text{Tr}(Y_L m_{\hat{E}}^{2*} Y_L^\dagger) \tag{106} \\
\beta_{m_{H_d}^2}^{(2)} & = -15\Lambda_T^2 (m_{H_d}^2 + m_{H_u}^2 + m_t^2) \Lambda_T^{*2} - 3m_{H_d}^2 \lambda |\lambda_T|^2 \lambda^* - 3m_{H_u}^2 \lambda |\lambda_T|^2 \lambda^* - 6m_S^2 \lambda |\lambda_T|^2 \lambda^*
\end{aligned}$$



$$\begin{aligned}
& -6m_t^2\lambda|\lambda_T|^2\lambda^* - 12m_{H_d}^2\lambda^2\lambda^{*,2} - 12m_{H_u}^2\lambda^2\lambda^{*,2} - 12m_S^2\lambda^2\lambda^{*,2} + \frac{12}{5}g_1^2m_{H_d}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\
& + \frac{12}{5}g_1^2m_{R_u}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 3m_{H_d}^2|\lambda_{TR}|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 3m_{R_d}^2|\lambda_{TR}|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 6m_{R_u}^2|\lambda_{TR}|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\
& - 3m_t^2|\lambda_{TR}|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 12m_{H_d}^2\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 - 12m_{R_u}^2\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 + \frac{12}{5}g_1^2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) \\
& - 3|\lambda_{TR}|^2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 12\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) \\
& - 2|\lambda_{SR}|^2\left(2\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\lambda\lambda^* + \left(2m_{R_u}^2 + m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + \left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right)\right) \\
& - 24m_{H_d}^2\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) - 12m_{R_u}^2\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) - 12\left(Y_{\hat{E}}Y_L^\dagger Y_L m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) \\
& - 12\left(Y_{\hat{E}}Y_L^\dagger m_t^* Y_L Y_{\hat{E}}^*\right) - 12\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) - 2m_{H_d}^2|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 4m_{H_u}^2|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 2m_{R_d}^2|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 2m_S^2|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 2|\lambda|^2\left(Y_{\hat{B}\hat{a}rE}m_{\hat{B}\hat{a}rE}^{2*}Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 2m_{H_d}^2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) - 2m_{R_u}^2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) - 2m_S^2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) \\
& - 2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 2\left(\lambda_{SE}^T Y_{\hat{E}}^*\lambda_{SE}^\dagger m_{\hat{E}}^2 Y_{\hat{E}}\right) - 2\left(\lambda_{SE}^T Y_{\hat{E}}^* m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger Y_{\hat{E}}\right) \\
& + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} - 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} - 2m_{H_d}^2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - 2m_{H_u}^2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) \\
& - 4m_S^2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - \frac{4}{5}g_1^2m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger\right) + 32g_3^2m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger\right) \\
& + \frac{12}{5}g_1^2m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger\right) + \frac{12}{5}g_1^2m_{H_d}^2\text{Tr}\left(Y_L Y_L^\dagger\right) - 6m_{H_d}^2|\lambda|^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 12m_{H_u}^2|\lambda|^2\text{Tr}\left(Y_u Y_u^\dagger\right) - 6m_S^2|\lambda|^2\text{Tr}\left(Y_u Y_u^\dagger\right) - 2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2\right) \\
& - 2|\lambda|^2\text{Tr}\left(\lambda_{SE}m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger\right) - \frac{4}{5}g_1^2\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 32g_3^2\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + \frac{12}{5}g_1^2\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) \\
& + \frac{12}{5}g_1^2\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) - \frac{4}{5}g_1^2\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) + 32g_3^2\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) - 6|\lambda|^2\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) \\
& + 3|\Lambda_T|^2\left(4g_2^2m_{H_d}^2 + 4g_2^2m_{H_u}^2 + 4g_2^2m_t^2 - \lambda_{TR}\left(2m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\lambda_{TR}^* - \lambda_T\left(3m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_S^2\right)\lambda_T^*\right) \\
& - 4m_{H_d}^2\lambda\lambda^* - 4m_{H_u}^2\lambda\lambda^* - 2m_S^2\lambda\lambda^* - 2m_t^2\lambda\lambda^* - m_{H_d}^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 2m_{H_u}^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) \\
& - m_{R_d}^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - m_t^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - \left(Y_{\hat{B}\hat{a}rE}m_{\hat{B}\hat{a}rE}^{2*}Y_{\hat{B}\hat{a}rE}^*\right) - 3m_{H_d}^2\text{Tr}\left(Y_u Y_u^\dagger\right) - 6m_{H_u}^2\text{Tr}\left(Y_u Y_u^\dagger\right) \\
& - 3m_t^2\text{Tr}\left(Y_u Y_u^\dagger\right) - 3\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) - 3\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \\
& - 6|\lambda|^2\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) + \frac{12}{5}g_1^2\text{Tr}\left(Y_L Y_L^\dagger m_l^2\right) + \frac{12}{5}g_1^2\text{Tr}\left(Y_L m_{\hat{E}}^{2*} Y_L^\dagger\right) \\
& - 2m_{H_d}^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*\right) - 2m_S^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*\right) - 36m_{H_d}^2\text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) \\
& - 6m_{H_d}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 6m_{H_u}^2\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 12m_{H_d}^2\text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) \\
& - 12m_{H_d}^2\text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger\right) - 24m_{H_d}^2\text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^*\right) - 2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2 Y_L^T Y_L^*\right)
\end{aligned}$$

$$\begin{aligned}
& -2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T m_t^2 Y_L^*\right) - 2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^* m_{\hat{E}}^2\right) - 2\text{Tr}\left(\lambda_{SE}m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger Y_L^T Y_L^*\right) \\
& -36\text{Tr}\left(m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger\right) - 6\text{Tr}\left(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger\right) - 12\text{Tr}\left(m_e^2 Y_e Y_e^\dagger Y_e Y_e^\dagger\right) - 12\text{Tr}\left(m_t^2 Y_e^\dagger Y_e Y_e^\dagger Y_e\right) \\
& -36\text{Tr}\left(m_q^2 Y_d^\dagger Y_d Y_d^\dagger Y_d\right) - 6\text{Tr}\left(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u\right) - 6\text{Tr}\left(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d\right) \\
& -6\text{Tr}\left(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger\right) - 6\text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger m_t^{2*}\right) - 6\text{Tr}\left(Y_L Y_L^\dagger Y_L m_{\hat{E}}^{2*} Y_L^\dagger\right) - 6\text{Tr}\left(Y_L Y_L^\dagger m_t^{2*} Y_L Y_L^\dagger\right) \\
& -12\text{Tr}\left(Y_L Y_L^\dagger m_t^{2*} Y_e^T Y_e^*\right) - 12\text{Tr}\left(Y_L Y_L^\dagger Y_e^T m_e^{2*} Y_e^*\right) - 12\text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^* m_t^{2*}\right) \\
& -6\text{Tr}\left(Y_L m_{\hat{E}}^{2*} Y_L^\dagger Y_L Y_L^\dagger\right) - 12\text{Tr}\left(Y_L m_{\hat{E}}^{2*} Y_L^\dagger Y_e^T Y_e^*\right) \tag{107}
\end{aligned}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(1)} & = +3\left(m_{H_d}^2 + m_{H_u}^2 + m_t^2\right)|\Lambda_T|^2 + 2\left(m_{H_d}^2 + m_{H_u}^2 + m_S^2\right)|\lambda|^2 + 2m_{H_u}^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 2m_{R_d}^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 2\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*}\right) \\
& + \sqrt{\frac{3}{5}}g_1\sigma_{1,1} + 6m_{H_u}^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 6\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 6\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \tag{108}
\end{aligned}$$

$$\begin{aligned}
\beta_{m_{H_u}^2}^{(2)} & = -15\Lambda_T^2\left(m_{H_d}^2 + m_{H_u}^2 + m_t^2\right)\Lambda_T^{*,2} - 3m_{H_d}^2\lambda|\lambda_T|^2\lambda^* - 3m_{H_u}^2\lambda|\lambda_T|^2\lambda^* - 6m_S^2\lambda|\lambda_T|^2\lambda^* \\
& - 6m_t^2\lambda|\lambda_T|^2\lambda^* - 12m_{H_d}^2\lambda^2\lambda^{*,2} - 12m_{H_u}^2\lambda^2\lambda^{*,2} - 12m_S^2\lambda^2\lambda^{*,2} - 4m_{H_d}^2|\lambda|^2\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& - 2m_{H_u}^2|\lambda|^2\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 2m_{R_u}^2|\lambda|^2\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 2m_S^2|\lambda|^2\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 2|\lambda|^2\left(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right) \\
& + \frac{12}{5}g_1^2 m_{H_u}^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + \frac{12}{5}g_1^2 m_{R_d}^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 3m_{H_u}^2|\lambda_{TR}|^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 6m_{R_d}^2|\lambda_{TR}|^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 3m_{R_u}^2|\lambda_{TR}|^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 3m_t^2|\lambda_{TR}|^2\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 12m_{H_u}^2\left(\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 - 12m_{R_d}^2\left(\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\right)^2 \\
& + \frac{12}{5}g_1^2\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) - 3|\lambda_{TR}|^2\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) - 12\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right)\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 2|\lambda_{SR}|^2\left(2\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\lambda\lambda^* + \left(2m_{R_d}^2 + m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + \left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)\right) \\
& - 2m_{H_u}^2\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) - 2m_{R_d}^2\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) - 2m_S^2\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 2\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) - 2\left(Y_{\hat{B}\hat{a}rE}\lambda_{SE}^\dagger m_{\hat{E}}^2\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) - 2\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right) + 6g_2^4\sigma_{2,2} \\
& + \frac{6}{5}g_1^2\sigma_{2,11} + 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} - 2m_{H_d}^2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - 2m_{H_u}^2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) - 4m_S^2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) \\
& - 12m_{H_d}^2|\lambda|^2\text{Tr}\left(Y_d Y_d^\dagger\right) - 6m_{H_u}^2|\lambda|^2\text{Tr}\left(Y_d Y_d^\dagger\right) - 6m_S^2|\lambda|^2\text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 4m_{H_d}^2|\lambda|^2\text{Tr}\left(Y_e Y_e^\dagger\right) - 2m_{H_u}^2|\lambda|^2\text{Tr}\left(Y_e Y_e^\dagger\right) - 2m_S^2|\lambda|^2\text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 4m_{H_d}^2|\lambda|^2\text{Tr}\left(Y_L Y_L^\dagger\right) - 2m_{H_u}^2|\lambda|^2\text{Tr}\left(Y_L Y_L^\dagger\right) - 2m_S^2|\lambda|^2\text{Tr}\left(Y_L Y_L^\dagger\right) \\
& + \frac{8}{5}g_1^2 m_{H_u}^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 32g_3^2 m_{H_u}^2 \text{Tr}\left(Y_u Y_u^\dagger\right) - 2|\lambda|^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2\right) \\
& - 2|\lambda|^2\text{Tr}\left(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger\right) - 6|\lambda|^2\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) - 2|\lambda|^2\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right)
\end{aligned}$$

$$\begin{aligned}
& -2|\lambda|^2 \text{Tr}(m_t^2 Y_e^\dagger Y_e) - 6|\lambda|^2 \text{Tr}(m_q^2 Y_d^\dagger Y_d) + \frac{8}{5} g_1^2 \text{Tr}(m_q^2 Y_u^\dagger Y_u) + 32 g_3^2 \text{Tr}(m_q^2 Y_u^\dagger Y_u) \\
& + \frac{8}{5} g_1^2 \text{Tr}(m_u^2 Y_u Y_u^\dagger) + 32 g_3^2 \text{Tr}(m_u^2 Y_u Y_u^\dagger) - 2|\lambda|^2 \text{Tr}(Y_L Y_L^\dagger m_t^{2*}) \\
& + 3|\Lambda_T|^2 (4g_2^2 m_{H_d}^2 + 4g_2^2 m_{H_u}^2 + 4g_2^2 m_t^2 - \lambda_{TR} (2m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2)) \lambda_{TR}^* - \lambda_T (3m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_S^2) \lambda_T^* \\
& - 4m_{H_d}^2 \lambda \lambda^* - 4m_{H_u}^2 \lambda \lambda^* - 2m_S^2 \lambda \lambda^* - 2m_t^2 \lambda \lambda^* - 2m_{H_d}^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - m_{H_u}^2 (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& - m_{R_u}^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - m_t^2 (Y_{\hat{E}} Y_{\hat{E}}^*) - (Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) - 6m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) - 3m_{H_u}^2 \text{Tr}(Y_d Y_d^\dagger) \\
& - 3m_t^2 \text{Tr}(Y_d Y_d^\dagger) - 2m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) - m_{H_u}^2 \text{Tr}(Y_e Y_e^\dagger) - m_t^2 \text{Tr}(Y_e Y_e^\dagger) - 2m_{H_d}^2 \text{Tr}(Y_L Y_L^\dagger) \\
& - m_{H_u}^2 \text{Tr}(Y_L Y_L^\dagger) - m_t^2 \text{Tr}(Y_L Y_L^\dagger) - 3\text{Tr}(m_d^2 Y_d Y_d^\dagger) - \text{Tr}(m_e^2 Y_e Y_e^\dagger) - \text{Tr}(m_t^2 Y_e Y_e^\dagger) \\
& - 3\text{Tr}(m_q^2 Y_d^\dagger Y_d) - \text{Tr}(Y_L Y_L^\dagger m_t^{2*}) - \text{Tr}(Y_L m_{\hat{E}}^{2*} Y_L^\dagger) \\
& - 2|\lambda|^2 \text{Tr}(Y_L m_{\hat{E}}^{2*} Y_L^\dagger) - 6m_{H_d}^2 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) - 6m_{H_u}^2 \text{Tr}(Y_d Y_u^\dagger Y_u Y_d^\dagger) \\
& - 36m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger Y_u Y_u^\dagger) - 6\text{Tr}(m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger) - 6\text{Tr}(m_q^2 Y_d^\dagger Y_d Y_u^\dagger Y_u) \\
& - 6\text{Tr}(m_q^2 Y_u^\dagger Y_u Y_d^\dagger Y_d) - 36\text{Tr}(m_q^2 Y_u^\dagger Y_u Y_u^\dagger Y_u) - 6\text{Tr}(m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger) \\
& - 36\text{Tr}(m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger)
\end{aligned} \tag{109}$$

$$\beta_{m_d^2}^{(1)} = 2(2m_{H_d}^2 Y_d Y_d^\dagger + 2Y_d m_q^2 Y_d^\dagger + m_d^2 Y_d Y_d^\dagger + Y_d Y_d^\dagger m_d^2) + 2 \frac{1}{\sqrt{15}} g_1 \mathbf{1}_{\sigma_{1,1}} \tag{110}$$

$$\begin{aligned}
\beta_{m_d^2}^{(2)} = & \frac{2}{5} g_1^2 m_d^2 Y_d Y_d^\dagger + 6g_2^2 m_d^2 Y_d Y_d^\dagger - 3|\Lambda_T|^2 m_d^2 Y_d Y_d^\dagger - 2|\lambda|^2 m_d^2 Y_d Y_d^\dagger \\
& + \frac{4}{5} g_1^2 Y_d m_q^2 Y_d^\dagger + 12g_2^2 Y_d m_q^2 Y_d^\dagger - 6|\Lambda_T|^2 Y_d m_q^2 Y_d^\dagger - 4|\lambda|^2 Y_d m_q^2 Y_d^\dagger \\
& + \frac{2}{5} g_1^2 Y_d Y_d^\dagger m_d^2 + 6g_2^2 Y_d Y_d^\dagger m_d^2 - 3|\Lambda_T|^2 Y_d Y_d^\dagger m_d^2 - 2|\lambda|^2 Y_d Y_d^\dagger m_d^2 \\
& - 8m_{H_d}^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 4m_{H_d}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4m_{H_u}^2 Y_d Y_u^\dagger Y_u Y_d^\dagger \\
& - 2m_d^2 Y_d Y_d^\dagger Y_d Y_d^\dagger - 2m_d^2 Y_d Y_u^\dagger Y_u Y_d^\dagger - 4Y_d m_q^2 Y_d^\dagger Y_d Y_d^\dagger - 4Y_d m_q^2 Y_u^\dagger Y_u Y_d^\dagger \\
& - 4Y_d Y_d^\dagger m_d^2 Y_d Y_d^\dagger - 4Y_d Y_d^\dagger Y_d m_q^2 Y_d^\dagger - 2Y_d Y_d^\dagger Y_d Y_d^\dagger m_d^2 - 4Y_d Y_u^\dagger m_u^2 Y_u Y_d^\dagger \\
& - 4Y_d Y_u^\dagger Y_u m_q^2 Y_d^\dagger - 2Y_d Y_u^\dagger Y_u Y_d^\dagger m_d^2 - 2m_d^2 Y_d Y_d^\dagger (Y_{\hat{E}} Y_{\hat{E}}^*) \\
& - 4Y_d m_q^2 Y_d^\dagger (Y_{\hat{E}} Y_{\hat{E}}^*) - 2Y_d Y_d^\dagger m_d^2 (Y_{\hat{E}} Y_{\hat{E}}^*) + \frac{8}{15} \mathbf{1} (20g_3^4 \sigma_{2,3} + g_1 (g_1 \sigma_{2,11} + \sqrt{15} \sigma_{3,1})) \\
& - 6m_d^2 Y_d Y_d^\dagger \text{Tr}(Y_d Y_d^\dagger) - 12Y_d m_q^2 Y_d^\dagger \text{Tr}(Y_d Y_d^\dagger) - 6Y_d Y_d^\dagger m_d^2 \text{Tr}(Y_d Y_d^\dagger) \\
& - 2m_d^2 Y_d Y_d^\dagger \text{Tr}(Y_e Y_e^\dagger) - 4Y_d m_q^2 Y_d^\dagger \text{Tr}(Y_e Y_e^\dagger) - 2Y_d Y_d^\dagger m_d^2 \text{Tr}(Y_e Y_e^\dagger) \\
& - 2m_d^2 Y_d Y_d^\dagger \text{Tr}(Y_L Y_L^\dagger) - 4Y_d m_q^2 Y_d^\dagger \text{Tr}(Y_L Y_L^\dagger) - 2Y_d Y_d^\dagger m_d^2 \text{Tr}(Y_L Y_L^\dagger) \\
& - \frac{2}{5} Y_d Y_d^\dagger (15(2m_{H_d}^2 + m_{H_u}^2 + m_t^2) |\Lambda_T|^2)
\end{aligned}$$

$$\begin{aligned}
& + 2 \left( -g_1^2 m_{H_d}^2 - 15g_2^2 m_{H_d}^2 + 5 \left( 2m_{H_d}^2 + m_{H_u}^2 + m_S^2 \right) |\lambda|^2 + 5 \left( 2m_{H_d}^2 + m_{R_u}^2 \right) \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + 5 \left( Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^* \right) \right. \\
& + 30m_{H_d}^2 \text{Tr} \left( Y_d Y_d^\dagger \right) + 10m_{H_d}^2 \text{Tr} \left( Y_e Y_e^\dagger \right) + 10m_{H_d}^2 \text{Tr} \left( Y_L Y_L^\dagger \right) + 15 \text{Tr} \left( m_d^2 Y_d Y_d^\dagger \right) + 5 \text{Tr} \left( m_e^2 Y_e Y_e^\dagger \right) \\
& \left. + 5 \text{Tr} \left( m_l^2 Y_e Y_e^\dagger \right) + 15 \text{Tr} \left( m_q^2 Y_d^\dagger Y_d \right) + 5 \text{Tr} \left( Y_L Y_L^\dagger m_l^{2*} \right) + 5 \text{Tr} \left( Y_L m_{\hat{E}}^{2*} Y_L^\dagger \right) \right) \quad (111)
\end{aligned}$$

$$\beta_{m_u^2}^{(1)} = 2 \left( 2m_{H_u}^2 Y_u Y_u^\dagger + 2Y_u m_q^2 Y_u^\dagger + m_u^2 Y_u Y_u^\dagger + Y_u Y_u^\dagger m_u^2 \right) - 4 \frac{1}{\sqrt{15}} g_1 \mathbf{1} \sigma_{1,1} \quad (112)$$

$$\begin{aligned}
\beta_{m_u^2}^{(2)} = & -\frac{2}{5} g_1^2 m_u^2 Y_u Y_u^\dagger + 6g_2^2 m_u^2 Y_u Y_u^\dagger - 3|\Lambda_T|^2 m_u^2 Y_u Y_u^\dagger - 2|\lambda|^2 m_u^2 Y_u Y_u^\dagger \\
& - \frac{4}{5} g_1^2 Y_u m_q^2 Y_u^\dagger + 12g_2^2 Y_u m_q^2 Y_u^\dagger - 6|\Lambda_T|^2 Y_u m_q^2 Y_u^\dagger - 4|\lambda|^2 Y_u m_q^2 Y_u^\dagger \\
& - \frac{2}{5} g_1^2 Y_u Y_u^\dagger m_u^2 + 6g_2^2 Y_u Y_u^\dagger m_u^2 - 3|\Lambda_T|^2 Y_u Y_u^\dagger m_u^2 - 2|\lambda|^2 Y_u Y_u^\dagger m_u^2 \\
& - 4m_{H_d}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 4m_{H_u}^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 8m_{H_u}^2 Y_u Y_u^\dagger Y_u Y_u^\dagger \\
& - 2m_u^2 Y_u Y_d^\dagger Y_d Y_u^\dagger - 2m_u^2 Y_u Y_u^\dagger Y_u Y_u^\dagger - 4Y_u m_q^2 Y_d^\dagger Y_d Y_u^\dagger - 4Y_u m_q^2 Y_u^\dagger Y_u Y_u^\dagger \\
& - 4Y_u Y_d^\dagger m_d^2 Y_d Y_u^\dagger - 4Y_u Y_d^\dagger Y_d m_q^2 Y_u^\dagger - 2Y_u Y_d^\dagger Y_d Y_u^\dagger m_u^2 \\
& - 4Y_u Y_u^\dagger m_u^2 Y_u Y_u^\dagger - 4Y_u Y_u^\dagger Y_u m_q^2 Y_u^\dagger - 2Y_u Y_u^\dagger Y_u Y_u^\dagger m_u^2 - 2m_u^2 Y_u Y_u^\dagger \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) \\
& - 4Y_u m_q^2 Y_u^\dagger \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) - 2Y_u Y_u^\dagger m_u^2 \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) + \frac{16}{15} \mathbf{1} \left( 10g_3^4 \sigma_{2,3} + g_1 \left( 2g_1 \sigma_{2,11} - \sqrt{15} \sigma_{3,1} \right) \right) \\
& - 6m_u^2 Y_u Y_u^\dagger \text{Tr} \left( Y_u Y_u^\dagger \right) - 12Y_u m_q^2 Y_u^\dagger \text{Tr} \left( Y_u Y_u^\dagger \right) - 6Y_u Y_u^\dagger m_u^2 \text{Tr} \left( Y_u Y_u^\dagger \right) \\
& - \frac{2}{5} Y_u Y_u^\dagger \left( 15 \left( 2m_{H_u}^2 + m_{H_d}^2 + m_t^2 \right) |\Lambda_T|^2 \right. \\
& \left. + 2 \left( g_1^2 m_{H_u}^2 - 15g_2^2 m_{H_u}^2 + 5 \left( 2m_{H_u}^2 + m_{H_d}^2 + m_S^2 \right) |\lambda|^2 + 5 \left( 2m_{H_u}^2 + m_{R_d}^2 \right) \left( Y_{B\hat{a}rE} Y_{B\hat{a}rE}^* \right) + 5 \left( Y_{B\hat{a}rE} m_{B\hat{a}rE}^{2*} Y_{B\hat{a}rE}^* \right) \right. \right. \\
& \left. \left. + 30m_{H_u}^2 \text{Tr} \left( Y_u Y_u^\dagger \right) + 15 \text{Tr} \left( m_q^2 Y_u^\dagger Y_u \right) + 15 \text{Tr} \left( m_u^2 Y_u Y_u^\dagger \right) \right) \right) \quad (113)
\end{aligned}$$

$$\beta_{m_e^2}^{(1)} = 2 \left( 2m_{H_d}^2 Y_e Y_e^\dagger + 2Y_e m_l^2 Y_e^\dagger + m_e^2 Y_e Y_e^\dagger + Y_e Y_e^\dagger m_e^2 \right) + 2\sqrt{\frac{3}{5}} g_1 \mathbf{1} \sigma_{1,1} \quad (114)$$

$$\begin{aligned}
\beta_{m_e^2}^{(2)} = & -\frac{6}{5} g_1^2 m_e^2 Y_e Y_e^\dagger + 6g_2^2 m_e^2 Y_e Y_e^\dagger - 3|\Lambda_T|^2 m_e^2 Y_e Y_e^\dagger - 2|\lambda|^2 m_e^2 Y_e Y_e^\dagger \\
& - \frac{12}{5} g_1^2 Y_e m_l^2 Y_e^\dagger + 12g_2^2 Y_e m_l^2 Y_e^\dagger - 6|\Lambda_T|^2 Y_e m_l^2 Y_e^\dagger - 4|\lambda|^2 Y_e m_l^2 Y_e^\dagger \\
& - \frac{6}{5} g_1^2 Y_e Y_e^\dagger m_e^2 + 6g_2^2 Y_e Y_e^\dagger m_e^2 - 3|\Lambda_T|^2 Y_e Y_e^\dagger m_e^2 - 2|\lambda|^2 Y_e Y_e^\dagger m_e^2 \\
& - 8m_{H_d}^2 Y_e Y_e^\dagger Y_e Y_e^\dagger - 8m_{H_d}^2 Y_e Y_L^* Y_L^T Y_e^\dagger - 2m_e^2 Y_e Y_e^\dagger Y_e Y_e^\dagger - 2m_e^2 Y_e Y_L^* Y_L^T Y_e^\dagger \\
& - 4Y_e m_l^2 Y_e^\dagger Y_e Y_e^\dagger - 4Y_e m_l^2 Y_L^* Y_L^T Y_e^\dagger - 4Y_e Y_e^\dagger m_e^2 Y_e Y_e^\dagger - 4Y_e Y_e^\dagger Y_e m_l^2 Y_e^\dagger \\
& - 2Y_e Y_e^\dagger Y_e Y_e^\dagger m_e^2 - 4Y_e Y_L^* m_{\hat{E}}^2 Y_L^T Y_e^\dagger - 4Y_e Y_L^* Y_L^T m_l^2 Y_e^\dagger \\
& - 2Y_e Y_L^* Y_L^T Y_e^\dagger m_e^2 - 2m_e^2 Y_e Y_e^\dagger \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) - 4Y_e m_l^2 Y_e^\dagger \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) \\
& - 2Y_e Y_e^\dagger m_e^2 \left( Y_{\hat{E}} Y_{\hat{E}}^* \right) + \frac{8}{5} g_1 \mathbf{1} \left( 3g_1 \sigma_{2,11} + \sqrt{15} \sigma_{3,1} \right) - 6m_e^2 Y_e Y_e^\dagger \text{Tr} \left( Y_d Y_d^\dagger \right)
\end{aligned}$$

$$\begin{aligned}
& -12Y_e m_l^2 Y_e^\dagger \text{Tr}(Y_d Y_d^\dagger) - 6Y_e Y_e^\dagger m_e^2 \text{Tr}(Y_d Y_d^\dagger) - 2m_e^2 Y_e Y_e^\dagger \text{Tr}(Y_e Y_e^\dagger) \\
& -4Y_e m_l^2 Y_e^\dagger \text{Tr}(Y_e Y_e^\dagger) - 2Y_e Y_e^\dagger m_e^2 \text{Tr}(Y_e Y_e^\dagger) - 2m_e^2 Y_e Y_e^\dagger \text{Tr}(Y_L Y_L^\dagger) \\
& -4Y_e m_l^2 Y_e^\dagger \text{Tr}(Y_L Y_L^\dagger) - 2Y_e Y_e^\dagger m_e^2 \text{Tr}(Y_L Y_L^\dagger) \\
& -\frac{2}{5} Y_e Y_e^\dagger \left( 15(2m_{H_d}^2 + m_{H_u}^2 + m_t^2) |\Lambda_T|^2 \right. \\
& + 2(3g_1^2 m_{H_d}^2 - 15g_2^2 m_{H_d}^2 + 5(2m_{H_d}^2 + m_{H_u}^2 + m_S^2) |\lambda|^2 + 5(2m_{H_d}^2 + m_{R_u}^2) (Y_{\hat{E}} Y_{\hat{E}}^*) + 5(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) \\
& + 30m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) + 10m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 10m_{H_d}^2 \text{Tr}(Y_L Y_L^\dagger) + 15\text{Tr}(m_d^2 Y_d Y_d^\dagger) + 5\text{Tr}(m_e^2 Y_e Y_e^\dagger) \\
& \left. + 5\text{Tr}(m_l^2 Y_e^\dagger Y_e) + 15\text{Tr}(m_q^2 Y_d^\dagger Y_d) + 5\text{Tr}(Y_L Y_L^\dagger m_l^{2*}) + 5\text{Tr}(Y_L m_{\hat{E}}^{2*} Y_L^\dagger) \right) \quad (115)
\end{aligned}$$

$$\begin{aligned}
\beta_{m_S^2}^{(1)} & = +4(m_{R_d}^2 + m_{R_u}^2 + m_S^2) |\lambda_{SR}|^2 + 3(2m_t^2 + m_S^2) |\lambda_T|^2 \\
& + 2\left( 2(m_{H_d}^2 + m_{H_u}^2 + m_S^2) |\lambda|^2 + m_S^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) + \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2) + \text{Tr}(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger) \right) \quad (116)
\end{aligned}$$

$$\begin{aligned}
\beta_{m_S^2}^{(2)} & = -16\lambda_{SR}^2 (m_{R_d}^2 + m_{R_u}^2 + m_S^2) \lambda_{SR}^{*2} - 12\lambda_T^2 (2m_t^2 + m_S^2) \lambda_T^{*2} \\
& + 6|\lambda_T|^2 (4g_2^2 (2m_t^2 + m_S^2) - \Lambda_T (3m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_S^2) \Lambda_T^* - \lambda_{TR} (3m_t^2 + m_{R_d}^2 + m_{R_u}^2 + m_S^2) \lambda_{TR}^*) \\
& + \frac{4}{5} |\lambda_{SR}|^2 (3g_1^2 m_{R_d}^2 + 15g_2^2 m_{R_d}^2 + 3g_1^2 m_{R_u}^2 + 15g_2^2 m_{R_u}^2 + 3g_1^2 m_S^2 + 15g_2^2 m_S^2 \\
& - 15\lambda_{TR} (2m_{R_d}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2) \lambda_{TR}^* - 5(2m_{R_u}^2 + m_{H_d}^2 + m_{R_d}^2 + m_S^2) (Y_{\hat{E}} Y_{\hat{E}}^*) - 5(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) - 5m_{H_u}^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\
& - 10m_{R_d}^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 5m_{R_u}^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 5m_S^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) - 5(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*) \\
& - \frac{4}{5} (20(m_{H_d}^2 + m_{H_u}^2 + m_S^2) \lambda^2 \lambda^{*,2} + 5(m_{H_u}^2 + m_{R_d}^2 + m_S^2) (Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*) + 5(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger \lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*) \\
& + 5(Y_{\hat{B}\hat{a}rE} \lambda_{SE}^\dagger m_{\hat{E}}^2 \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*) + 5(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*) + 5m_{H_d}^2 (\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*) \\
& + 5m_{R_u}^2 (\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*) + 5m_S^2 (\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*) + 5(\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T m_{\hat{E}}^{2*} Y_{\hat{E}}^*) \\
& + 5(\lambda_{SE}^T Y_{\hat{E}}^* \lambda_{SE}^\dagger m_{\hat{E}}^2 Y_{\hat{E}}) + 5(\lambda_{SE}^T Y_{\hat{E}}^* m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger Y_{\hat{E}}) - 6g_1^2 m_S^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger) \\
& - 6g_1^2 \text{Tr}(\lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2) - 6g_1^2 \text{Tr}(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger) \\
& + |\lambda|^2 (-3g_1^2 m_{H_d}^2 - 15g_2^2 m_{H_d}^2 - 3g_1^2 m_{H_u}^2 - 15g_2^2 m_{H_u}^2 - 3g_1^2 m_S^2 - 15g_2^2 m_S^2 \\
& + 15\Lambda_T (2m_{H_d}^2 + 2m_{H_u}^2 + m_S^2 + m_t^2) \Lambda_T^* + 5(2m_{H_d}^2 + m_{H_u}^2 + m_{R_u}^2 + m_S^2) (Y_{\hat{E}} Y_{\hat{E}}^*) + 5(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*) + 5m_{H_d}^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) \\
& + 10m_{H_u}^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 5m_{R_d}^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 5m_S^2 (Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*) + 5(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*) + 30m_{H_d}^2 \text{Tr}(Y_d Y_d^\dagger) \\
& + 15m_{H_u}^2 \text{Tr}(Y_d Y_d^\dagger) + 15m_S^2 \text{Tr}(Y_d Y_d^\dagger) + 10m_{H_d}^2 \text{Tr}(Y_e Y_e^\dagger) + 5m_{H_u}^2 \text{Tr}(Y_e Y_e^\dagger) + 5m_S^2 \text{Tr}(Y_e Y_e^\dagger) \\
& + 10m_{H_d}^2 \text{Tr}(Y_L Y_L^\dagger) + 5m_{H_u}^2 \text{Tr}(Y_L Y_L^\dagger) + 5m_S^2 \text{Tr}(Y_L Y_L^\dagger) + 15m_{H_d}^2 \text{Tr}(Y_u Y_u^\dagger) + 30m_{H_u}^2 \text{Tr}(Y_u Y_u^\dagger) \\
& + 15m_S^2 \text{Tr}(Y_u Y_u^\dagger) + 15\text{Tr}(m_d^2 Y_d Y_d^\dagger) + 5\text{Tr}(m_e^2 Y_e Y_e^\dagger) + 5\text{Tr}(m_l^2 Y_e^\dagger Y_e) + 15\text{Tr}(m_q^2 Y_d^\dagger Y_d)
\end{aligned}$$

$$\begin{aligned}
& + 15\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 15\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) + 5\text{Tr}\left(Y_L Y_L^\dagger m_l^{2*}\right) + 5\text{Tr}\left(Y_L m_{\hat{E}}^{2*} Y_L^\dagger\right) \\
& + 10m_S^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger\right) + 5m_{H_d}^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*\right) + 5m_S^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*\right) + 5\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2\right) \\
& + 5\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger \lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger\right) + 5\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2 \lambda_{SE} \lambda_{SE}^\dagger\right) + 5\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2 Y_L^T Y_L^*\right) + 5\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T m_l^2 Y_L^*\right) \\
& + 5\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^* m_{\hat{E}}^2\right) + 5\text{Tr}\left(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger \lambda_{SE} \lambda_{SE}^\dagger\right) + 5\text{Tr}\left(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger Y_L^T Y_L^*\right) \tag{117}
\end{aligned}$$

$$\beta_{m_t^2}^{(1)} = 2\left(\left(2m_t^2 + m_S^2\right)|\lambda_T|^2 + \left(m_{H_d}^2 + m_{H_u}^2 + m_t^2\right)|\Lambda_T|^2 + \left(m_{R_d}^2 + m_{R_u}^2 + m_t^2\right)|\lambda_{TR}|^2\right) \tag{118}$$

$$\begin{aligned}
\beta_{m_t^2}^{(2)} & = -12\lambda_{TR}^2 \left(m_{R_d}^2 + m_{R_u}^2 + m_t^2\right) \lambda_{TR}^{*2} \\
& + \frac{2}{5} |\lambda_{TR}|^2 \left(3g_1^2 m_{R_d}^2 - 5g_2^2 m_{R_d}^2 + 3g_1^2 m_{R_u}^2 - 5g_2^2 m_{R_u}^2 + 3g_1^2 m_t^2 - 5g_2^2 m_t^2\right) \\
& - 10\lambda_{SR} \left(2m_{R_d}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2\right) \lambda_{SR}^* - 5\lambda_T \left(3m_t^2 + m_{R_d}^2 + m_{R_u}^2 + m_S^2\right) \lambda_T^* - 5m_{H_d}^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 5m_{R_d}^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& - 10m_{R_u}^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 5m_t^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 5\left(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right) - 5m_{H_u}^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 10m_{R_d}^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 5m_{R_u}^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 5m_t^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 5\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - \frac{2}{5} \left(-3g_1^2 m_{H_d}^2 |\Lambda_T|^2 + 5g_2^2 m_{H_d}^2 |\Lambda_T|^2 - 3g_1^2 m_{H_u}^2 |\Lambda_T|^2 + 5g_2^2 m_{H_u}^2 |\Lambda_T|^2 - 3g_1^2 m_t^2 |\Lambda_T|^2\right. \\
& + 5g_2^2 m_t^2 |\Lambda_T|^2 + 10\lambda_T \left(2\left(m_S^2 + m_t^2\right) + m_{R_d}^2 + m_{R_u}^2\right) |\lambda_{SR}|^2 \lambda_T^* + 25\lambda_T^2 \left(2m_t^2 + m_S^2\right) \lambda_T^{*2} + 30\Lambda_T^2 m_{H_d}^2 \Lambda_T^{*2} \\
& + 30\Lambda_T^2 m_{H_u}^2 \Lambda_T^{*2} + 30\Lambda_T^2 m_t^2 \Lambda_T^{*2} + 20m_{H_d}^2 \lambda |\Lambda_T|^2 \lambda^* + 20m_{H_u}^2 \lambda |\Lambda_T|^2 \lambda^* + 10m_S^2 \lambda |\Lambda_T|^2 \lambda^* \\
& + 10m_t^2 \lambda |\Lambda_T|^2 \lambda^* + 10m_{H_d}^2 |\Lambda_T|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 5m_{H_u}^2 |\Lambda_T|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 5m_{R_u}^2 |\Lambda_T|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& + 5m_t^2 |\Lambda_T|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 5|\Lambda_T|^2 \left(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right) + 5m_{H_d}^2 |\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 10m_{H_u}^2 |\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 5m_{R_d}^2 |\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 5m_t^2 |\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 5|\Lambda_T|^2 \left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) - 40g_2^4 \sigma_{2,2} \\
& + 30m_{H_d}^2 |\Lambda_T|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 15m_{H_u}^2 |\Lambda_T|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 15m_t^2 |\Lambda_T|^2 \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& + 10m_{H_d}^2 |\Lambda_T|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 5m_{H_u}^2 |\Lambda_T|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 5m_t^2 |\Lambda_T|^2 \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + 10m_{H_d}^2 |\Lambda_T|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 5m_{H_u}^2 |\Lambda_T|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 5m_t^2 |\Lambda_T|^2 \text{Tr}\left(Y_L Y_L^\dagger\right) \\
& + 15m_{H_d}^2 |\Lambda_T|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 30m_{H_u}^2 |\Lambda_T|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 15m_t^2 |\Lambda_T|^2 \text{Tr}\left(Y_u Y_u^\dagger\right) \\
& + 5|\lambda_T|^2 \left(\Lambda_T \left(3m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_S^2\right) \Lambda_T^* + 2\left(2\left(m_S^2 + m_t^2\right) + m_{H_d}^2 + m_{H_u}^2\right) \lambda \lambda^* + 2m_S^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) + 2m_t^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right)\right. \\
& + \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2\right) + \text{Tr}\left(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger\right) \\
& + 15|\Lambda_T|^2 \text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 5|\Lambda_T|^2 \text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + 5|\Lambda_T|^2 \text{Tr}\left(m_l^2 Y_l Y_l^\dagger\right) \\
& + 15|\Lambda_T|^2 \text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) + 15|\Lambda_T|^2 \text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 15|\Lambda_T|^2 \text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \\
& + 5|\Lambda_T|^2 \text{Tr}\left(Y_L Y_L^\dagger m_l^{2*}\right) + 5|\Lambda_T|^2 \text{Tr}\left(Y_L m_{\hat{E}}^{2*} Y_L^\dagger\right) \tag{119}
\end{aligned}$$

$$\beta_{m_O^2}^{(1)} = 0 \quad (120)$$

$$\beta_{m_O^2}^{(2)} = 24g_3^4\sigma_{2,3} \quad (121)$$

$$\begin{aligned} \beta_{m_{R_u}^2}^{(1)} &= +2\left(m_{R_d}^2 + m_{R_u}^2 + m_S^2\right)|\lambda_{SR}|^2 + 3\left(m_{R_d}^2 + m_{R_u}^2 + m_t^2\right)|\lambda_{TR}|^2 + 2m_{H_d}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 2m_{R_u}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + 2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) \\ &\quad - \sqrt{\frac{3}{5}}g_1\sigma_{1,1} \end{aligned} \quad (122)$$

$$\begin{aligned} \beta_{m_{R_u}^2}^{(2)} &= -12\lambda_{SR}^2\left(m_{R_d}^2 + m_{R_u}^2 + m_S^2\right)\lambda_{SR}^{*,2} - 15\lambda_{TR}^2\left(m_{R_d}^2 + m_{R_u}^2 + m_t^2\right)\lambda_{TR}^{*,2} + \frac{12}{5}g_1^2m_{H_d}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) + \frac{12}{5}g_1^2m_{R_u}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\ &\quad - 6m_{H_d}^2|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 3m_{H_u}^2|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 3m_{R_u}^2|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 3m_t^2|\Lambda_T|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\ &\quad - 4m_{H_d}^2|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 2m_{H_u}^2|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 2m_{R_u}^2|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) - 2m_S^2|\lambda|^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right) \\ &\quad - 12m_{H_d}^2\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 - 12m_{R_u}^2\left(\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\right)^2 + \frac{12}{5}g_1^2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 3|\Lambda_T|^2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) \\ &\quad - 2|\lambda|^2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 12\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 8m_{H_d}^2\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) \\ &\quad - 4m_{R_u}^2\left(Y_{\hat{E}}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) - 4\left(Y_{\hat{E}}Y_L^\dagger Y_L m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 4\left(Y_{\hat{E}}Y_L^\dagger m_l^{2*}Y_L Y_{\hat{E}}^*\right) \\ &\quad - 4\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_L^\dagger Y_L Y_{\hat{E}}^*\right) \\ &\quad + 3|\lambda_{TR}|^2\left(4g_2^2m_{R_d}^2 + 4g_2^2m_{R_u}^2 + 4g_2^2m_t^2 - \lambda_T\left(3m_t^2 + m_{R_d}^2 + m_{R_u}^2 + m_S^2\right)\lambda_T^* - \Lambda_T\left(2m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\Lambda_T^*\right. \\ &\quad \left. - m_{H_u}^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - 2m_{R_d}^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - m_{R_u}^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - m_t^2\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) - \left(Y_{\hat{B}\hat{a}rE}m_{\hat{B}\hat{a}rE}^{2*}Y_{\hat{B}\hat{a}rE}^*\right)\right) \\ &\quad - 2m_{H_d}^2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) - 2m_{R_u}^2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) - 2m_S^2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*\right) \\ &\quad - 2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right) - 2\left(\lambda_{SE}^T Y_{\hat{E}}^*\lambda_{SE}^\dagger m_{\hat{E}}^2 Y_{\hat{E}}\right) - 2\left(\lambda_{SE}^T Y_{\hat{E}}^* m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger Y_{\hat{E}}\right) \\ &\quad + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} - 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} - 12m_{H_d}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_d Y_d^\dagger\right) - 6m_{R_u}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_d Y_d^\dagger\right) \\ &\quad - 6\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_d Y_d^\dagger\right) - 4m_{H_d}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_e Y_e^\dagger\right) - 2m_{R_u}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_e Y_e^\dagger\right) \\ &\quad - 2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_e Y_e^\dagger\right) - 4m_{H_d}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L Y_L^\dagger\right) - 2m_{R_u}^2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L Y_L^\dagger\right) \\ &\quad - 2\left(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L Y_L^\dagger\right) \\ &\quad - |\lambda_{SR}|^2\left(6\lambda_{TR}\left(2m_{R_d}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2\right)\lambda_{TR}^* + 3\lambda_T\left(2\left(m_S^2 + m_t^2\right) + m_{R_d}^2 + m_{R_u}^2\right)\lambda_T^*\right. \\ &\quad \left. + 2\left(2\left(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2\right)\lambda\lambda^* + \left(2m_{R_d}^2 + m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\left(Y_{\hat{B}\hat{a}rE}Y_{\hat{B}\hat{a}rE}^*\right) + \left(Y_{\hat{B}\hat{a}rE}m_{\hat{B}\hat{a}rE}^{2*}Y_{\hat{B}\hat{a}rE}^*\right) + \right. \\ &\quad \left. + m_{R_u}^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + 2m_S^2\text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger\right) + \text{Tr}\left(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2\right) + \text{Tr}\left(\lambda_{SE}m_{\hat{B}\hat{a}rE}^{2*}\lambda_{SE}^\dagger\right)\right) \\ &\quad - 6\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) - 2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) - 2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(m_l^2 Y_e^\dagger Y_e\right) \\ &\quad - 6\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) - 2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L Y_L^\dagger m_l^{2*}\right) - 2\left(Y_{\hat{E}}Y_{\hat{E}}^*\right)\text{Tr}\left(Y_L m_{\hat{E}}^{2*}Y_L^\dagger\right) \end{aligned} \quad (123)$$

$$\beta_{m_{R_d}^2}^{(1)} = +2(m_{R_d}^2 + m_{R_u}^2 + m_S^2)|\lambda_{SR}|^2 + 3(m_{R_d}^2 + m_{R_u}^2 + m_t^2)|\lambda_{TR}|^2 + 2m_{H_u}^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 2m_{R_d}^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + \sqrt{\frac{3}{5}}g_1\sigma_{1,1} \quad (124)$$

$$\begin{aligned} \beta_{m_{R_d}^2}^{(2)} = & -12\lambda_{SR}^2(m_{R_d}^2 + m_{R_u}^2 + m_S^2)\lambda_{SR}^{*,2} - 15\lambda_{TR}^2(m_{R_d}^2 + m_{R_u}^2 + m_t^2)\lambda_{TR}^{*,2} \\ & + 3|\lambda_{TR}|^2(4g_2^2m_{R_d}^2 + 4g_2^2m_{R_u}^2 + 4g_2^2m_t^2 - \lambda_T(3m_t^2 + m_{R_d}^2 + m_{R_u}^2 + m_S^2)\lambda_T^* - \Lambda_T(2m_t^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2)\Lambda_T^* \\ & - m_{H_d}^2(Y_{\hat{E}}Y_{\hat{E}}^*) - m_{R_d}^2(Y_{\hat{E}}Y_{\hat{E}}^*) - 2m_{R_u}^2(Y_{\hat{E}}Y_{\hat{E}}^*) - m_t^2(Y_{\hat{E}}Y_{\hat{E}}^*) - (Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*)) \\ & + \frac{12}{5}g_1^2m_{H_u}^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + \frac{12}{5}g_1^2m_{R_d}^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 3m_{H_d}^2|\Lambda_T|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 6m_{H_u}^2|\Lambda_T|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \\ & - 3m_{R_d}^2|\Lambda_T|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 3m_t^2|\Lambda_T|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 2m_{H_d}^2|\lambda|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 4m_{H_u}^2|\lambda|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \\ & - 2m_{R_d}^2|\lambda|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 2m_S^2|\lambda|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 12m_{H_u}^2((Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*))^2 - 12m_{R_d}^2((Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*))^2 \\ & + \frac{12}{5}g_1^2(Y_{B\hat{a}rE}m_{B\hat{a}rE}^{2*}Y_{B\hat{a}rE}^*) - 3|\Lambda_T|^2(Y_{B\hat{a}rE}m_{B\hat{a}rE}^{2*}Y_{B\hat{a}rE}^*) - 2|\lambda|^2(Y_{B\hat{a}rE}m_{B\hat{a}rE}^{2*}Y_{B\hat{a}rE}^*) \\ & - 12(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*)(Y_{B\hat{a}rE}m_{B\hat{a}rE}^{2*}Y_{B\hat{a}rE}^*) - 2m_{H_u}^2(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) - 2m_{R_d}^2(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) \\ & - 2m_S^2(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) - 2(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}m_{B\hat{a}rE}^{2*}Y_{B\hat{a}rE}^*) - 2(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}m_{\hat{E}}^2\lambda_{SE}Y_{B\hat{a}rE}^*) \\ & - 2(Y_{B\hat{a}rE}m_{B\hat{a}rE}^{2*}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) + 6g_2^4\sigma_{2,2} + \frac{6}{5}g_1^2\sigma_{2,11} + 4\sqrt{\frac{3}{5}}g_1\sigma_{3,1} - 12m_{H_u}^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*)\text{Tr}(Y_u Y_u^\dagger) \\ & - 6m_{R_d}^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*)\text{Tr}(Y_u Y_u^\dagger) - 6(Y_{B\hat{a}rE}m_{B\hat{a}rE}^{2*}Y_{B\hat{a}rE}^*)\text{Tr}(Y_u Y_u^\dagger) \\ & - |\lambda_{SR}|^2(6\lambda_{TR}(2m_{R_d}^2 + 2m_{R_u}^2 + m_S^2 + m_t^2)\lambda_{TR}^* + 3\lambda_T(2(m_S^2 + m_t^2) + m_{R_d}^2 + m_{R_u}^2)\lambda_T^* \\ & + 2(2(2m_S^2 + m_{H_d}^2 + m_{H_u}^2 + m_{R_d}^2 + m_{R_u}^2)\lambda\lambda^* + (2m_{R_u}^2 + m_{H_d}^2 + m_{R_d}^2 + m_S^2)(Y_{\hat{E}}Y_{\hat{E}}^*) + (Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*) + m_{R_d}^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) \\ & + m_{R_u}^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) + 2m_S^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) + \text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2) + \text{Tr}(\lambda_{SE}m_{B\hat{a}rE}^{2*}\lambda_{SE}^\dagger)) \\ & - 6(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*)\text{Tr}(m_q^2 Y_u^\dagger Y_u) - 6(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*)\text{Tr}(m_u^2 Y_u Y_u^\dagger) \end{aligned} \quad (125)$$

$$\begin{aligned} \beta_{m_{\hat{E}}^2}^{(1)} = & +2m_S^2\lambda_{SE}\lambda_{SE}^\dagger + 4m_{H_d}^2 Y_L^T Y_L^* + \lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2 + 2\lambda_{SE}m_{B\hat{a}rE}^{2*}\lambda_{SE}^\dagger + m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger \\ & + 2m_{\hat{E}}^2 Y_L^T Y_L^* + 4Y_L^T m_l Y_L^* + 2Y_L^T Y_L^* m_{\hat{E}}^2 + 2\sqrt{\frac{3}{5}}g_1\mathbf{1}_{\sigma_{1,1}} + 2Y_{\hat{E},i_2}^* (2(m_{H_d}^2 + m_{R_u}^2)Y_{\hat{E},i_1} + (m_{\hat{E}}^2 Y_{\hat{E}})_{i_1}) \\ & + 2Y_{\hat{E},i_1} (m_{\hat{E}}^{2*} Y_{\hat{E}}^*)_{i_2} \end{aligned} \quad (126)$$

$$\begin{aligned} \beta_{m_{\hat{E}}^2}^{(2)} = & -4m_{R_d}^2|\lambda_{SR}|^2\lambda_{SE}\lambda_{SE}^\dagger - 4m_{R_u}^2|\lambda_{SR}|^2\lambda_{SE}\lambda_{SE}^\dagger - 8m_S^2|\lambda_{SR}|^2\lambda_{SE}\lambda_{SE}^\dagger \\ & - 6m_S^2|\lambda_T|^2\lambda_{SE}\lambda_{SE}^\dagger - 6m_t^2|\lambda_T|^2\lambda_{SE}\lambda_{SE}^\dagger - 4m_{H_d}^2|\lambda|^2\lambda_{SE}\lambda_{SE}^\dagger \\ & - 4m_{H_u}^2|\lambda|^2\lambda_{SE}\lambda_{SE}^\dagger - 8m_S^2|\lambda|^2\lambda_{SE}\lambda_{SE}^\dagger - \frac{12}{5}g_1^2m_{H_d}^2 Y_L^T Y_L^* + 12g_2^2m_{H_d}^2 Y_L^T Y_L^* \\ & - 12m_{H_d}^2|\Lambda_T|^2 Y_L^T Y_L^* - 6m_{H_u}^2|\Lambda_T|^2 Y_L^T Y_L^* - 6m_t^2|\Lambda_T|^2 Y_L^T Y_L^* \end{aligned}$$



$$\begin{aligned}
& -8m_{H_d}^2|\lambda|^2Y_L^TY_L^* - 4m_{H_u}^2|\lambda|^2Y_L^TY_L^* - 4m_S^2|\lambda|^2Y_L^TY_L^* \\
& -2|\lambda_{SR}|^2\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2 - \frac{3}{2}|\lambda_T|^2\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2 - 2|\lambda|^2\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2 \\
& -4|\lambda_{SR}|^2\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger - 3|\lambda_T|^2\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger - 4|\lambda|^2\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger \\
& -2|\lambda_{SR}|^2m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger - \frac{3}{2}|\lambda_T|^2m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger - 2|\lambda|^2m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger - \frac{6}{5}g_1^2m_{\hat{E}}^2Y_L^TY_L^* \\
& + 6g_2^2m_{\hat{E}}^2Y_L^TY_L^* - 3|\Lambda_T|^2m_{\hat{E}}^2Y_L^TY_L^* - 2|\lambda|^2m_{\hat{E}}^2Y_L^TY_L^* - \frac{12}{5}g_1^2Y_L^Tm_i^2Y_L^* \\
& + 12g_2^2Y_L^Tm_i^2Y_L^* - 6|\Lambda_T|^2Y_L^Tm_i^2Y_L^* - 4|\lambda|^2Y_L^Tm_i^2Y_L^* - \frac{6}{5}g_1^2Y_L^TY_L^*m_{\hat{E}}^2 \\
& + 6g_2^2Y_L^TY_L^*m_{\hat{E}}^2 - 3|\Lambda_T|^2Y_L^TY_L^*m_{\hat{E}}^2 - 2|\lambda|^2Y_L^TY_L^*m_{\hat{E}}^2 - 4m_S^2\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger \\
& - 8m_{H_d}^2Y_L^TY_e^TY_eY_L^* - 8m_{H_d}^2Y_L^TY_L^TY_L^TY_L^* - \lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2 - 2\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger \\
& - 2\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger - 2\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger - m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger - 2m_{\hat{E}}^2Y_L^TY_e^TY_eY_L^* \\
& - 2m_{\hat{E}}^2Y_L^TY_L^TY_L^TY_L^* - 4Y_L^Tm_i^2Y_e^\dagger Y_eY_L^* - 4Y_L^Tm_i^2Y_L^TY_L^TY_L^* - 4Y_L^TY_e^\dagger m_e^2Y_eY_L^* \\
& - 4Y_L^TY_e^\dagger Y_e m_e^2Y_L^* - 2Y_L^TY_e^\dagger Y_eY_L^*m_{\hat{E}}^2 - 4Y_L^TY_L^*m_{\hat{E}}^2Y_L^TY_L^* - 4Y_L^TY_L^*Y_L^TY_L^*m_i^2Y_L^* \\
& - 2Y_L^TY_L^*Y_L^TY_L^*m_{\hat{E}}^2 - 8m_{H_d}^2Y_L^TY_L^*(Y_{\hat{E}}Y_{\hat{E}}^*) - 4m_{R_u}^2Y_L^TY_L^*(Y_{\hat{E}}Y_{\hat{E}}^*) \\
& - 2m_{\hat{E}}^2Y_L^TY_L^*(Y_{\hat{E}}Y_{\hat{E}}^*) - 4Y_L^Tm_i^2Y_L^*(Y_{\hat{E}}Y_{\hat{E}}^*) - 2Y_L^TY_L^*m_{\hat{E}}^2(Y_{\hat{E}}Y_{\hat{E}}^*) \\
& - 4Y_L^TY_L^*(Y_{\hat{E}}m_{\hat{E}}^{2*}Y_{\hat{E}}^*) + \frac{8}{5}g_1\mathbf{1}(3g_1\sigma_{2,11} + \sqrt{15}\sigma_{3,1}) - 4m_S^2\lambda_{SE}\lambda_{SE}^\dagger\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) \\
& - \lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) - 2\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) - m_{\hat{E}}^2\lambda_{SE}\lambda_{SE}^\dagger\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) \\
& - 24m_{H_d}^2Y_L^TY_L^*\text{Tr}(Y_dY_d^\dagger) - 6m_{\hat{E}}^2Y_L^TY_L^*\text{Tr}(Y_dY_d^\dagger) - 12Y_L^Tm_i^2Y_L^*\text{Tr}(Y_dY_d^\dagger) \\
& - 6Y_L^TY_L^*m_{\hat{E}}^2\text{Tr}(Y_dY_d^\dagger) - 8m_{H_d}^2Y_L^TY_L^*\text{Tr}(Y_eY_e^\dagger) - 2m_{\hat{E}}^2Y_L^TY_L^*\text{Tr}(Y_eY_e^\dagger) \\
& - 4Y_L^Tm_i^2Y_L^*\text{Tr}(Y_eY_e^\dagger) - 2Y_L^TY_L^*m_{\hat{E}}^2\text{Tr}(Y_eY_e^\dagger) - 8m_{H_d}^2Y_L^TY_L^*\text{Tr}(Y_LY_L^\dagger) \\
& - 2m_{\hat{E}}^2Y_L^TY_L^*\text{Tr}(Y_LY_L^\dagger) - 4Y_L^Tm_i^2Y_L^*\text{Tr}(Y_LY_L^\dagger) - 2Y_L^TY_L^*m_{\hat{E}}^2\text{Tr}(Y_LY_L^\dagger) \\
& - 2\lambda_{SE}\lambda_{SE}^\dagger\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger m_{\hat{E}}^2) - 2\lambda_{SE}\lambda_{SE}^\dagger\text{Tr}(\lambda_{SEM_{\hat{B}\hat{a}rE}}^{2*}\lambda_{SE}^\dagger) - 12Y_L^TY_L^*\text{Tr}(m_d^2Y_dY_d^\dagger) \\
& - 4Y_L^TY_L^*\text{Tr}(m_e^2Y_eY_e^\dagger) - 4Y_L^TY_L^*\text{Tr}(m_i^2Y_e^\dagger Y_e) - 12Y_L^TY_L^*\text{Tr}(m_q^2Y_d^\dagger Y_d) \\
& - 4Y_L^TY_L^*\text{Tr}(Y_LY_L^\dagger m_i^{2*}) - 4Y_L^TY_L^*\text{Tr}(Y_Lm_{\hat{E}}^{2*}Y_L^\dagger) - 4m_{H_u}^2(\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*)_{i_1}(\lambda_{SE}^*Y_{\hat{B}\hat{a}rE})_{i_2} \\
& - 4m_{R_d}^2(\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*)_{i_1}(\lambda_{SE}^*Y_{\hat{B}\hat{a}rE})_{i_2} - 4m_S^2(\lambda_{SE}Y_{\hat{B}\hat{a}rE}^*)_{i_1}(\lambda_{SE}^*Y_{\hat{B}\hat{a}rE})_{i_2} - \frac{6}{5}g_1^2Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} + 6g_2^2Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} \\
& - 2|\lambda_{SR}|^2Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} - 3|\lambda_{TR}|^2Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} - 3|\Lambda_T|^2Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} - 2|\lambda|^2Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} \\
& - 4(Y_{\hat{E}}Y_{\hat{E}}^*)_{i_2}Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} - 6\text{Tr}(Y_dY_d^\dagger)Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2} - 2\text{Tr}(Y_eY_e^\dagger)Y_{\hat{E},i_1}(m_{\hat{E}}^{2*}Y_{\hat{E}}^*)_{i_2}
\end{aligned}$$

$$\begin{aligned}
& -2\text{Tr}\left(Y_L Y_L^\dagger\right) Y_{\hat{E},i_1} \left(m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right)_{i_2} - 4\left(\lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_2} \left(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_1} - 2\left(\lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_2} \left(m_{\hat{E}}^2 \lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right)_{i_1} - 8m_{H_d}^2 Y_{\hat{E},i_1} \left(m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right)_{i_2} \\
& - 2\left(m_{\hat{E}}^2 Y_{\hat{E}}\right)_{i_1} \left(Y_L^\dagger Y_L Y_{\hat{E}}^*\right)_{i_2} - 4\left(\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right)_{i_1} \left(\lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 Y_{\hat{B}\hat{a}rE}\right)_{i_2} - 2\left(\lambda_{SE} Y_{\hat{B}\hat{a}rE}^*\right)_{i_1} \left(m_{\hat{E}}^{2*} \lambda_{SE}^* Y_{\hat{B}\hat{a}rE}\right)_{i_2} - 2\left(m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right)_{i_2} \left(m_{\hat{E}}^2 Y_{\hat{E}}\right)_{i_1} \\
& - 2Y_{\hat{E},i_1} \left(m_{\hat{E}}^{2*} Y_L^\dagger Y_L Y_{\hat{E}}^*\right)_{i_2} \\
& - \frac{1}{5} Y_{\hat{E},i_2}^* \left(2\left(6g_1^2 m_{H_d}^2 - 30g_2^2 m_{H_d}^2 + 6g_1^2 m_{R_u}^2 - 30g_2^2 m_{R_u}^2 + 10\left(2m_{R_u}^2 + m_{H_d}^2 + m_{R_d}^2 + m_S^2\right)\right) |\lambda_{SR}|^2 \right. \\
& + 15\left(2m_{R_u}^2 + m_{H_d}^2 + m_{R_d}^2 + m_t^2\right) |\lambda_{TR}|^2 + 30m_{H_d}^2 |\Lambda_T|^2 + 15m_{H_u}^2 |\Lambda_T|^2 + 15m_{R_u}^2 |\Lambda_T|^2 + 15m_t^2 |\Lambda_T|^2 \\
& + 20m_{H_d}^2 |\lambda|^2 + 10m_{H_u}^2 |\lambda|^2 + 10m_{R_u}^2 |\lambda|^2 + 10m_S^2 |\lambda|^2 + 40m_{H_d}^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 40m_{R_u}^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& + 20\left(Y_{\hat{E}} m_{\hat{E}}^{2*} Y_{\hat{E}}^*\right) + 60m_{H_d}^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 30m_{R_u}^2 \text{Tr}\left(Y_d Y_d^\dagger\right) + 20m_{H_d}^2 \text{Tr}\left(Y_e Y_e^\dagger\right) + 10m_{R_u}^2 \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& + 20m_{H_d}^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 10m_{R_u}^2 \text{Tr}\left(Y_L Y_L^\dagger\right) + 30\text{Tr}\left(m_d^2 Y_d Y_d^\dagger\right) + 10\text{Tr}\left(m_e^2 Y_e Y_e^\dagger\right) + 10\text{Tr}\left(m_l^2 Y_l Y_l^\dagger\right) \\
& + 30\text{Tr}\left(m_q^2 Y_d^\dagger Y_d\right) + 10\text{Tr}\left(Y_L Y_L^\dagger m_l^{2*}\right) + 10\text{Tr}\left(Y_L m_{\hat{E}}^{2*} Y_L^\dagger\right) \left. Y_{\hat{E},i_1} \right) \\
& + \left(6g_1^2 - 30g_2^2 + 10|\lambda_{SR}|^2 + 15|\lambda_{TR}|^2 + 15|\Lambda_T|^2 + 10|\lambda|^2 + 20\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 30\text{Tr}\left(Y_d Y_d^\dagger\right) + 10\text{Tr}\left(Y_e Y_e^\dagger\right) \right. \\
& + 10\text{Tr}\left(Y_L Y_L^\dagger\right) \left. \right) \left(m_{\hat{E}}^2 Y_{\hat{E}}\right)_{i_1} \\
& + 10\left(2\left(2m_{H_d}^2 + m_{R_u}^2\right) \left(Y_L^T Y_L^* Y_{\hat{E}}\right)_{i_1} + 2\left(\left(Y_L^T m_l^2 Y_L^* Y_{\hat{E}}\right)_{i_1} + \left(Y_L^T Y_L^* m_{\hat{E}}^2 Y_{\hat{E}}\right)_{i_1}\right) + \left(m_{\hat{E}}^2 Y_L^T Y_L^* Y_{\hat{E}}\right)_{i_1} \right) \quad (127)
\end{aligned}$$

$$\begin{aligned}
\beta_{m_{\hat{B}\hat{a}rE}^2}^{(1)} & = +2m_S^2 \lambda_{SE}^T \lambda_{SE}^* + m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* + \lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 + 2\lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* - 2\sqrt{\frac{3}{5}} g_1 \mathbf{1}\sigma_{1,1} \\
& + 2Y_{\hat{B}\hat{a}rE,i_2}^* \left(2\left(m_{H_u}^2 + m_{R_d}^2\right) Y_{\hat{B}\hat{a}rE,i_1} + \left(m_{\hat{B}\hat{a}rE}^2 Y_{\hat{B}\hat{a}rE}\right)_{i_1}\right) + 2Y_{\hat{B}\hat{a}rE,i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} \quad (128)
\end{aligned}$$

$$\begin{aligned}
\beta_{m_{\hat{B}\hat{a}rE}^2}^{(2)} & = -4m_{R_d}^2 |\lambda_{SR}|^2 \lambda_{SE}^T \lambda_{SE}^* - 4m_{R_u}^2 |\lambda_{SR}|^2 \lambda_{SE}^T \lambda_{SE}^* - 8m_S^2 |\lambda_{SR}|^2 \lambda_{SE}^T \lambda_{SE}^* \\
& - 6m_S^2 |\lambda_T|^2 \lambda_{SE}^T \lambda_{SE}^* - 6m_t^2 |\lambda_T|^2 \lambda_{SE}^T \lambda_{SE}^* - 4m_{H_d}^2 |\lambda|^2 \lambda_{SE}^T \lambda_{SE}^* \\
& - 4m_{H_u}^2 |\lambda|^2 \lambda_{SE}^T \lambda_{SE}^* - 8m_S^2 |\lambda|^2 \lambda_{SE}^T \lambda_{SE}^* - 2|\lambda_{SR}|^2 m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* \\
& - \frac{3}{2} |\lambda_T|^2 m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* - 2|\lambda|^2 m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* - 2|\lambda_{SR}|^2 \lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 \\
& - \frac{3}{2} |\lambda_T|^2 \lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 - 2|\lambda|^2 \lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 - 4|\lambda_{SR}|^2 \lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* \\
& - 3|\lambda_T|^2 \lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* - 4|\lambda|^2 \lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* - 4m_{H_d}^2 \lambda_{SE}^T Y_L^\dagger Y_L \lambda_{SE}^* \\
& - 4m_S^2 \lambda_{SE}^T Y_L^\dagger Y_L \lambda_{SE}^* - 4m_S^2 \lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* - 2m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T Y_L^\dagger Y_L \lambda_{SE}^* - m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* \\
& - 2\lambda_{SE}^T Y_L^\dagger Y_L \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 - 4\lambda_{SE}^T Y_L^\dagger Y_L m_{\hat{E}}^{2*} \lambda_{SE}^* - 4\lambda_{SE}^T Y_L^\dagger m_l^{2*} Y_L \lambda_{SE}^* \\
& - 2\lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* - \lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 - 2\lambda_{SE}^T \lambda_{SE}^* \lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* - 4\lambda_{SE}^T m_{\hat{E}}^{2*} Y_L^\dagger Y_L \lambda_{SE}^* \\
& - 2\lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* \lambda_{SE}^T \lambda_{SE}^* + \frac{8}{5} g_1 \mathbf{1} \left(3g_1 \sigma_{2,11} - \sqrt{15} \sigma_{3,1}\right) - 4m_S^2 \lambda_{SE}^T \lambda_{SE}^* \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) \\
& - m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T \lambda_{SE}^* \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) - \lambda_{SE}^T \lambda_{SE}^* m_{\hat{B}\hat{a}rE}^2 \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) - 2\lambda_{SE}^T m_{\hat{E}}^{2*} \lambda_{SE}^* \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right)
\end{aligned}$$

$$\begin{aligned}
& -2\lambda_{SE}^T \lambda_{SE}^* \text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger m_{\hat{E}}^2\right) - 2\lambda_{SE}^T \lambda_{SE}^* \text{Tr}\left(\lambda_{SE} m_{\hat{B}\hat{a}rE}^{2*} \lambda_{SE}^\dagger\right) \\
& - \frac{1}{5} Y_{\hat{B}\hat{a}rE, i_2}^* \left(2\left(6g_1^2 m_{H_u}^2 - 30g_2^2 m_{H_u}^2 + 6g_1^2 m_{R_d}^2 - 30g_2^2 m_{R_d}^2 + 10\left(2m_{R_d}^2 + m_{H_u}^2 + m_{R_u}^2 + m_S^2\right)\right) |\lambda_{SR}|^2 \right. \\
& + 15\left(2m_{R_d}^2 + m_{H_u}^2 + m_{R_u}^2 + m_t^2\right) |\lambda_{TR}|^2 + 15m_{H_d}^2 |\Lambda_T|^2 + 30m_{H_u}^2 |\Lambda_T|^2 + 15m_{R_d}^2 |\Lambda_T|^2 + 15m_t^2 |\Lambda_T|^2 \\
& + 10m_{H_d}^2 |\lambda|^2 + 20m_{H_u}^2 |\lambda|^2 + 10m_{R_d}^2 |\lambda|^2 + 10m_S^2 |\lambda|^2 + 40m_{H_u}^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 40m_{R_d}^2 \left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& + 20\left(Y_{\hat{B}\hat{a}rE} m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right) + 60m_{H_u}^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 30m_{R_d}^2 \text{Tr}\left(Y_u Y_u^\dagger\right) + 30\text{Tr}\left(m_q^2 Y_u^\dagger Y_u\right) + 30\text{Tr}\left(m_u^2 Y_u Y_u^\dagger\right) \Big) Y_{\hat{B}\hat{a}rE, i_1} \\
& + \left(10|\lambda|^2 + 10|\lambda_{SR}|^2 + 15|\Lambda_T|^2 + 15|\lambda_{TR}|^2 + 20\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) - 30g_2^2 + 30\text{Tr}\left(Y_u Y_u^\dagger\right) + 6g_1^2\right) \left(m_{\hat{B}\hat{a}rE}^2 Y_{\hat{B}\hat{a}rE}\right)_{i_1} \Big) \\
& - \frac{6}{5} g_1^2 Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} + 6g_2^2 Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} - 2|\lambda_{SR}|^2 Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} - 3|\lambda_{TR}|^2 Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} \\
& - 3|\Lambda_T|^2 Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} - 2|\lambda|^2 Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} - 4\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) Y_{\hat{B}\hat{a}rE, i_1} \left(m_{\hat{B}\hat{a}rE}^{2*} Y_{\hat{B}\hat{a}rE}^*\right)_{i_2} - 6\text{Tr}\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) \\
& - 4m_{H_d}^2 \left(\lambda_{SE}^\dagger Y_{\hat{E}}\right)_{i_2} \left(\lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1} - 4m_{R_u}^2 \left(\lambda_{SE}^\dagger Y_{\hat{E}}\right)_{i_2} \left(\lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1} - 4m_S^2 \left(\lambda_{SE}^\dagger Y_{\hat{E}}\right)_{i_2} \left(\lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1} - 2\left(\lambda_{SE}^\dagger Y_{\hat{E}}\right)_{i_2} \left(m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^T Y_{\hat{E}}\right)_{i_1} \\
& - 4\left(\lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1} \left(\lambda_{SE}^\dagger m_{\hat{E}}^2 Y_{\hat{E}}\right)_{i_2} - 2\left(\lambda_{SE}^T Y_{\hat{E}}^*\right)_{i_1} \left(m_{\hat{B}\hat{a}rE}^2 \lambda_{SE}^\dagger Y_{\hat{E}}\right)_{i_2} - 4\left(\lambda_{SE}^\dagger Y_{\hat{E}}\right)_{i_2} \left(\lambda_{SE}^T m_{\hat{E}}^2 Y_{\hat{E}}^*\right)_{i_1} \quad (129)
\end{aligned}$$

### 3.8 Vacuum expectation values

$$\begin{aligned}
\beta_{v_d}^{(1)} &= \frac{1}{20} v_d \left(3g_1^2 + 15g_2^2 + 3g_1^2 \text{Xi} + 15g_2^2 \text{Xi} - 30|\Lambda_T|^2 - 20|\lambda|^2 - 20\left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 60\text{Tr}\left(Y_d Y_d^\dagger\right) - 20\text{Tr}\left(Y_e Y_e^\dagger\right) \right. \\
& \left. - 20\text{Tr}\left(Y_L Y_L^\dagger\right)\right) \quad (130)
\end{aligned}$$

$$\begin{aligned}
\beta_{v_d}^{(2)} &= \frac{1}{400} v_d \left(-594g_1^4 - 180g_1^2 g_2^2 - 2100g_2^4 - 9g_1^4 \text{Xi} - 90g_1^2 g_2^2 \text{Xi} + 875g_2^4 \text{Xi} + 9g_1^4 \text{Xi}^2 + 90g_1^2 g_2^2 \text{Xi}^2 \right. \\
& - 225g_2^4 \text{Xi}^2 + 1500\Lambda_T^2 \Lambda_T^{*,2} + 1200\lambda^2 \lambda^{*,2} - 480g_1^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 120g_1^2 \text{Xi} \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) - 600g_2^2 \text{Xi} \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) \\
& + 400|\lambda_{SR}|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 600|\lambda_{TR}|^2 \left(Y_{\hat{E}} Y_{\hat{E}}^*\right) + 1200\left(\left(Y_{\hat{E}} Y_{\hat{E}}^*\right)\right)^2 + 2400\left(Y_{\hat{E}} Y_L^\dagger Y_L Y_{\hat{E}}^*\right) \\
& + 400\left(\lambda_{SE}^\dagger Y_{\hat{E}} \lambda_{SE}^T Y_{\hat{E}}^*\right) + 160g_1^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 6400g_3^2 \text{Tr}\left(Y_d Y_d^\dagger\right) - 360g_1^2 \text{Xi} \text{Tr}\left(Y_d Y_d^\dagger\right) \\
& - 1800g_2^2 \text{Xi} \text{Tr}\left(Y_d Y_d^\dagger\right) - 480g_1^2 \text{Tr}\left(Y_e Y_e^\dagger\right) - 120g_1^2 \text{Xi} \text{Tr}\left(Y_e Y_e^\dagger\right) - 600g_2^2 \text{Xi} \text{Tr}\left(Y_e Y_e^\dagger\right) \\
& - 480g_1^2 \text{Tr}\left(Y_L Y_L^\dagger\right) - 120g_1^2 \text{Xi} \text{Tr}\left(Y_L Y_L^\dagger\right) - 600g_2^2 \text{Xi} \text{Tr}\left(Y_L Y_L^\dagger\right) \\
& - 60|\Lambda_T|^2 \left(-10\lambda_T \lambda_T^* - 10\lambda_{TR} \lambda_{TR}^* - 10\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 15g_2^2 \text{Xi} - 20\lambda\lambda^* - 30\text{Tr}\left(Y_u Y_u^\dagger\right) + 3g_1^2 \text{Xi} + 40g_2^2\right) \\
& - 40|\lambda|^2 \left(-10\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger\right) - 10\left(Y_{\hat{B}\hat{a}rE} Y_{\hat{B}\hat{a}rE}^*\right) + 15g_2^2 \text{Xi} - 15\lambda_T \lambda_T^* - 20\lambda_{SR} \lambda_{SR}^* - 30\text{Tr}\left(Y_u Y_u^\dagger\right) + 3g_1^2 \text{Xi}\right) \\
& + 400\text{Tr}\left(\lambda_{SE} \lambda_{SE}^\dagger Y_L^T Y_L^*\right) + 3600\text{Tr}\left(Y_d Y_d^\dagger Y_d Y_d^\dagger\right) + 1200\text{Tr}\left(Y_d Y_u^\dagger Y_u Y_d^\dagger\right) + 1200\text{Tr}\left(Y_e Y_e^\dagger Y_e Y_e^\dagger\right) \\
& + 1200\text{Tr}\left(Y_L Y_L^\dagger Y_L Y_L^\dagger\right) + 2400\text{Tr}\left(Y_L Y_L^\dagger Y_e^T Y_e^*\right) \Big) \quad (131)
\end{aligned}$$

$$\beta_{v_u}^{(1)} = \frac{1}{20}v_u \left( 15g_2^2 + 15g_2^2\text{Xi} - 20|\lambda|^2 - 20(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 30|\Lambda_T|^2 + 3g_1^2 + 3g_1^2\text{Xi} - 60\text{Tr}(Y_uY_u^\dagger) \right) \quad (132)$$

$$\begin{aligned} \beta_{v_u}^{(2)} = & \frac{1}{400}v_u \left( -594g_1^4 - 180g_1^2g_2^2 - 2100g_2^4 - 9g_1^4\text{Xi} - 90g_1^2g_2^2\text{Xi} + 875g_2^4\text{Xi} + 9g_1^4\text{Xi}^2 + 90g_1^2g_2^2\text{Xi}^2 \right. \\ & - 225g_2^4\text{Xi}^2 + 1500\Lambda_T^2\Lambda_T^{*,2} + 1200\lambda^2\lambda^{*,2} - 480g_1^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 120g_1^2\text{Xi}(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 600g_2^2\text{Xi}(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \\ & + 400|\lambda_{SR}|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 600|\lambda_{TR}|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 1200((Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*))^2 + 400(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) \\ & - 60|\Lambda_T|^2(40g_2^2 + 3g_1^2\text{Xi} + 15g_2^2\text{Xi} - 10\lambda_{TR}\lambda_{TR}^* - 10\lambda_T\lambda_T^* - 20\lambda\lambda^* - 10(Y_{\hat{E}}Y_{\hat{E}}^*)) - 30\text{Tr}(Y_dY_d^\dagger) - 10\text{Tr}(Y_eY_e^\dagger) \\ & - 10\text{Tr}(Y_LY_L^\dagger) \\ & - 40|\lambda|^2(3g_1^2\text{Xi} + 15g_2^2\text{Xi} - 20\lambda_{SR}\lambda_{SR}^* - 15\lambda_T\lambda_T^* - 10(Y_{\hat{E}}Y_{\hat{E}}^*)) - 10\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) - 30\text{Tr}(Y_dY_d^\dagger) - 10\text{Tr}(Y_eY_e^\dagger) \\ & - 10\text{Tr}(Y_LY_L^\dagger) \\ & - 320g_1^2\text{Tr}(Y_uY_u^\dagger) - 6400g_3^2\text{Tr}(Y_uY_u^\dagger) - 360g_1^2\text{Xi}\text{Tr}(Y_uY_u^\dagger) - 1800g_2^2\text{Xi}\text{Tr}(Y_uY_u^\dagger) \\ & + 1200\text{Tr}(Y_dY_u^\dagger Y_uY_d^\dagger) + 3600\text{Tr}(Y_uY_u^\dagger Y_uY_u^\dagger) \left. \right) \quad (133) \end{aligned}$$

$$\beta_{v_T}^{(1)} = v_T \left( 2g_2^2 + 2g_2^2\text{Xi} - |\lambda_T|^2 - |\Lambda_T|^2 - |\lambda_{TR}|^2 \right) \quad (134)$$

$$\begin{aligned} \beta_{v_T}^{(2)} = & -19g_2^4v_T + \frac{10}{3}g_2^4v_T\text{Xi} + g_2^4v_T\text{Xi}^2 - \frac{3}{5}g_1^2v_T|\Lambda_T|^2 + g_2^2v_T|\Lambda_T|^2 - 4g_2^2v_T\text{Xi}|\Lambda_T|^2 \\ & + 3\lambda_{TR}^2v_T\lambda_{TR}^{*,2} + \frac{5}{2}\lambda_T^2v_T\lambda_T^{*,2} + 3\Lambda_T^2v_T\Lambda_T^{*,2} + 2v_T\lambda|\Lambda_T|^2\lambda^* + v_T|\Lambda_T|^2(Y_{\hat{E}}Y_{\hat{E}}^*) \\ & - \frac{1}{5}v_T|\lambda_{TR}|^2(-10\lambda_{SR}\lambda_{SR}^* + 20g_2^2\text{Xi} + 3g_1^2 - 5g_2^2 - 5\lambda_T\lambda_T^* - 5(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) - 5(Y_{\hat{E}}Y_{\hat{E}}^*)) + v_T|\Lambda_T|^2(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) \\ & + v_T|\lambda_T|^2(2\lambda\lambda^* + 2\lambda_{SR}\lambda_{SR}^* - 4g_2^2\text{Xi} + \Lambda_T\Lambda_T^* + \text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger)) + 3v_T|\Lambda_T|^2\text{Tr}(Y_dY_d^\dagger) \\ & + v_T|\Lambda_T|^2\text{Tr}(Y_eY_e^\dagger) + v_T|\Lambda_T|^2\text{Tr}(Y_LY_L^\dagger) + 3v_T|\Lambda_T|^2\text{Tr}(Y_uY_u^\dagger) \quad (135) \end{aligned}$$

$$\beta_{v_s}^{(1)} = -\frac{1}{2}v_s \left( 2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) + 3|\lambda_T|^2 + 4|\lambda|^2 + 4|\lambda_{SR}|^2 \right) \quad (136)$$

$$\begin{aligned} \beta_{v_s}^{(2)} = & \frac{1}{5}v_s \left( 20\lambda_{SR}^2\lambda_{SR}^{*,2} + 15\lambda_T^2\lambda_T^{*,2} + 15|\lambda_T|^2(-4g_2^2 + \Lambda_T\Lambda_T^* + \lambda_{TR}\lambda_{TR}^*) \right. \\ & + 2|\lambda_{SR}|^2(-15g_2^2 + 15\lambda_{TR}\lambda_{TR}^* - 3g_1^2 + 5(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 5(Y_{\hat{E}}Y_{\hat{E}}^*)) \\ & + 2(10\lambda^2\lambda^{*,2} + 5(Y_{B\hat{a}rE}\lambda_{SE}^\dagger\lambda_{SE}Y_{B\hat{a}rE}^*) + 5(\lambda_{SE}^\dagger Y_{\hat{E}}\lambda_{SE}^T Y_{\hat{E}}^*)) - 6g_1^2\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger) \\ & + |\lambda|^2(-3g_1^2 - 15g_2^2 + 15\Lambda_T\Lambda_T^* + 5(Y_{\hat{E}}Y_{\hat{E}}^*)) + 5(Y_{B\hat{a}rE}Y_{B\hat{a}rE}^*) + 15\text{Tr}(Y_dY_d^\dagger) + 5\text{Tr}(Y_eY_e^\dagger) + 5\text{Tr}(Y_LY_L^\dagger) \\ & + 15\text{Tr}(Y_uY_u^\dagger) \\ & \left. + 5\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger\lambda_{SE}\lambda_{SE}^\dagger) + 5\text{Tr}(\lambda_{SE}\lambda_{SE}^\dagger Y_L^T Y_L^*) \right) \quad (137) \end{aligned}$$

## 4 Field Rotations

### 4.1 Rotations in gauge sector for eigenstates 'EWSB'

$$\begin{pmatrix} B_\rho \\ W_{3\rho} \end{pmatrix} = Z^{\gamma Z} \begin{pmatrix} \gamma_\rho \\ Z_\rho \end{pmatrix} \quad (138)$$

$$\begin{pmatrix} W_{1\rho} \\ W_{2\rho} \end{pmatrix} = Z^W \begin{pmatrix} W_\rho^- \\ W_\rho^- \end{pmatrix} \quad (139)$$

$$\begin{pmatrix} \lambda_{\tilde{W},1} \\ \lambda_{\tilde{W},2} \\ \lambda_{\tilde{W},3} \end{pmatrix} = Z^{\tilde{W}} \begin{pmatrix} \tilde{W}^- \\ \tilde{W}^+ \\ \tilde{W}^0 \end{pmatrix} \quad (140)$$

$$(141)$$

The mixing matrices are parametrized by

$$Z^{\gamma Z} = \begin{pmatrix} \cos \Theta_W & -\sin \Theta_W \\ \sin \Theta_W & \cos \Theta_W \end{pmatrix} \quad (142)$$

$$Z^W = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} \end{pmatrix} \quad (143)$$

$$Z^{\tilde{W}} = \begin{pmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & 0 \\ -i\frac{1}{\sqrt{2}} & i\frac{1}{\sqrt{2}} & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (144)$$

$$(145)$$

### 4.2 Rotations in Mass sector for eigenstates 'EWSB'

#### 4.2.1 Mass Matrices for Scalars

- Mass matrix for Down-Squarks, Basis:  $(\tilde{d}_{L,\alpha_1}, \tilde{d}_{R,\alpha_2}), (\tilde{d}_{L,\beta_1}^*, \tilde{d}_{R,\beta_2}^*)$

$$m_{\tilde{d}}^2 = \begin{pmatrix} m_{\tilde{d}_L \tilde{d}_L^*} & -\frac{1}{4}v_u \left( -2v_s \lambda + \sqrt{2}(2\mu + \Lambda_T v_T) \right) Y_d^\dagger \delta_{\alpha_1 \beta_2} \\ -\frac{1}{4}v_u Y_d \left( -2v_s \lambda^* + \sqrt{2}(2\mu^* + v_T \Lambda_T^*) \right) \delta_{\alpha_2 \beta_1} & m_{\tilde{d}_R \tilde{d}_R^*} \end{pmatrix} \quad (146)$$

$$m_{\tilde{d}_L \tilde{d}_L^*} = +\frac{1}{2} \delta_{\alpha_1 \beta_1} \left( 2m_q^2 + v_d^2 Y_d^\dagger Y_d \right) - \frac{1}{24} \mathbf{1}_{\delta_{\alpha_1 \beta_1}} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 \left( -v_u^2 + v_d^2 \right) + g_2 \left( 12v_T M_D^{W,*} + 3 \left( 4M_D^W v_T + g_2 \left( -v_u^2 + v_d^2 \right) \right) \right) \right) \quad (147)$$

$$m_{\tilde{d}_R \tilde{d}_R^*} = \frac{1}{12} g_1 \mathbf{1} \delta_{\alpha_2 \beta_2} \left( 8v_s \Re(M_D^B) + g_1(-v_d^2 + v_u^2) \right) + \frac{1}{2} \delta_{\alpha_2 \beta_2} \left( 2m_d^2 + v_d^2 Y_d Y_d^\dagger \right) \quad (148)$$

This matrix is diagonalized by  $Z^D$ :

$$Z^D m_{\tilde{d}}^2 Z^{D,\dagger} = m_{2,d}^{dia} \quad (149)$$

with

$$\tilde{d}_{L,i\alpha} = \sum_j Z_{ji}^{D,*} \tilde{d}_{j\alpha}, \quad \tilde{d}_{R,i\alpha} = \sum_j Z_{ji}^{D,*} \tilde{d}_{j\alpha} \quad (150)$$

- **Mass matrix for Sneutrinos**, Basis:  $(\tilde{\nu}_L, R_u^0, R_d^{0,*}), (\tilde{\nu}_L^*, R_u^{0,*}, R_d^0)$

$$m_{\tilde{\nu}}^2 = \begin{pmatrix} m_{\tilde{\nu}_L \tilde{\nu}_L^*} & 0 & 0 \\ 0 & m_{R_u^0 R_u^{0,*}} & m_{R_d^{0,*} R_u^{0,*}}^\dagger \\ 0 & m_{R_u^0 R_d^0} & m_{R_d^{0,*} R_d^0} \end{pmatrix} \quad (151)$$

$$m_{\tilde{\nu}_L \tilde{\nu}_L^*} = \frac{1}{8} \mathbf{1} \left( -8g_1 v_s \Re(M_D^B) + g_1^2(-v_u^2 + v_d^2) + g_2(8v_T \Re(M_D^W) + g_2(-v_u^2 + v_d^2)) \right) + m_l^2 \quad (152)$$

$$m_{R_u^0 R_u^{0,*}} = +m_{R_u^0}^2 + \frac{1}{4} \left( -\left( 2\mu_R - \lambda_{TR} v_T + \sqrt{2} \lambda_{SR} v_s \right) \left( -2\mu_R^* + v_T \lambda_{TR}^* \right) + v_s \left( 2\left( \lambda_{SR} v_s + \sqrt{2} \mu_R \right) - \sqrt{2} \lambda_{TR} v_T \right) \lambda_{SR}^* \right) \\ + \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + g_1^2(-v_u^2 + v_d^2) + g_2(8v_T \Re(M_D^W) + g_2(-v_u^2 + v_d^2)) \right) \quad (153)$$

$$m_{R_u^0 R_d^0} = \frac{1}{4} \left( 2\sqrt{2} \lambda_{SR} v_s M_S^* + 4B_R + v_d v_u \left( 2\lambda_{SR} \lambda^* + \lambda_{TR} \Lambda_T^* \right) + v_T \left( \lambda_{SR} v_T - \sqrt{2} \lambda_{TR} v_s \right) \lambda_T^* \right) \quad (154)$$

$$m_{R_d^{0,*} R_d^0} = +m_{R_d^0}^2 + \frac{1}{4} \left( -\left( 2\mu_R - \lambda_{TR} v_T + \sqrt{2} \lambda_{SR} v_s \right) \left( -2\mu_R^* + v_T \lambda_{TR}^* \right) + v_s \left( 2\left( \lambda_{SR} v_s + \sqrt{2} \mu_R \right) - \sqrt{2} \lambda_{TR} v_T \right) \lambda_{SR}^* \right) \\ + \frac{1}{8} \left( 8g_1 v_s \Re(M_D^B) + g_1^2(-v_d^2 + v_u^2) + g_2(-8v_T \Re(M_D^W) + g_2(-v_d^2 + v_u^2)) \right) \quad (155)$$

This matrix is diagonalized by  $Z^V$ :

$$Z^V m_{\tilde{\nu}}^2 Z^{V,\dagger} = m_{2,\tilde{\nu}}^{dia} \quad (156)$$

with

$$\tilde{\nu}_{L,i} = \sum_j Z_{ji}^{V,*} \tilde{\nu}_j, \quad R_u^0 = \sum_j Z_{j4}^{V,*} \tilde{\nu}_j, \quad R_d^0 = \sum_j Z_{j5}^{V,*} \tilde{\nu}_j \quad (157)$$

- **Mass matrix for Up-Squarks**, Basis:  $(\tilde{u}_{L,\alpha_1}, \tilde{u}_{R,\alpha_2}), (\tilde{u}_{L,\beta_1}^*, \tilde{u}_{R,\beta_2}^*)$

$$m_{\tilde{u}}^2 = \begin{pmatrix} m_{\tilde{u}_L \tilde{u}_L^*} & -\frac{1}{4} v_d \left( -2v_s \lambda + \sqrt{2} (2\mu + \Lambda_T v_T) \right) Y_u^\dagger \delta_{\alpha_1 \beta_2} \\ -\frac{1}{4} v_d Y_u \left( -2v_s \lambda^* + \sqrt{2} (2\mu^* + v_T \Lambda_T^*) \right) \delta_{\alpha_2 \beta_1} & m_{\tilde{u}_R \tilde{u}_R^*} \end{pmatrix} \quad (158)$$

$$m_{\tilde{u}_L \tilde{u}_L^*} = +\frac{1}{2} \delta_{\alpha_1 \beta_1} \left( 2m_q^2 + v_u^2 Y_u^\dagger Y_u \right)$$

$$+ \frac{1}{24} \mathbf{1}_{\alpha_1 \beta_1} \left( 8g_1 v_s \Re(M_D^B) + g_1^2 (-v_d^2 + v_u^2) + g_2 \left( 12v_T M_D^{W,*} + 3 \left( 4M_D^W v_T + g_2 (-v_u^2 + v_d^2) \right) \right) \right) \quad (159)$$

$$m_{\tilde{u}_R \tilde{u}_R^*} = \frac{1}{2} \delta_{\alpha_2 \beta_2} \left( 2m_u^2 + v_u^2 Y_u Y_u^\dagger \right) + \frac{1}{6} g_1 \mathbf{1}_{\alpha_2 \beta_2} \left( -8v_s \Re(M_D^B) + g_1 (-v_u^2 + v_d^2) \right) \quad (160)$$

This matrix is diagonalized by  $Z^U$ :

$$Z^U m_u^2 Z^{U,\dagger} = m_{2,\tilde{u}}^{dia} \quad (161)$$

with

$$\tilde{u}_{L,i\alpha} = \sum_j Z_{ji}^{U,*} \tilde{u}_{j\alpha}, \quad \tilde{u}_{R,i\alpha} = \sum_j Z_{ji}^U \tilde{u}_{j\alpha} \quad (162)$$

- **Mass matrix for Sleptons, Basis:**  $\left( \tilde{e}_L, \tilde{e}_R, R_u^+, R_d^{+,*}, \tilde{E}, \tilde{E}^* \right), \left( \tilde{e}_L^*, \tilde{e}_R^*, R_u^{+,*}, R_d^+, \tilde{E}^*, \tilde{E} \right)$

$$m_{\tilde{e}}^2 = \begin{pmatrix} m_{\tilde{e}_L \tilde{e}_L^*} & m_{\tilde{e}_R \tilde{e}_L^*}^\dagger & m_{R_u^+ \tilde{e}_L^*}^\dagger & 0 & m_{\tilde{E} \tilde{e}_L^*}^\dagger & m_{\tilde{E}^* \tilde{e}_L^*}^\dagger \\ m_{\tilde{e}_L \tilde{e}_R^*} & m_{\tilde{e}_R \tilde{e}_R^*} & 0 & 0 & m_{\tilde{E} \tilde{e}_R^*}^\dagger & 0 \\ m_{\tilde{e}_L R_u^{+,*}} & 0 & m_{R_u^+ R_u^{+,*}} & m_{R_d^{+,*} R_u^{+,*}}^\dagger & m_{\tilde{E} R_u^{+,*}}^\dagger & m_{\tilde{E}^* R_u^{+,*}}^\dagger \\ 0 & 0 & m_{R_u^+ R_d^+} & m_{R_d^{+,*} R_d^+} & m_{\tilde{E} R_d^+}^\dagger & m_{\tilde{E}^* R_d^+}^\dagger \\ m_{\tilde{e}_L \tilde{E}^*} & m_{\tilde{e}_R \tilde{E}^*} & m_{R_u^+ \tilde{E}^*} & m_{R_d^{+,*} \tilde{E}^*} & m_{\tilde{E} \tilde{E}^*} & m_{\tilde{E}^* \tilde{E}^*}^\dagger \\ m_{\tilde{e}_L \tilde{E}} & 0 & m_{R_u^+ \tilde{E}} & m_{R_d^{+,*} \tilde{E}} & m_{\tilde{E} \tilde{E}} & m_{\tilde{E}^* \tilde{E}} \end{pmatrix} \quad (163)$$

$$m_{\tilde{e}_L \tilde{e}_L^*} = +\frac{1}{2} \left( 2m_l^2 + v_d^2 \left( Y_e^\dagger Y_e + Y_L^* Y_L^T \right) \right) + \frac{1}{8} \mathbf{1} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 (-v_u^2 + v_d^2) + g_2 \left( -8v_T \Re(M_D^W) + g_2 (-v_d^2 + v_u^2) \right) \right) \quad (164)$$

$$m_{\tilde{e}_L \tilde{e}_R^*} = -\frac{1}{4} v_u Y_e \left( -2v_s \lambda^* + \sqrt{2} (2\mu^* + v_T \Lambda_T^*) \right) \quad (165)$$

$$m_{\tilde{e}_R \tilde{e}_R^*} = \frac{1}{2} v_d^2 Y_e Y_e^\dagger + \frac{1}{4} g_1 \mathbf{1} \left( 8v_s \Re(M_D^B) + g_1 (-v_d^2 + v_u^2) \right) + m_e^2 \quad (166)$$

$$m_{\tilde{e}_L R_u^{+,*}} = \frac{1}{2} v_d^2 \sum_{a=1}^2 Y_{\tilde{E},a}^* Y_{L,p_1 a} \quad (167)$$

$$m_{R_u^+ R_u^{+,*}} = +m_{R_u}^2 + \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + g_1^2 (-v_u^2 + v_d^2) + g_2 \left( -8v_T \Re(M_D^W) + g_2 (-v_d^2 + v_u^2) \right) \right) + \frac{1}{4} \left( \left( 2\mu_R + \lambda_{TR} v_T + \sqrt{2} \lambda_{SR} v_s \right) \left( 2\mu_R^* + v_T \lambda_{TR}^* \right) + 2v_d^2 \sum_{a=1}^2 |Y_{\tilde{E},a}|^2 + v_s \left( 2 \left( \lambda_{SR} v_s + \sqrt{2} \mu_R \right) + \sqrt{2} \lambda_{TR} v_T \right) \lambda_{SR}^* \right) \quad (168)$$

$$m_{R_u^+ R_d^+} = \frac{1}{4} \left( -2\lambda_{SR} \left( \sqrt{2} v_s M_S^* + v_d v_u \lambda^* \right) - 4B_R + \lambda_{TR} v_d v_u \Lambda_T^* - v_T \left( \lambda_{SR} v_T + \sqrt{2} \lambda_{TR} v_s \right) \lambda_T^* \right) \quad (169)$$

$$m_{R_d^{+,*} R_d^+} = +m_{R_d}^2 + \frac{1}{8} \left( 8g_1 v_s \Re(M_D^B) + g_1^2 (-v_d^2 + v_u^2) + g_2 \left( 8v_T \Re(M_D^W) + g_2 (-v_u^2 + v_d^2) \right) \right)$$

$$+ \frac{1}{4} \left( (2\mu_R + \lambda_{TR}v_T + \sqrt{2}\lambda_{SR}v_s) (2\mu_R^* + v_T\lambda_{TR}^*) + 2v_u^2 \sum_{a=1}^2 |Y_{B\hat{a}rE,a}|^2 + v_s (2(\lambda_{SR}v_s + \sqrt{2}\mu_R) + \sqrt{2}\lambda_{TR}v_T) \lambda_{SR}^* \right) \quad (170)$$

$$m_{\tilde{e}_L \tilde{E}^*} = \frac{1}{4} v_u \left( -2v_s \lambda^* + \sqrt{2} (2\mu^* + v_T \Lambda_T^*) \right) Y_L^T \quad (171)$$

$$m_{\tilde{e}_R \tilde{E}^*} = -\frac{1}{2} v_d^2 Y_L^T Y_e^\dagger \quad (172)$$

$$m_{R_u^+ \tilde{E}^*} = \frac{1}{4} v_u \left( -2v_s \lambda^* + \sqrt{2} (2\mu^* + v_T \Lambda_T^*) \right) Y_{\hat{E},o_5} \quad (173)$$

$$m_{R_d^+ \tilde{E}^*} = \frac{1}{4} \left( 2v_u \left( \sqrt{2} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* \mu_{E,o_5 a} + v_s \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* \lambda_{SE,o_5 a} \right) + v_d \left( 2v_s \lambda_{SR}^* + \sqrt{2} (2\mu_R^* + v_T \lambda_{TR}^*) \right) \right) Y_{\hat{E},o_5} \quad (174)$$

$$m_{\tilde{E} \tilde{E}^*} = +\frac{1}{4} g_1 \mathbf{1} \left( 8v_s \Re(M_D^B) + g_1 (-v_d^2 + v_u^2) \right) + \frac{1}{2} \left( 2(m_{\tilde{E}}^2 + \mu_E \mu_E^\dagger) + \sqrt{2} v_s (\lambda_{SE} \mu_E^\dagger + \mu_E \lambda_{SE}^\dagger) + v_d^2 (Y_{\tilde{E},p_5}^* Y_{\tilde{E},o_5} + Y_L^T Y_L^*) + v_s^2 \lambda_{SE} \lambda_{SE}^\dagger \right) \quad (175)$$

$$m_{\tilde{e}_L \tilde{E}} = -\frac{1}{2} v_d \left( \sqrt{2} \mu_E^\dagger Y_L^T + v_s \lambda_{SE}^\dagger Y_L^T \right) \quad (176)$$

$$m_{R_u^+ \tilde{E}} = \frac{1}{4} \left( - \left( 2(\lambda_{SR}v_s + \sqrt{2}\mu_R) + \sqrt{2}\lambda_{TR}v_T \right) v_u Y_{B\hat{a}rE,o_6}^* - 2v_d \left( \sqrt{2} \sum_{a=1}^2 \mu_{E,ao_6}^* Y_{\tilde{E},a} + v_s \sum_{a=1}^2 \lambda_{SE,ao_6}^* Y_{\tilde{E},a} \right) \right) \quad (177)$$

$$m_{R_d^+ \tilde{E}} = -\frac{1}{4} v_d \left( -2v_s \lambda + \sqrt{2} (2\mu + \Lambda_T v_T) \right) Y_{B\hat{a}rE,o_6}^* \quad (178)$$

$$m_{\tilde{E} \tilde{E}} = \frac{1}{4} \left( 2(\sqrt{2} M_S v_s + v_d v_u \lambda) + \lambda_T v_T^2 \right) \lambda_{SE}^\dagger + B_E^\dagger \quad (179)$$

$$m_{\tilde{E}^* \tilde{E}} = +\frac{1}{4} g_1 \mathbf{1} \left( -8v_s \Re(M_D^B) + g_1 (-v_u^2 + v_d^2) \right) + \frac{1}{2} \left( 2(m_{B\hat{a}rE}^{2,*} + \mu_E^\dagger \mu_E) + \sqrt{2} v_s (\lambda_{SE}^\dagger \mu_E + \mu_E^\dagger \lambda_{SE}) + v_s^2 \lambda_{SE}^\dagger \lambda_{SE} + v_u^2 Y_{B\hat{a}rE,o_6}^* Y_{B\hat{a}rE,p_6} \right) \quad (180)$$

This matrix is diagonalized by  $Z^E$ :

$$Z^E m_{\tilde{e}}^2 Z^{E,\dagger} = m_{2,\tilde{e}}^{dia} \quad (181)$$

with

$$\tilde{e}_{L,i} = \sum_j Z_{ji}^{E,*} \tilde{e}_j, \quad \tilde{e}_{R,i} = \sum_j Z_{ji}^E \tilde{e}_j, \quad R_u^+ = \sum_j Z_{j7}^{E,*} \tilde{e}_j \quad (182)$$

$$R_d^+ = \sum_j Z_{j8}^E \tilde{e}_j^*, \quad \tilde{E}_i = \sum_j Z_{ji}^{E,*} \tilde{e}_j, \quad \tilde{E}_i = \sum_j Z_{ji}^E \tilde{e}_j^* \quad (183)$$

- **Mass matrix for Higgs, Basis:**  $(\phi_d, \phi_u, \phi_S, \phi_T), (\phi_d, \phi_u, \phi_S, \phi_T)$



$$m_h^2 = \begin{pmatrix} m_{\phi_d\phi_d} & m_{\phi_u\phi_d} & m_{\phi_S\phi_d} & m_{\phi_T\phi_d} \\ m_{\phi_d\phi_u} & m_{\phi_u\phi_u} & m_{\phi_S\phi_u} & m_{\phi_T\phi_u} \\ m_{\phi_d\phi_S} & m_{\phi_u\phi_S} & m_{\phi_S\phi_S} & m_{\phi_T\phi_S} \\ m_{\phi_d\phi_T} & m_{\phi_u\phi_T} & m_{\phi_S\phi_T} & m_{\phi_T\phi_T} \end{pmatrix} \quad (184)$$

$$\begin{aligned} m_{\phi_d\phi_d} &= +m_{H_d}^2 \\ &+ \frac{1}{4} \left( (\Lambda_T (v_T^2 + v_u^2) + v_T (2\mu - \sqrt{2}v_s\lambda)) \Lambda_T^* + (2(v_s^2 + v_u^2)\lambda + \sqrt{2}v_s(-2\mu - \Lambda_T v_T)) \right) \lambda^* \\ &+ 2(2\mu + \Lambda_T v_T - \sqrt{2}v_s\lambda) \mu^* \\ &+ \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + 8g_2 v_T \Re(M_D^W) + (g_1^2 + g_2^2)(3v_d^2 - v_u^2) \right) \end{aligned} \quad (185)$$

$$\begin{aligned} m_{\phi_d\phi_u} &= -\frac{1}{4}(g_1^2 + g_2^2)v_d v_u \\ &+ \frac{1}{8} \left( 2v_T^2 \Re(\lambda\lambda_T^*) - 8\Re(B_\mu) - \sqrt{2}v_s(2v_T \Re(\Lambda_T \lambda_T^*) - 4\Re(\lambda M_S^*)) \right) + v_d v_u (4|\Lambda_T|^2 + 8|\lambda|^2) \end{aligned} \quad (186)$$

$$\begin{aligned} m_{\phi_u\phi_u} &= +m_{H_u}^2 \\ &+ \frac{1}{4} \left( (\Lambda_T (v_d^2 + v_T^2) + v_T (2\mu - \sqrt{2}v_s\lambda)) \Lambda_T^* + (2(v_d^2 + v_s^2)\lambda - \sqrt{2}v_s(2\mu + \Lambda_T v_T)) \right) \lambda^* \\ &+ 2(2\mu + \Lambda_T v_T - \sqrt{2}v_s\lambda) \mu^* \\ &+ \frac{1}{8} \left( 3(g_1^2 + g_2^2)v_u^2 + 8g_1 v_s \Re(M_D^B) - 8g_2 v_T \Re(M_D^W) + (-g_1^2 - g_2^2)v_d^2 \right) \end{aligned} \quad (187)$$

$$\begin{aligned} m_{\phi_d\phi_S} &= -g_1 v_d \Re(M_D^B) \\ &+ \frac{1}{8} \left( \sqrt{2}v_T (- (2v_d\lambda + \lambda_T v_u) \Lambda_T^* - \Lambda_T v_u \lambda_T^*) - 2v_d (2\sqrt{2}\lambda\mu^* + (2\sqrt{2}\mu - 4v_s\lambda + \sqrt{2}\Lambda_T v_T) \lambda^*) \right. \\ &\left. + 4\sqrt{2}v_u \Re(\lambda M_S^*) \right) \end{aligned} \quad (188)$$

$$\begin{aligned} m_{\phi_u\phi_S} &= +g_1 v_u \Re(M_D^B) \\ &+ \frac{1}{8} \left( \sqrt{2}v_T (- (2v_u\lambda + \lambda_T v_d) \Lambda_T^* - \Lambda_T v_d \lambda_T^*) - 2v_u (2\sqrt{2}\lambda\mu^* + (2\sqrt{2}\mu - 4v_s\lambda + \sqrt{2}\Lambda_T v_T) \lambda^*) \right. \\ &\left. + 4\sqrt{2}v_d \Re(\lambda M_S^*) \right) \end{aligned} \quad (189)$$

$$m_{\phi_S\phi_S} = \frac{1}{2} \left( 2|M_S|^2 + 8M_D^{B,2} + (v_d^2 + v_u^2)|\lambda|^2 + v_T^2|\lambda_T|^2 \right) + m_S^2 + \Re(B_S) \quad (190)$$

$$\begin{aligned} m_{\phi_d\phi_T} &= +\frac{1}{8} \left( (-\sqrt{2}\lambda_T v_s v_u + v_d(-2\sqrt{2}v_s\lambda + 4(\Lambda_T v_T + \mu))) \Lambda_T^* + v_u(2\lambda_T v_T \lambda^* + (2v_T\lambda - \sqrt{2}\Lambda_T v_s) \lambda_T^*) \right. \\ &\left. + \Lambda_T v_d(-2\sqrt{2}v_s\lambda^* + 4\mu^*) \right) \\ &+ g_2 v_d \Re(M_D^W) \end{aligned} \quad (191)$$

$$m_{\phi_u\phi_T} = +\frac{1}{8} \left( (4v_u(\Lambda_T v_T + \mu) + \sqrt{2}v_s(-2v_u\lambda - \lambda_T v_d)) \Lambda_T^* + v_d(2\lambda_T v_T \lambda^* + (2v_T\lambda - \sqrt{2}\Lambda_T v_s) \lambda_T^*) \right)$$

$$\begin{aligned}
& + \Lambda_T v_u \left( -2\sqrt{2}v_s \lambda^* + 4\mu^* \right) \\
& - g_2 v_u \Re(M_D^W)
\end{aligned} \tag{192}$$

$$m_{\phi_S \phi_T} = \frac{1}{8} \left( \left( (2\sqrt{2}M_S + 8\lambda_T v_s) v_T - \sqrt{2}\Lambda_T v_d v_u \right) \lambda_T^* + \sqrt{2} \left( -2(v_d^2 + v_u^2) \Re(\lambda \Lambda_T^*) + \lambda_T (2v_T M_S^* - v_d v_u \Lambda_T^*) \right) \right) \tag{193}$$

$$\begin{aligned}
m_{\phi_T \phi_T} & = +m_t^2 \\
& + \frac{1}{4} \left( 16M_D^{W,2} + \left( \lambda_T (2v_s^2 + 3v_T^2) + \sqrt{2}M_S v_s + v_d v_u \lambda \right) \lambda_T^* + \lambda_T \left( \sqrt{2}v_s M_S^* + v_d v_u \lambda^* \right) + (v_d^2 + v_u^2) |\Lambda_T|^2 \right)
\end{aligned} \tag{194}$$

This matrix is diagonalized by  $Z^H$ :

$$Z^H m_h^2 Z^{H,\dagger} = m_{2,h}^{dia} \tag{195}$$

with

$$\phi_d = \sum_j Z_{j1}^H h_j, \quad \phi_u = \sum_j Z_{j2}^H h_j, \quad \phi_S = \sum_j Z_{j3}^H h_j \tag{196}$$

$$\phi_T = \sum_j Z_{j4}^H h_j \tag{197}$$

- **Mass matrix for Pseudo-Scalar Higgs, Basis:**  $(\sigma_d, \sigma_u, \sigma_S, \sigma_T), (\sigma_d, \sigma_u, \sigma_S, \sigma_T)$

$$m_{A^0}^2 = \begin{pmatrix} m_{\sigma_d \sigma_d} & m_{\sigma_u \sigma_d} & m_{\sigma_S \sigma_d} & m_{\sigma_T \sigma_d} \\ m_{\sigma_d \sigma_u} & m_{\sigma_u \sigma_u} & m_{\sigma_S \sigma_u} & m_{\sigma_T \sigma_u} \\ m_{\sigma_d \sigma_S} & m_{\sigma_u \sigma_S} & m_{\sigma_S \sigma_S} & m_{\sigma_T \sigma_S} \\ m_{\sigma_d \sigma_T} & m_{\sigma_u \sigma_T} & m_{\sigma_S \sigma_T} & m_{\sigma_T \sigma_T} \end{pmatrix} + \xi_Z m^2(Z) \tag{198}$$

$$\begin{aligned}
m_{\sigma_d \sigma_d} & = +m_{H_d}^2 \\
& + \frac{1}{4} \left( \left( \Lambda_T (v_T^2 + v_u^2) + v_T (2\mu - \sqrt{2}v_s \lambda) \right) \Lambda_T^* + \left( 2(v_s^2 + v_u^2) \lambda + \sqrt{2}v_s (-2\mu - \Lambda_T v_T) \right) \lambda^* \right. \\
& + 2(2\mu + \Lambda_T v_T - \sqrt{2}v_s \lambda) \mu^* \\
& + \frac{1}{8} \left( -8g_1 v_s \Re(M_D^B) + 8g_2 v_T \Re(M_D^W) + (g_1^2 + g_2^2) (-v_u^2 + v_d^2) \right)
\end{aligned} \tag{199}$$

$$m_{\sigma_d \sigma_u} = \frac{1}{8} \left( -2v_T^2 \Re(\lambda \lambda_T^*) + 8\Re(B_\mu) + \sqrt{2}v_s (2v_T \Re(\Lambda_T \lambda_T^*) - 4\Re(\lambda M_S^*)) \right) \tag{200}$$

$$\begin{aligned}
m_{\sigma_u \sigma_u} & = +m_{H_u}^2 \\
& + \frac{1}{4} \left( \left( \Lambda_T (v_d^2 + v_T^2) + v_T (2\mu - \sqrt{2}v_s \lambda) \right) \Lambda_T^* + \left( 2(v_d^2 + v_s^2) \lambda - \sqrt{2}v_s (2\mu + \Lambda_T v_T) \right) \lambda^* \right. \\
& + 2(2\mu + \Lambda_T v_T - \sqrt{2}v_s \lambda) \mu^* \\
& + \frac{1}{8} \left( 8g_1 v_s \Re(M_D^B) - 8g_2 v_T \Re(M_D^W) + (-g_1^2 - g_2^2) v_d^2 + (g_1^2 + g_2^2) v_u^2 \right)
\end{aligned} \tag{201}$$

$$m_{\sigma_d \sigma_S} = -\frac{1}{4} \frac{1}{\sqrt{2}} v_u \left( 2v_T \Re(\Lambda_T \lambda_T^*) - 4\Re(\lambda M_S^*) \right) \quad (202)$$

$$m_{\sigma_u \sigma_S} = -\frac{1}{4} \frac{1}{\sqrt{2}} v_d \left( 2v_T \Re(\Lambda_T \lambda_T^*) - 4\Re(\lambda M_S^*) \right) \quad (203)$$

$$m_{\sigma_S \sigma_S} = \frac{1}{2} \left( 2|M_S|^2 - 2\Re(B_S) + (v_d^2 + v_u^2)|\lambda|^2 + v_T^2 |\lambda_T|^2 \right) + m_S^2 \quad (204)$$

$$m_{\sigma_d \sigma_T} = -\frac{1}{8} v_u \left( (-2v_T \lambda + \sqrt{2} \Lambda_T v_s) \lambda_T^* + \lambda_T (-2v_T \lambda^* + \sqrt{2} v_s \Lambda_T^*) \right) \quad (205)$$

$$m_{\sigma_u \sigma_T} = -\frac{1}{8} v_d \left( (-2v_T \lambda + \sqrt{2} \Lambda_T v_s) \lambda_T^* + \lambda_T (-2v_T \lambda^* + \sqrt{2} v_s \Lambda_T^*) \right) \quad (206)$$

$$m_{\sigma_S \sigma_T} = \frac{1}{4} \frac{1}{\sqrt{2}} \left( 2\lambda_T v_T M_S^* + (2M_S v_T + \Lambda_T v_d v_u) \lambda_T^* - \Lambda_T (v_d^2 + v_u^2) \lambda^* + (\lambda_T v_d v_u - (v_d^2 + v_u^2) \lambda) \Lambda_T^* \right) \quad (207)$$

$$m_{\sigma_T \sigma_T} = +m_t^2 + \frac{1}{4} \left( (2\lambda_T v_s^2 + \lambda_T v_T^2 - \sqrt{2} M_S v_s - v_d v_u \lambda) \lambda_T^* - \lambda_T (\sqrt{2} v_s M_S^* + v_d v_u \lambda^*) + (v_d^2 + v_u^2) |\Lambda_T|^2 \right) \quad (208)$$

Gauge fixing contributions:

$$m^2(\xi_Z) = \begin{pmatrix} m_{\sigma_d \sigma_d} & m_{\sigma_u \sigma_d} & 0 & 0 \\ m_{\sigma_d \sigma_u} & m_{\sigma_u \sigma_u} & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \quad (209)$$

$$m_{\sigma_d \sigma_d} = \frac{1}{4} v_d^2 (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (210)$$

$$m_{\sigma_d \sigma_u} = -\frac{1}{4} v_d v_u (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (211)$$

$$m_{\sigma_u \sigma_u} = \frac{1}{4} v_u^2 (g_1 \sin \Theta_W + g_2 \cos \Theta_W)^2 \quad (212)$$

This matrix is diagonalized by  $Z^A$ :

$$Z^A m_{A_0}^2 Z^{A,\dagger} = m_{2,A_0}^{dia} \quad (213)$$

with

$$\sigma_d = \sum_j Z_{j1}^A A_j^0, \quad \sigma_u = \sum_j Z_{j2}^A A_j^0, \quad \sigma_S = \sum_j Z_{j3}^A A_j^0 \quad (214)$$

$$\sigma_T = \sum_j Z_{j4}^A A_j^0 \quad (215)$$

- **Mass matrix for Charged Higgs, Basis:**  $(H_d^-, H_u^{+,*}, T^-, T^{+,*}), (H_d^{-,*}, H_u^+, T^{-,*}, T^+)$

$$m_{H^-}^2 = \begin{pmatrix} m_{H_d^- H_d^{-,*}} & m_{H_u^{+,*} H_d^{-,*}}^* & m_{T^- H_d^{-,*}}^* & m_{T^{+,*} H_d^{-,*}}^* \\ m_{H_d^- H_u^+} & m_{H_u^{+,*} H_u^+} & m_{T^- H_u^+}^* & m_{T^{+,*} H_u^+}^* \\ m_{H_d^- T^{-,*}} & m_{H_u^{+,*} T^{-,*}} & m_{T^- T^{-,*}} & m_{T^{+,*} T^{-,*}}^* \\ m_{H_d^- T^+} & m_{H_u^{+,*} T^+} & m_{T^- T^+} & m_{T^{+,*} T^+} \end{pmatrix} + \xi_{W^-} m^2(W^-) \quad (216)$$

$$\begin{aligned}
m_{H_d^- H_d^-} &= +m_{H_d}^2 \\
&+ \frac{1}{4} \left( 2v_s^2 |\lambda|^2 + \left( 2\Lambda_T v_u^2 + v_T \left( -2\mu + \Lambda_T v_T + \sqrt{2} v_s \lambda \right) \right) \Lambda_T^* - 2 \left( -2\mu + \Lambda_T v_T \right) \mu^* \right. \\
&+ \left. \sqrt{2} v_s \left( -2\lambda \mu^* + \left( -2\mu + \Lambda_T v_T \right) \lambda^* \right) \right) \\
&+ \frac{1}{8} \left( -8g_1 v_s \Re \left( M_D^B \right) + g_1^2 \left( -v_u^2 + v_d^2 \right) + g_2 \left( -8v_T \Re \left( M_D^W \right) + g_2 \left( v_d^2 + v_u^2 \right) \right) \right) \quad (217)
\end{aligned}$$

$$m_{H_d^- H_u^+} = \frac{1}{4} \left( -2\lambda \left( \sqrt{2} v_s M_S^* + v_d v_u \lambda^* \right) + 4B_\mu + v_d v_u |\Lambda_T|^2 - v_T \left( \sqrt{2} \Lambda_T v_s + v_T \lambda \right) \lambda_T^* \right) + \frac{1}{4} g_2^2 v_d v_u \quad (218)$$

$$\begin{aligned}
m_{H_u^+ H_u^+} &= +m_{H_u}^2 \\
&+ \frac{1}{4} \left( 2v_s^2 |\lambda|^2 + \left( \Lambda_T \left( 2v_d^2 + v_T^2 \right) + v_T \left( -2\mu + \sqrt{2} v_s \lambda \right) \right) \Lambda_T^* - 2 \left( -2\mu + \Lambda_T v_T \right) \mu^* \right. \\
&+ \left. \sqrt{2} v_s \left( -2\lambda \mu^* + \left( -2\mu + \Lambda_T v_T \right) \lambda^* \right) \right) \\
&+ \frac{1}{8} \left( 8g_1 v_s \Re \left( M_D^B \right) + g_1^2 \left( -v_d^2 + v_u^2 \right) + g_2 \left( 8v_T \Re \left( M_D^W \right) + g_2 \left( v_d^2 + v_u^2 \right) \right) \right) \quad (219)
\end{aligned}$$

$$m_{H_d^- T^-} = \frac{1}{2} \frac{1}{\sqrt{2}} g_2 v_d \left( 2M_D^{W,*} + g_2 v_T \right) + \frac{1}{4} \left( -2\Lambda_T v_s v_u \lambda_T^* - v_d \left( 2v_s \lambda + \sqrt{2} \left( -2\mu + \Lambda_T v_T \right) \right) \Lambda_T^* \right) \quad (220)$$

$$m_{H_u^+ T^-} = \frac{1}{2} \frac{1}{\sqrt{2}} g_2 v_u \left( 2M_D^{W,*} + g_2 v_T \right) - \frac{1}{4} v_u \left( -2v_s \lambda + \sqrt{2} \left( 2\mu + \Lambda_T v_T \right) \right) \Lambda_T^* \quad (221)$$

$$m_{T^- T^-} = \frac{1}{2} \left( 4M_D^{W,2} + v_d^2 |\Lambda_T|^2 + v_s^2 |\lambda_T|^2 \right) + \frac{1}{4} g_2^2 \left( 2v_T^2 - v_d^2 + v_u^2 \right) + m_t^2 \quad (222)$$

$$m_{H_d^- T^+} = \frac{1}{2} \frac{1}{\sqrt{2}} g_2 v_d \left( 2M_D^W - g_2 v_T \right) + \frac{1}{4} \Lambda_T v_d \left( -2v_s \lambda^* + \sqrt{2} \left( 2\mu^* + v_T \Lambda_T^* \right) \right) \quad (223)$$

$$m_{H_u^+ T^+} = -\frac{1}{2} \frac{1}{\sqrt{2}} g_2 \left( -2M_D^W + g_2 v_T \right) v_u + \frac{1}{4} \left( 2v_s \left( \lambda_T v_d \Lambda_T^* + \Lambda_T v_u \lambda^* \right) + \sqrt{2} \Lambda_T v_u \left( -2\mu^* + v_T \Lambda_T^* \right) \right) \quad (224)$$

$$m_{T^- T^+} = -\frac{1}{2} g_2^2 v_T^2 + \frac{1}{4} \left( 8M_D^{W,2} + \lambda_T \left( 2 \left( \sqrt{2} v_s M_S^* + v_d v_u \lambda^* \right) + v_T^2 \lambda_T^* \right) \right) \quad (225)$$

$$m_{T^+ T^+} = \frac{1}{2} \left( 4M_D^{W,2} + v_s^2 |\lambda_T|^2 + v_u^2 |\Lambda_T|^2 \right) + \frac{1}{4} g_2^2 \left( 2v_T^2 - v_u^2 + v_d^2 \right) + m_t^2 \quad (226)$$

Gauge fixing contributions:

$$m^2(\xi_{W^-}) = \begin{pmatrix} \frac{1}{4} g_2^2 v_d^2 & -\frac{1}{4} g_2^2 v_d v_u & \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T & \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T \\ -\frac{1}{4} g_2^2 v_d v_u & \frac{1}{4} g_2^2 v_u^2 & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u \\ \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u & \frac{1}{2} g_2^2 v_T^2 & \frac{1}{2} g_2^2 v_T^2 \\ \frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_d v_T & -\frac{1}{2} \frac{1}{\sqrt{2}} g_2^2 v_T v_u & \frac{1}{2} g_2^2 v_T^2 & \frac{1}{2} g_2^2 v_T^2 \end{pmatrix} \quad (227)$$

This matrix is diagonalized by  $Z^+$ :

$$Z^+ m_{H^-}^2 Z^{+, \dagger} = m_{2,H^-}^{dia} \quad (228)$$

with

$$H_d^- = \sum_j Z_{j1}^+ H_j^-, \quad H_u^+ = \sum_j Z_{j2}^+ H_j^+, \quad T^- = \sum_j Z_{j3}^+ H_j^- \quad (229)$$

$$T^+ = \sum_j Z_{j4}^+ H_j^+ \quad (230)$$

#### 4.2.2 Mass Matrices for Fermions

- **Mass matrix for Neutralinos**, Basis:  $(\lambda_{\tilde{B}}, \tilde{W}^0, \tilde{H}_d^0, \tilde{H}_u^0, \tilde{S}, \tilde{T}^0), (\lambda_{\tilde{B}}, \tilde{W}^0, \tilde{H}_d^0, \tilde{H}_u^0, \tilde{S}, \tilde{T}^0)$

$$m_{\tilde{\chi}^0} = \begin{pmatrix} 0 & 0 & -\frac{1}{2}g_1 v_d & \frac{1}{2}g_1 v_u & M_D^B & 0 \\ 0 & 0 & \frac{1}{2}g_2 v_d & -\frac{1}{2}g_2 v_u & 0 & M_D^W \\ -\frac{1}{2}g_1 v_d & \frac{1}{2}g_2 v_d & 0 & m_{\tilde{H}_d^0 \tilde{H}_u^0} & \frac{1}{\sqrt{2}}v_u \lambda & -\frac{1}{2}\Lambda_T v_u \\ \frac{1}{2}g_1 v_u & -\frac{1}{2}g_2 v_u & m_{\tilde{H}_d^0 \tilde{H}_u^0} & 0 & \frac{1}{\sqrt{2}}v_d \lambda & -\frac{1}{2}\Lambda_T v_d \\ M_D^B & 0 & \frac{1}{\sqrt{2}}v_u \lambda & \frac{1}{\sqrt{2}}v_d \lambda & M_S & \frac{1}{\sqrt{2}}\lambda_T v_T \\ 0 & M_D^W & -\frac{1}{2}\Lambda_T v_u & -\frac{1}{2}\Lambda_T v_d & \frac{1}{\sqrt{2}}\lambda_T v_T & \frac{1}{\sqrt{2}}\lambda_T v_s \end{pmatrix} \quad (231)$$

$$m_{\tilde{H}_d^0 \tilde{H}_u^0} = -\frac{1}{2}\Lambda_T v_T + \frac{1}{\sqrt{2}}v_s \lambda - \mu \quad (232)$$

This matrix is diagonalized by  $N$ :

$$N^* m_{\tilde{\chi}^0} N^\dagger = m_{\tilde{\chi}^0}^{dia} \quad (233)$$

with

$$\lambda_{\tilde{B}} = \sum_j N_{j1}^* \lambda_j^0, \quad \tilde{W}^0 = \sum_j N_{j2}^* \lambda_j^0, \quad \tilde{H}_d^0 = \sum_j N_{j3}^* \lambda_j^0 \quad (234)$$

$$\tilde{H}_u^0 = \sum_j N_{j4}^* \lambda_j^0, \quad \tilde{S} = \sum_j N_{j5}^* \lambda_j^0, \quad \tilde{T}^0 = \sum_j N_{j6}^* \lambda_j^0 \quad (235)$$

- **Mass matrix for Charginos**, Basis:  $(\tilde{W}^-, \tilde{H}_d^-, \tilde{T}^-), (\tilde{W}^+, \tilde{H}_u^+, \tilde{T}^+)$

$$m_{\tilde{\chi}^\pm} = \begin{pmatrix} 0 & \frac{1}{\sqrt{2}}g_2 v_u & -g_2 v_T + M_D^W \\ \frac{1}{\sqrt{2}}g_2 v_d & -\frac{1}{2}\Lambda_T v_T - \frac{1}{\sqrt{2}}v_s \lambda + \mu & -\frac{1}{\sqrt{2}}\Lambda_T v_u \\ g_2 v_T + M_D^W & \frac{1}{\sqrt{2}}\Lambda_T v_d & \frac{1}{\sqrt{2}}\lambda_T v_s \end{pmatrix} \quad (236)$$

This matrix is diagonalized by  $U$  and  $V$

$$U^* m_{\tilde{\chi}^\pm} V^\dagger = m_{\tilde{\chi}^\pm}^{dia} \quad (237)$$

with

$$\tilde{W}^- = \sum_{t_2} U_{j1}^* \lambda_j^-, \quad \tilde{H}_d^- = \sum_{t_2} U_{j2}^* \lambda_j^-, \quad \tilde{T}^- = \sum_{t_2} U_{j3}^* \lambda_j^- \quad (238)$$

$$\tilde{W}^+ = \sum_{t_2} V_{1j}^* \lambda_j^+, \quad \tilde{H}_u^+ = \sum_{t_2} V_{2j}^* \lambda_j^+, \quad \tilde{T}^+ = \sum_{t_2} V_{3j}^* \lambda_j^+ \quad (239)$$

- **Mass matrix for Neutrinos**, Basis:  $(\nu_L, \tilde{R}_u^0, \tilde{R}_d^0), (\nu_L, \tilde{R}_u^0, \tilde{R}_d^0)$

$$m_\nu = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2}\lambda_{TR}v_T + \frac{1}{\sqrt{2}}\lambda_{SR}v_s + \mu_R \\ 0 & -\frac{1}{2}\lambda_{TR}v_T + \frac{1}{\sqrt{2}}\lambda_{SR}v_s + \mu_R & 0 \end{pmatrix} \quad (240)$$

This matrix is diagonalized by  $U^V$ :

$$U^{V,*} m_\nu U^{V,\dagger} = m_\nu^{dia} \quad (241)$$

with

$$\nu_{L,i} = \sum_j U_{ji}^{V,*} \rho_j^0, \quad \tilde{R}_u^0 = \sum_j U_{j4}^{V,*} \rho_j^0, \quad \tilde{R}_d^0 = \sum_j U_{j5}^{V,*} \rho_j^0 \quad (242)$$

- **Mass matrix for Leptons**, Basis:  $(e_L, \tilde{R}_u^+, \bar{E}^*), (e_R^*, \tilde{R}_d^+, E^*)$

$$m_e = \begin{pmatrix} \frac{1}{\sqrt{2}}v_d Y_e^T & 0 & -\frac{1}{\sqrt{2}}v_d Y_L \\ 0 & -\frac{1}{2}\lambda_{TR}v_T - \frac{1}{\sqrt{2}}\lambda_{SR}v_s - \mu_R & -\frac{1}{\sqrt{2}}v_d Y_{\hat{E},p_3} \\ 0 & \frac{1}{\sqrt{2}}v_u Y_{B\hat{a}rE,o_3} & \frac{1}{\sqrt{2}}v_s \lambda_{SE}^T + \mu_E^T \end{pmatrix} \quad (243)$$

This matrix is diagonalized by  $U_L^e$  and  $U_R^e$

$$U_L^{e,*} m_e U_R^{e,\dagger} = m_e^{dia} \quad (244)$$

with

$$e_{L,i} = \sum_{t_2} U_{L,ji}^{e,*} E_{L,j}, \quad \tilde{R}_u^+ = \sum_{t_2} U_{L,j4}^{e,*} E_{L,j}, \quad \bar{E}_i = \sum_{t_2} U_{L,ji}^e E_{L,j}^* \quad (245)$$

$$e_{R,i} = \sum_{t_2} U_{R,ij}^e E_{R,j}^*, \quad \tilde{R}_d^+ = \sum_{t_2} U_{R,4j}^{e,*} E_{R,j}, \quad E_i = \sum_{t_2} U_{R,ij}^e E_{R,j}^* \quad (246)$$

- **Mass matrix for Down-Quarks**, Basis:  $(d_{L,\alpha_1}), (d_{R,\beta_1}^*)$

$$m_d = \left( \frac{1}{\sqrt{2}}v_d \delta_{\alpha_1\beta_1} Y_d^T \right) \quad (247)$$

This matrix is diagonalized by  $U_L^d$  and  $U_R^d$

$$U_L^{d,*} m_d U_R^{d,\dagger} = m_d^{dia} \quad (248)$$

with

$$d_{L,i\alpha} = \sum_{t_2} U_{L,ji}^{d,*} D_{L,j\alpha} \quad (249)$$

$$d_{R,i\alpha} = \sum_{t_2} U_{R,ij}^d D_{R,j\alpha}^* \quad (250)$$

- **Mass matrix for Up-Quarks**, Basis:  $(u_{L,\alpha_1}), (u_{R,\beta_1}^*)$

$$m_u = \left( \frac{1}{\sqrt{2}} v_u \delta_{\alpha_1 \beta_1} Y_u^T \right) \quad (251)$$

This matrix is diagonalized by  $U_L^u$  and  $U_R^u$

$$U_L^{u,*} m_u U_R^{u,\dagger} = m_u^{dia} \quad (252)$$

with

$$u_{L,i\alpha} = \sum_{t_2} U_{L,ji}^{u,*} U_{L,j\alpha} \quad (253)$$

$$u_{R,i\alpha} = \sum_{t_2} U_{R,ij}^u U_{R,j\alpha}^* \quad (254)$$

- **Mass matrix for Gluino**, Basis:  $(\lambda_{\tilde{g},\alpha_1}, \tilde{O}_{\alpha_2}), (\lambda_{\tilde{g},\beta_1}, \tilde{O}_{\beta_2})$

$$m_{\tilde{g}} = \begin{pmatrix} 0 & M_D^O \delta_{\alpha_1 \beta_2} \\ M_D^O \delta_{\alpha_2 \beta_1} & 0 \end{pmatrix} \quad (255)$$

This matrix is diagonalized by  $Z^G$ :

$$Z^{G,*} m_{\tilde{g}} Z^{G,\dagger} = m_{\tilde{g}}^{dia} \quad (256)$$

with

$$\lambda_{\tilde{g},\alpha} = \sum_j Z_{j1}^{G,*} \lambda_{G,j\alpha}, \quad \tilde{O}_\alpha = \sum_j Z_{j2}^{G,*} \lambda_{G,j\alpha} \quad (257)$$

## 5 Vacuum Expectation Values

$$H_d^0 = \frac{1}{\sqrt{2}} \phi_d + \frac{1}{\sqrt{2}} v_d + i \frac{1}{\sqrt{2}} \sigma_d \quad (258)$$

$$H_u^0 = \frac{1}{\sqrt{2}} \phi_u + \frac{1}{\sqrt{2}} v_u + i \frac{1}{\sqrt{2}} \sigma_u \quad (259)$$

$$T^0 = \frac{1}{\sqrt{2}} \phi_T + \frac{1}{\sqrt{2}} v_T + i \frac{1}{\sqrt{2}} \sigma_T \quad (260)$$

$$S = \frac{1}{\sqrt{2}} \phi_S + \frac{1}{\sqrt{2}} v_s + i \frac{1}{\sqrt{2}} \sigma_S \quad (261)$$

$$O = \frac{1}{\sqrt{2}} \phi_o + i \frac{1}{\sqrt{2}} \sigma_o \quad (262)$$

## 6 Tadpole Equations

$$\begin{aligned}
\frac{\partial V}{\partial \phi_d} = & +\frac{1}{8}v_d\left(-4g_1v_s(M_D^B + M_D^{B,*}) + 8g_2v_T\Re(M_D^W) + (g_1^2 + g_2^2)(-v_u + v_d)(v_d + v_u)\right) \\
& +\frac{1}{8}\left(\left(2\Lambda_Tv_d(v_T^2 + v_u^2) - v_T(-4v_d\mu + \sqrt{2}v_s(2v_d\lambda + \lambda_Tv_u))\right)\Lambda_T^* \right. \\
& + 2\sqrt{2}v_s\left(\lambda(-2v_d\mu^* + v_uM_S^*) + (M_Sv_u + v_d(-2\mu - \Lambda_Tv_T))\lambda^*\right) \\
& \left. + v_d\left(4(\Lambda_Tv_T\mu^* + (v_s^2 + v_u^2)|\lambda|^2) + 8(m_{H_d}^2 + |\mu|^2)\right) + v_u\left(-8\Re(B_\mu) + \lambda_Tv_T^2\lambda^* + v_T(-\sqrt{2}\Lambda_Tv_s + v_T\lambda)\lambda_T^*\right)\right) \quad (263)
\end{aligned}$$

$$\begin{aligned}
\frac{\partial V}{\partial \phi_u} = & +\frac{1}{8}\left(2v_u(4m_{H_u}^2 + (\Lambda_T(v_d^2 + v_T^2) + v_T(2\mu - \sqrt{2}v_s\lambda))\Lambda_T^* + (2(v_d^2 + v_s^2)\lambda - \sqrt{2}v_s(2\mu + \Lambda_Tv_T))\lambda^* \right. \\
& + 2(2\mu + \Lambda_Tv_T - \sqrt{2}v_s\lambda)\mu^*) \\
& + v_d\left(-4(B_\mu + B_\mu^*) - \sqrt{2}v_s(-2(\lambda M_S^* + M_S\lambda^*) + v_T(\lambda_T\Lambda_T^* + \Lambda_T\lambda_T^*)) + v_T^2(\lambda\lambda_T^* + \lambda_T\lambda^*)\right) \\
& \left. + \frac{1}{8}v_u\left(8g_1v_s\Re(M_D^B) + g_1^2(-v_d^2 + v_u^2) + g_2(-4v_T(M_D^W + M_D^{W,*}) + g_2(-v_d^2 + v_u^2))\right)\right) \quad (264)
\end{aligned}$$

$$\begin{aligned}
\frac{\partial V}{\partial \phi_T} = & +\frac{1}{8}\left(8(4M_D^{W,2} + m_t^2)v_T + (2\lambda_Tv_T^3 - \sqrt{2}\Lambda_Tv_dv_s v_u + v_T(2(\sqrt{2}M_Sv_s + v_dv_u\lambda) + 4\lambda_Tv_s^2))\lambda_T^* \right. \\
& + \lambda_T(2v_T(\sqrt{2}v_sM_S^* + v_dv_u\lambda^*) - \sqrt{2}v_dv_s v_u\Lambda_T^*) \\
& + (v_d^2 + v_u^2)\left(\left(2(\Lambda_Tv_T + \mu) - \sqrt{2}v_s\lambda\right)\Lambda_T^* + \Lambda_T(2\mu^* - \sqrt{2}v_s\lambda^*)\right) \\
& \left. + \frac{1}{2}g_2(-v_u + v_d)(v_d + v_u)\Re(M_D^W)\right) \quad (265)
\end{aligned}$$

$$\begin{aligned}
\frac{\partial V}{\partial \phi_S} = & +\frac{1}{8}\left(\sqrt{2}\left((2v_dv_u\lambda + \lambda_Tv_T^2)M_S^* + (2M_Sv_dv_u - 2v_d^2\mu + v_u^2(-2\mu - \Lambda_Tv_T))\lambda^* \right. \right. \\
& + v_T(-\Lambda_Tv_d^2\lambda^* + (-\Lambda_Tv_dv_u + M_Sv_T)\lambda_T^* - (\lambda_Tv_dv_u + (v_d^2 + v_u^2)\lambda)\Lambda_T^*) - 2(v_d^2 + v_u^2)\lambda\mu^*) \\
& + 4v_s\left(2(m_S^2 + |M_S|^2) + 8M_D^{B,2} + (v_d^2 + v_u^2)|\lambda|^2 + v_T^2|\lambda_T|^2 + B_S + B_S^*\right) \\
& \left. + \frac{1}{4}g_1\left(2v_u^2\Re(M_D^B) - v_d^2(M_D^B + M_D^{B,*})\right)\right) \quad (266)
\end{aligned}$$

$$\frac{\partial V}{\partial \phi_o} = 0 \quad (267)$$

## 7 Particle content for eigenstates 'EWSB'

Name	Type	complex/real	Generations	Indices
$\sigma_o$	Scalar	real	1	color, 8
$\phi_o$	Scalar	real	1	color, 8



$\tilde{d}$	Scalar	complex	6	generation, 6, color, 3
$\tilde{\nu}$	Scalar	complex	5	generation, 5
$\tilde{u}$	Scalar	complex	6	generation, 6, color, 3
$\tilde{e}$	Scalar	complex	12	generation, 12
$h$	Scalar	real	4	generation, 4
$A^0$	Scalar	real	4	generation, 4
$H^-$	Scalar	complex	4	generation, 4
$\tilde{\chi}^0$	Fermion	Majorana	6	generation, 6
$\tilde{\chi}^-$	Fermion	Dirac	3	generation, 3
$\nu$	Fermion	Majorana	5	generation, 5
$e$	Fermion	Dirac	6	generation, 6
$d$	Fermion	Dirac	3	generation, 3, color, 3
$u$	Fermion	Dirac	3	generation, 3, color, 3
$\tilde{g}$	Fermion	Majorana	2	generation, 2, color, 8
$g$	Vector	real	1	color, 8, lorentz, 4
$\gamma$	Vector	real	1	lorentz, 4
$Z$	Vector	real	1	lorentz, 4
$W^-$	Vector	complex	1	lorentz, 4
$\eta^G$	Ghost	real	1	color, 8
$\eta^\gamma$	Ghost	real	1	
$\eta^Z$	Ghost	real	1	
$\eta^-$	Ghost	complex	1	
$\eta^+$	Ghost	complex	1	

## 8 One Loop Self-Energy and One Loop Tadpoles for eigenstates 'EWSB'

### 8.1 One Loop Self-Energy

- Self-Energy for Down-Squarks ( $\tilde{d}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) = & +4\Gamma_{\tilde{d}_i, \tilde{d}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{d}_i, \tilde{d}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{8}{3} \sum_{a=1}^2 m_{\tilde{g}_a} \sum_{b=1}^3 B_0(p^2, m_{\tilde{g}_a}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{d}_j^*, \tilde{g}_a, d_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{g}_a, d_b}^R + \Gamma_{\tilde{d}_j^*, \tilde{g}_a, d_b}^{R*} \Gamma_{\tilde{d}_i, \tilde{g}_a, d_b}^L \right)
\end{aligned}$$

$$\begin{aligned}
& + \frac{4}{3} \sum_{a=1}^2 \sum_{b=1}^3 G_0(p^2, m_{\tilde{g}_a}^2, m_{\tilde{d}_b}^2) \left( \Gamma_{\tilde{d}_j^*, \tilde{g}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{d}_i^*, \tilde{g}_a, \tilde{d}_b}^L + \Gamma_{\tilde{d}_j^*, \tilde{g}_a, \tilde{d}_b}^{R*} \Gamma_{\tilde{d}_i^*, \tilde{g}_a, \tilde{d}_b}^R \right) \\
& - 2 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{d}_j^*, u_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{d}_i^*, u_a, \tilde{\chi}_b^-}^R \right) \\
& - 2 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^6 B_0(p^2, m_{d_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^6 G_0(p^2, m_{d_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{d}_j^*, d_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i^*, d_a, \tilde{\chi}_b^0}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, h_a, h_a} - \sum_{a=1}^5 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{\nu}_a^*, \tilde{\nu}_a} \\
& + \frac{4}{3} \sum_{a=1}^6 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{\phi}_o}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, \tilde{\phi}_o}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, \tilde{\phi}_o} - C \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{d}_a^*, \tilde{d}_a} \\
& - C \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{d}_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, A_b^0}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, A_b^0} \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{h}_b}^2) \Gamma_{\tilde{d}_j^*, \tilde{d}_a, \tilde{h}_b}^* \Gamma_{\tilde{d}_i^*, \tilde{d}_a, \tilde{h}_b} + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{u}_a}^2, m_{H_b^-}^2) \Gamma_{\tilde{d}_j^*, \tilde{u}_a, H_b^-}^* \Gamma_{\tilde{d}_i^*, \tilde{u}_a, H_b^-} \\
& - \sum_{a=1}^{12} A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{d}_i^*, \tilde{d}_j^*, \tilde{e}_a^*, \tilde{e}_a} + \frac{4}{3} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\sigma}_o}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{d}_j^*, \tilde{\sigma}_o, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, \tilde{\sigma}_o, \tilde{d}_b} \\
& + \frac{4}{3} \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, g, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, g, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, 0) + \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, \gamma, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, \gamma, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, 0) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, Z, \tilde{d}_b}^* \Gamma_{\tilde{d}_i^*, Z, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, m_Z^2) + \sum_{b=1}^6 \Gamma_{\tilde{d}_j^*, W^-, \tilde{u}_b}^* \Gamma_{\tilde{d}_i^*, W^-, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, m_{W^-}^2) \tag{268}
\end{aligned}$$

• Self-Energy for Sneutrinos ( $\tilde{\nu}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{\nu}_i, \tilde{\nu}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - 2 \sum_{a=1}^3 m_{\tilde{\chi}_a^-} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\tilde{\nu}_j^*, \tilde{\chi}_a^+, e_b}^{L*} \Gamma_{\tilde{\nu}_i^*, \tilde{\chi}_a^+, e_b}^R + \Gamma_{\tilde{\nu}_j^*, \tilde{\chi}_a^+, e_b}^{R*} \Gamma_{\tilde{\nu}_i^*, \tilde{\chi}_a^+, e_b}^L \right)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^3 \sum_{b=1}^6 G_0 \left( p^2, m_{\tilde{\chi}_a^-}^2, m_{e_b}^2 \right) \left( \Gamma_{\tilde{\nu}_j^*, \tilde{\chi}_a^+, e_b}^{L*} \Gamma_{\tilde{\nu}_i^*, \tilde{\chi}_a^+, e_b}^L + \Gamma_{\tilde{\nu}_j^*, \tilde{\chi}_a^+, e_b}^{R*} \Gamma_{\tilde{\nu}_i^*, \tilde{\chi}_a^+, e_b}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{A_a^0}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0 \left( m_{H_a^-}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{h_a}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, h_a, h_a} + \sum_{a=1}^4 \sum_{b=1}^{12} B_0 \left( p^2, m_{H_a^-}^2, m_{\tilde{e}_b}^2 \right) \Gamma_{\tilde{\nu}_j^*, H_a^+, \tilde{e}_b}^* \Gamma_{\tilde{\nu}_i^*, H_a^+, \tilde{e}_b} \\
& - \sum_{a=1}^5 A_0 \left( m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, \tilde{\nu}_a, \tilde{\nu}_a} + \sum_{a=1}^5 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\nu}_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\nu}_j^*, \tilde{\nu}_a, A_b^0}^* \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_a, A_b^0} \\
& + \sum_{a=1}^5 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\nu}_a}^2, m_{h_b}^2 \right) \Gamma_{\tilde{\nu}_j^*, \tilde{\nu}_a, h_b}^* \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_a, h_b} \\
& - \sum_{a=1}^5 m_{\nu_a} \sum_{b=1}^6 B_0 \left( p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2 \right) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^6 G_0 \left( p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^0}^2 \right) \left( \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{\nu}_j^*, \nu_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i^*, \nu_a, \tilde{\chi}_b^0}^R \right) \\
& - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, \tilde{d}_a^*, \tilde{d}_a} - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, \tilde{u}_a^*, \tilde{u}_a} \\
& - \sum_{a=1}^{12} A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\nu}_i^*, \tilde{\nu}_j^*, \tilde{e}_a^*, \tilde{e}_a} + \sum_{b=1}^5 \Gamma_{\tilde{\nu}_j^*, Z, \tilde{\nu}_b}^* \Gamma_{\tilde{\nu}_i^*, Z, \tilde{\nu}_b} F_0 \left( p^2, m_{\tilde{\nu}_b}^2, m_Z^2 \right) \\
& + \sum_{b=1}^{12} \Gamma_{\tilde{\nu}_j^*, W^+, \tilde{e}_b}^* \Gamma_{\tilde{\nu}_i^*, W^+, \tilde{e}_b} F_0 \left( p^2, m_{\tilde{e}_b}^2, m_{W^-}^2 \right) \tag{269}
\end{aligned}$$

• Self-Energy for Up-Squarks ( $\tilde{u}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{u}_i, \tilde{u}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0 \left( m_{W^-}^2 \right) \right) + 2\Gamma_{\tilde{u}_i, \tilde{u}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0 \left( m_Z^2 \right) \right) \\
& - \frac{8}{3} \sum_{a=1}^2 m_{\tilde{g}_a} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{g}_a}^2, m_{u_b}^2 \right) m_{u_b} \left( \Gamma_{\tilde{u}_j^*, \tilde{g}_a, u_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{g}_a, u_b}^R + \Gamma_{\tilde{u}_j^*, \tilde{g}_a, u_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{g}_a, u_b}^L \right) \\
& + \frac{4}{3} \sum_{a=1}^2 \sum_{b=1}^3 G_0 \left( p^2, m_{\tilde{g}_a}^2, m_{u_b}^2 \right) \left( \Gamma_{\tilde{u}_j^*, \tilde{g}_a, u_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{g}_a, u_b}^L + \Gamma_{\tilde{u}_j^*, \tilde{g}_a, u_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{g}_a, u_b}^R \right) \\
& - 2 \sum_{a=1}^3 m_{\tilde{\chi}_a^-} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_a^-}^2, m_{d_b}^2 \right) m_{d_b} \left( \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, d_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, d_b}^R + \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, d_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, d_b}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0 \left( p^2, m_{\tilde{\chi}_a^-}^2, m_{d_b}^2 \right) \left( \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, d_b}^{L*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, d_b}^L + \Gamma_{\tilde{u}_j^*, \tilde{\chi}_a^+, d_b}^{R*} \Gamma_{\tilde{u}_i^*, \tilde{\chi}_a^+, d_b}^R \right)
\end{aligned}$$

$$\begin{aligned}
& -2 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^6 B_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^6 G_0(p^2, m_{u_a}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{u}_j^*, u_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i^*, u_a, \tilde{\chi}_b^0}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, h_a, h_a} + \sum_{a=1}^4 \sum_{b=1}^6 B_0(p^2, m_{H_a^-}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{u}_j^*, H_a^+, \tilde{d}_b}^* \Gamma_{\tilde{u}_i^*, H_a^+, \tilde{d}_b} \\
& - \sum_{a=1}^5 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{\nu}_a^*, \tilde{\nu}_a} + \frac{4}{3} \sum_{a=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\phi_o}^2) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, \phi_o}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, \phi_o} \\
& + \frac{4}{3} \sum_{a=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\sigma_o}^2) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, \sigma_o}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, \sigma_o} - C \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{d}_a^*, \tilde{d}_a} \\
& - C \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{u}_a^*, \tilde{u}_a} + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{u}_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, A_b^0}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, A_b^0} \\
& + \sum_{a=1}^6 \sum_{b=1}^4 B_0(p^2, m_{\tilde{u}_a}^2, m_{h_b}^2) \Gamma_{\tilde{u}_j^*, \tilde{u}_a, h_b}^* \Gamma_{\tilde{u}_i^*, \tilde{u}_a, h_b} - \sum_{a=1}^{12} A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{u}_i, \tilde{u}_j^*, \tilde{e}_a^*, \tilde{e}_a} \\
& + \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, W^+, \tilde{d}_b}^* \Gamma_{\tilde{u}_i^*, W^+, \tilde{d}_b} F_0(p^2, m_{\tilde{d}_b}^2, m_{W^-}^2) + \frac{4}{3} \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, g, \tilde{u}_b}^* \Gamma_{\tilde{u}_i^*, g, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, 0) \\
& + \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, \gamma, \tilde{u}_b}^* \Gamma_{\tilde{u}_i^*, \gamma, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, 0) + \sum_{b=1}^6 \Gamma_{\tilde{u}_j^*, Z, \tilde{u}_b}^* \Gamma_{\tilde{u}_i^*, Z, \tilde{u}_b} F_0(p^2, m_{\tilde{u}_b}^2, m_Z^2) \tag{270}
\end{aligned}$$

• Self-Energy for Sleptons ( $\tilde{e}$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) & = +4\Gamma_{\tilde{e}_i, \tilde{e}_j^*, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{e}_i, \tilde{e}_j^*, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, h_a, h_a} - \sum_{a=1}^5 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{\nu}_a^*, \tilde{\nu}_a} \\
& - 2 \sum_{a=1}^5 m_{\nu_a} \sum_{b=1}^3 B_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^5 \sum_{b=1}^3 G_0(p^2, m_{\nu_a}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{e}_j^*, \nu_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i^*, \nu_a, \tilde{\chi}_b^-}^R \right)
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^5 \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\nu}_a}^2, m_{H_b^-}^2 \right) \Gamma_{\tilde{e}_j^*, \tilde{\nu}_a, H_b^-}^* \Gamma_{\tilde{e}_i^*, \tilde{\nu}_a, H_b^-} - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{d}_a^*, \tilde{d}_a} \\
& - 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{u}_a^*, \tilde{u}_a} \\
& - 2 \sum_{a=1}^6 m_{e_a} \sum_{b=1}^6 B_0 \left( p^2, m_{e_a}^2, m_{\tilde{\chi}_b^0}^2 \right) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^L \right) \\
& + \sum_{a=1}^6 \sum_{b=1}^6 G_0 \left( p^2, m_{e_a}^2, m_{\tilde{\chi}_b^0}^2 \right) \left( \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{e}_j^*, e_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i^*, e_a, \tilde{\chi}_b^0}^R \right) \\
& - \sum_{a=1}^{12} A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{e}_i, \tilde{e}_j^*, \tilde{e}_a^*, \tilde{e}_a} + \sum_{a=1}^{12} \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{e}_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{e}_j^*, \tilde{e}_a, A_b^0}^* \Gamma_{\tilde{e}_i^*, \tilde{e}_a, A_b^0} \\
& + \sum_{a=1}^{12} \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{e}_a}^2, m_{h_b}^2 \right) \Gamma_{\tilde{e}_j^*, \tilde{e}_a, h_b}^* \Gamma_{\tilde{e}_i^*, \tilde{e}_a, h_b} + \sum_{b=1}^5 \Gamma_{\tilde{e}_j^*, W^-, \tilde{\nu}_b}^* \Gamma_{\tilde{e}_i^*, W^-, \tilde{\nu}_b} F_0 \left( p^2, m_{\tilde{\nu}_b}^2, m_{W^-}^2 \right) \\
& + \sum_{b=1}^{12} \Gamma_{\tilde{e}_j^*, \gamma, \tilde{e}_b}^* \Gamma_{\tilde{e}_i^*, \gamma, \tilde{e}_b} F_0 \left( p^2, m_{\tilde{e}_b}^2, 0 \right) + \sum_{b=1}^{12} \Gamma_{\tilde{e}_j^*, Z, \tilde{e}_b}^* \Gamma_{\tilde{e}_i^*, Z, \tilde{e}_b} F_0 \left( p^2, m_{\tilde{e}_b}^2, m_Z^2 \right) \tag{271}
\end{aligned}$$

• **Self-Energy for Higgs ( $h$ )**

$$\begin{aligned}
\Pi_{i,j}(p^2) = & + 2 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_Z^2, m_Z^2 \right) \right) \Gamma_{h_j, Z, Z}^* \Gamma_{h_i, Z, Z} + 4 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{W^-}^2, m_{W^-}^2 \right) \right) \Gamma_{h_j, W^+, W^-}^* \Gamma_{h_i, W^+, W^-} \\
& - B_0 \left( p^2, m_{\eta^-}^2, m_{\eta^-}^2 \right) \Gamma_{h_i, \eta^-, \eta^-} \Gamma_{h_j, \eta^-, \eta^-} - B_0 \left( p^2, m_{\eta^+}^2, m_{\eta^+}^2 \right) \Gamma_{h_i, \eta^+, \eta^+} \Gamma_{h_j, \eta^+, \eta^+} \\
& - B_0 \left( p^2, m_{\eta^z}^2, m_{\eta^z}^2 \right) \Gamma_{h_i, \eta^z, \eta^z} \Gamma_{h_j, \eta^z, \eta^z} + 4 \Gamma_{h_i, h_j, W^+, W^-} + \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0 \left( m_{W^-}^2 \right) \right) \\
& + 2 \Gamma_{h_i, h_j, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0 \left( m_Z^2 \right) \right) \\
& - 2 \sum_{a=1}^3 m_{\tilde{\chi}_a^-} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2 \right) m_{\tilde{\chi}_b^-} \left( \Gamma_{h_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{h_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R + \Gamma_{h_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{h_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0 \left( p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2 \right) \left( \Gamma_{h_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{h_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L + \Gamma_{h_j, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{h_i, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R \right) \\
& - 6 \sum_{a=1}^3 m_{\tilde{d}_a} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2 \right) m_{\tilde{d}_b} \left( \Gamma_{h_j, \tilde{d}_a, \tilde{d}_b}^{L*} \Gamma_{h_i, \tilde{d}_a, \tilde{d}_b}^R + \Gamma_{h_j, \tilde{d}_a, \tilde{d}_b}^{R*} \Gamma_{h_i, \tilde{d}_a, \tilde{d}_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0 \left( p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2 \right) \left( \Gamma_{h_j, \tilde{d}_a, \tilde{d}_b}^{L*} \Gamma_{h_i, \tilde{d}_a, \tilde{d}_b}^L + \Gamma_{h_j, \tilde{d}_a, \tilde{d}_b}^{R*} \Gamma_{h_i, \tilde{d}_a, \tilde{d}_b}^R \right) \\
& - 6 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0 \left( p^2, m_{u_a}^2, m_{u_b}^2 \right) m_{u_b} \left( \Gamma_{h_j, \tilde{u}_a, u_b}^{L*} \Gamma_{h_i, \tilde{u}_a, u_b}^R + \Gamma_{h_j, \tilde{u}_a, u_b}^{R*} \Gamma_{h_i, \tilde{u}_a, u_b}^L \right)
\end{aligned}$$

$$\begin{aligned}
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{u_b}^2) \left( \Gamma_{\check{h}_j, \bar{u}_a, u_b}^{L*} \Gamma_{\check{h}_i, \bar{u}_a, u_b}^L + \Gamma_{\check{h}_j, \bar{u}_a, u_b}^{R*} \Gamma_{\check{h}_i, \bar{u}_a, u_b}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\check{h}_i, \check{h}_j, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\check{h}_i, \check{h}_j, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\check{h}_i, \check{h}_j, h_a, h_a} + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{A_a^0}^2, m_{A_b^0}^2) \Gamma_{\check{h}_j, A_a^0, A_b^0}^* \Gamma_{\check{h}_i, A_a^0, A_b^0} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{H_a^-}^2, m_{H_b^-}^2) \Gamma_{\check{h}_j, H_a^+, H_b^-}^* \Gamma_{\check{h}_i, H_a^+, H_b^-} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{h_a}^2, m_{A_b^0}^2) \Gamma_{\check{h}_j, h_a, A_b^0}^* \Gamma_{\check{h}_i, h_a, A_b^0} + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{h_a}^2, m_{h_b}^2) \Gamma_{\check{h}_j, h_a, h_b}^* \Gamma_{\check{h}_i, h_a, h_b} \\
& - \sum_{a=1}^5 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{\check{h}_i, \check{h}_j, \tilde{\nu}_a^*, \tilde{\nu}_a} + \sum_{a=1}^5 \sum_{b=1}^5 B_0(p^2, m_{\tilde{\nu}_a}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\check{h}_j, \tilde{\nu}_a^*, \tilde{\nu}_b}^* \Gamma_{\check{h}_i, \tilde{\nu}_a^*, \tilde{\nu}_b} \\
& - \sum_{a=1}^5 m_{\nu_a} \sum_{b=1}^5 B_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) m_{\nu_b} \left( \Gamma_{\check{h}_j, \nu_a, \nu_b}^{L*} \Gamma_{\check{h}_i, \nu_a, \nu_b}^R + \Gamma_{\check{h}_j, \nu_a, \nu_b}^{R*} \Gamma_{\check{h}_i, \nu_a, \nu_b}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^5 G_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) \left( \Gamma_{\check{h}_j, \nu_a, \nu_b}^{L*} \Gamma_{\check{h}_i, \nu_a, \nu_b}^L + \Gamma_{\check{h}_j, \nu_a, \nu_b}^{R*} \Gamma_{\check{h}_i, \nu_a, \nu_b}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\check{h}_i, \check{h}_j, \tilde{d}_a^*, \tilde{d}_a} - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\check{h}_i, \check{h}_j, \tilde{u}_a^*, \tilde{u}_a} \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\check{h}_j, \tilde{d}_a^*, \tilde{d}_b}^* \Gamma_{\check{h}_i, \tilde{d}_a^*, \tilde{d}_b} \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) \Gamma_{\check{h}_j, \tilde{u}_a^*, \tilde{u}_b}^* \Gamma_{\check{h}_i, \tilde{u}_a^*, \tilde{u}_b} \\
& - 2 \sum_{a=1}^6 m_{e_a} \sum_{b=1}^6 B_0(p^2, m_{e_a}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{L*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^R + \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{R*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^L \right) \\
& + \sum_{a=1}^6 \sum_{b=1}^6 G_0(p^2, m_{e_a}^2, m_{e_b}^2) \left( \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{L*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^L + \Gamma_{\check{h}_j, \bar{e}_a, e_b}^{R*} \Gamma_{\check{h}_i, \bar{e}_a, e_b}^R \right) \\
& - \sum_{a=1}^6 m_{\tilde{\chi}_a^0} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\check{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\check{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R + \Gamma_{\check{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\check{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\check{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\check{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L + \Gamma_{\check{h}_j, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\check{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R \right)
\end{aligned}$$

$$\begin{aligned}
& - \sum_{a=1}^{12} A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{h}_i, \tilde{h}_j, \tilde{e}_a^*, \tilde{e}_a} + \sum_{a=1}^{12} \sum_{b=1}^{12} B_0(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{h}_j, \tilde{e}_a^*, \tilde{e}_b}^* \Gamma_{\tilde{h}_i, \tilde{e}_a^*, \tilde{e}_b} \\
& + \sum_{b=1}^4 \Gamma_{\tilde{h}_j, Z, A_b^0}^* \Gamma_{\tilde{h}_i, Z, A_b^0} F_0(p^2, m_{A_b^0}^2, m_Z^2) + 2 \sum_{b=1}^4 \Gamma_{\tilde{h}_j, W^+, H_b^-}^* \Gamma_{\tilde{h}_i, W^+, H_b^-} F_0(p^2, m_{H_b^-}^2, m_{W^+}^2)
\end{aligned} \tag{272}$$

• Self-Energy for Pseudo-Scalar Higgs ( $A^0$ )

$$\begin{aligned}
\Pi_{i,j}(p^2) = & -B_0(p^2, m_{\eta^-}^2, m_{\eta^-}^2) \Gamma_{\tilde{A}_i^0, \eta^-, \eta^-} \Gamma_{\tilde{A}_j^0, \eta^-, \eta^-} - B_0(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \Gamma_{\tilde{A}_i^0, \eta^+, \eta^+} \Gamma_{\tilde{A}_j^0, \eta^+, \eta^+} \\
& + 4\Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2\Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right) \\
& - 2 \sum_{a=1}^3 m_{\tilde{\chi}_a^-} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^+, \tilde{\chi}_b^-}^R \right) \\
& - 6 \sum_{a=1}^3 m_{d_a} \sum_{b=1}^3 B_0(p^2, m_{d_a}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^R + \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{d_a}^2, m_{d_b}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^L + \Gamma_{\tilde{A}_j^0, \tilde{d}_a, d_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{d}_a, d_b}^R \right) \\
& - 6 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0(p^2, m_{u_a}^2, m_{u_b}^2) m_{u_b} \left( \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^R + \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{u_b}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^L + \Gamma_{\tilde{A}_j^0, \tilde{u}_a, u_b}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{u}_a, u_b}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, H_a^+, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, h_a, h_a} + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{A_a^0}^2, m_{A_b^0}^2) \Gamma_{\tilde{A}_j^0, A_a^0, A_b^0}^* \Gamma_{\tilde{A}_i^0, A_a^0, A_b^0} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{H_a^-}^2, m_{H_b^-}^2) \Gamma_{\tilde{A}_j^0, H_a^+, H_b^-}^* \Gamma_{\tilde{A}_i^0, H_a^+, H_b^-} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{h_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{A}_j^0, h_a, A_b^0}^* \Gamma_{\tilde{A}_i^0, h_a, A_b^0} \\
& + \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{h_a}^2, m_{h_b}^2) \Gamma_{\tilde{A}_j^0, h_a, h_b}^* \Gamma_{\tilde{A}_i^0, h_a, h_b} - \sum_{a=1}^5 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{\nu}_a^*, \tilde{\nu}_a}
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^5 \sum_{b=1}^5 B_0(p^2, m_{\tilde{\nu}_a}^2, m_{\tilde{\nu}_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{\nu}_a^*, \tilde{\nu}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{\nu}_a^*, \tilde{\nu}_b} \\
& - \sum_{a=1}^5 m_{\nu_a} \sum_{b=1}^5 B_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) m_{\nu_b} \left( \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{L*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^R + \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{R*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^5 G_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) \left( \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{L*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^L + \Gamma_{\tilde{A}_j^0, \nu_a, \nu_b}^{R*} \Gamma_{\tilde{A}_i^0, \nu_a, \nu_b}^R \right) \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{d}_a^*, \tilde{d}_a} - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{u}_a^*, \tilde{u}_a} \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{d}_a^*, \tilde{d}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{d}_a^*, \tilde{d}_b} \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{u}_a^*, \tilde{u}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{u}_a^*, \tilde{u}_b} \\
& - 2 \sum_{a=1}^6 m_{e_a} \sum_{b=1}^6 B_0(p^2, m_{e_a}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\tilde{A}_j^0, \bar{e}_a, e_b}^{L*} \Gamma_{\tilde{A}_i^0, \bar{e}_a, e_b}^R + \Gamma_{\tilde{A}_j^0, \bar{e}_a, e_b}^{R*} \Gamma_{\tilde{A}_i^0, \bar{e}_a, e_b}^L \right) \\
& + \sum_{a=1}^6 \sum_{b=1}^6 G_0(p^2, m_{e_a}^2, m_{e_b}^2) \left( \Gamma_{\tilde{A}_j^0, \bar{e}_a, e_b}^{L*} \Gamma_{\tilde{A}_i^0, \bar{e}_a, e_b}^L + \Gamma_{\tilde{A}_j^0, \bar{e}_a, e_b}^{R*} \Gamma_{\tilde{A}_i^0, \bar{e}_a, e_b}^R \right) \\
& - \sum_{a=1}^6 m_{\tilde{\chi}_a^0} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2) m_{\tilde{\chi}_b^0} \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L \right) \\
& + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2) \left( \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L + \Gamma_{\tilde{A}_j^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{A}_i^0, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R \right) \\
& - \sum_{a=1}^{12} A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{A}_i^0, \tilde{A}_j^0, \tilde{e}_a^*, \tilde{e}_a} + \sum_{a=1}^{12} \sum_{b=1}^{12} B_0(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{A}_j^0, \tilde{e}_a^*, \tilde{e}_b}^* \Gamma_{\tilde{A}_i^0, \tilde{e}_a^*, \tilde{e}_b} \\
& + \sum_{b=1}^4 \Gamma_{\tilde{A}_j^0, Z, h_b}^* \Gamma_{\tilde{A}_i^0, Z, h_b} F_0(p^2, m_{h_b}^2, m_Z^2) + 2 \sum_{b=1}^4 \Gamma_{\tilde{A}_j^0, W^+, H_b^-}^* \Gamma_{\tilde{A}_i^0, W^+, H_b^-} F_0(p^2, m_{H_b^-}^2, m_{W^-}^2) \quad (273)
\end{aligned}$$

• **Self-Energy for Charged Higgs ( $H^-$ )**

$$\begin{aligned}
\Pi_{i,j}(p^2) = & +4 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, 0, m_{W^-}^2) \right) \Gamma_{\tilde{H}_j^+, W^-, \gamma}^* \Gamma_{\tilde{H}_i^+, W^-, \gamma} + 4 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{W^-}^2, m_Z^2) \right) \Gamma_{\tilde{H}_j^+, Z, W^-}^* \Gamma_{\tilde{H}_i^+, Z, W^-} \\
& - B_0(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \Gamma_{\tilde{H}_i^+, \eta^+, \eta^+} \Gamma_{\tilde{H}_j^-, \eta^+, \eta^+} - B_0(p^2, m_{\eta^-}^2, m_{\eta^-}^2) \Gamma_{\tilde{H}_i^+, \eta^-, \eta^-} \Gamma_{\tilde{H}_j^-, \eta^-, \eta^-} \\
& + 4 \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0(m_{W^-}^2) \right) + 2 \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0(m_Z^2) \right)
\end{aligned}$$



$$\begin{aligned}
& -6 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^3 B_0(p^2, m_{u_a}^2, m_{d_b}^2) m_{d_b} \left( \Gamma_{\tilde{H}_j^+, \tilde{u}_a, d_b}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{u}_a, d_b}^R + \Gamma_{\tilde{H}_j^+, \tilde{u}_a, d_b}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{u}_a, d_b}^L \right) \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 G_0(p^2, m_{u_a}^2, m_{d_b}^2) \left( \Gamma_{\tilde{H}_j^+, \tilde{u}_a, d_b}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{u}_a, d_b}^L + \Gamma_{\tilde{H}_j^+, \tilde{u}_a, d_b}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{u}_a, d_b}^R \right) \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, A_a^0, A_a^0} - \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, H_a^-, H_a^-} \\
& - \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, h_a, h_a} + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{H_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{H}_j^+, H_a^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, H_a^-, A_b^0} \\
& + \sum_{a=1}^4 \sum_{b=1}^4 B_0(p^2, m_{H_a^-}^2, m_{h_b}^2) \Gamma_{\tilde{H}_j^+, H_a^-, h_b}^* \Gamma_{\tilde{H}_i^+, H_a^-, h_b} - \sum_{a=1}^5 A_0(m_{\nu_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \nu_a^*, \nu_a} \\
& - 2 \sum_{a=1}^5 m_{\nu_a} \sum_{b=1}^6 B_0(p^2, m_{\nu_a}^2, m_{e_b}^2) m_{e_b} \left( \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{L*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^R + \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{R*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^L \right) \\
& + \sum_{a=1}^5 \sum_{b=1}^6 G_0(p^2, m_{\nu_a}^2, m_{e_b}^2) \left( \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{L*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^L + \Gamma_{\tilde{H}_j^+, \nu_a, e_b}^{R*} \Gamma_{\tilde{H}_i^+, \nu_a, e_b}^R \right) \\
& + \sum_{a=1}^5 \sum_{b=1}^{12} B_0(p^2, m_{\nu_a}^2, m_{\tilde{e}_b}^2) \Gamma_{\tilde{H}_j^+, \nu_a^*, \tilde{e}_b}^* \Gamma_{\tilde{H}_i^+, \nu_a^*, \tilde{e}_b} - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{d}_a^*, \tilde{d}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{u}_a^*, \tilde{u}_a} \\
& - 2 \sum_{a=1}^6 m_{\tilde{\chi}_a^0} \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_b^-} \left( \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^R + \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^L \right) \\
& + \sum_{a=1}^6 \sum_{b=1}^3 G_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^-}^2) \left( \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^L + \Gamma_{\tilde{H}_j^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{H}_i^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^R \right) \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{H}_j^+, \tilde{u}_a^*, \tilde{d}_b}^* \Gamma_{\tilde{H}_i^+, \tilde{u}_a^*, \tilde{d}_b} - \sum_{a=1}^{12} A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{H}_i^-, \tilde{H}_j^+, \tilde{e}_a^*, \tilde{e}_a} \\
& + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, W^-, A_b^0}^* \Gamma_{\tilde{H}_i^+, W^-, A_b^0} F_0(p^2, m_{A_b^0}^2, m_{W^-}^2) + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, W^-, h_b}^* \Gamma_{\tilde{H}_i^+, W^-, h_b} F_0(p^2, m_{h_b}^2, m_{W^-}^2) \\
& + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, \gamma, H_b^-}^* \Gamma_{\tilde{H}_i^+, \gamma, H_b^-} F_0(p^2, m_{H_b^-}^2, 0) + \sum_{b=1}^4 \Gamma_{\tilde{H}_j^+, Z, H_b^-}^* \Gamma_{\tilde{H}_i^+, Z, H_b^-} F_0(p^2, m_{H_b^-}^2, m_Z^2) \tag{274}
\end{aligned}$$

• Self-Energy for Neutralinos ( $\tilde{\chi}^0$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & +2 \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^R \\
& + 2 \sum_{a=1}^5 \sum_{b=1}^5 B_0(p^2, m_{\nu_b}^2, m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\nu}_a^*, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{\chi}_i^0, \tilde{\nu}_a^*, \nu_b}^R \\
& + 6 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^R \\
& + 6 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{L*} m_{u_b} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^R \\
& + \sum_{a=1}^6 m_{\tilde{\chi}_a^0} \sum_{b=1}^4 B_0(p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, A_b^0}^R \\
& + 2 \sum_{a=1}^{12} \sum_{b=1}^6 B_0(p^2, m_{e_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{L*} m_{e_b} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^R \\
& - 8 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2) \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\chi}_b^-}^{R*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\chi}_b^-}^L \\
& - 4 \sum_{b=1}^6 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2) \right) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{R*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^L \tag{275} \\
\Sigma_{i,j}^R(p^2) = & - \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^R \\
& - \sum_{a=1}^5 \sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\nu}_a^*, \nu_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\nu}_a^*, \nu_b}^R \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^R \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^R \\
& - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, A_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, A_b^0}^R
\end{aligned}$$

$$\begin{aligned}
& - \sum_{a=1}^{12} \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{R*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^R \\
& - 2 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\chi}_b^-}^L - \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^L \quad (276)
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) = & - \sum_{a=1}^4 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, H_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^0, H_a^+, \tilde{\chi}_b^-}^L \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, h_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, h_a, \tilde{\chi}_b^0}^L \\
& - \sum_{a=1}^5 \sum_{b=1}^5 B_1 \left( p^2, m_{\nu_b}^2, m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\nu}_a^*, \nu_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\nu}_a^*, \nu_b}^L \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{d_b}^2, m_{\tilde{d}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{d}_a^*, d_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{d}_a^*, d_b}^L \\
& - 3 \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{u_b}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{u}_a^*, u_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{u}_a^*, u_b}^L \\
& - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{\chi}_a^0, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{\chi}_a^0, A_b^0}^L \\
& - \sum_{a=1}^{12} \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^0, \tilde{e}_a^*, e_b}^{L*} \Gamma_{\tilde{\chi}_i^0, \tilde{e}_a^*, e_b}^L \\
& - 2 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^0, W^+, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^0, W^+, \tilde{\chi}_b^-}^R - \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^0, Z, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^0, Z, \tilde{\chi}_b^0}^R \quad (277)
\end{aligned}$$

• Self-Energy for Charginos ( $\tilde{\chi}^-$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^3 m_{\tilde{\chi}_a^-} \sum_{b=1}^4 B_0 \left( p^2, m_{\tilde{\chi}_a^-}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\chi}_j^+, \tilde{\chi}_a^-, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{\chi}_a^-, A_b^0}^R \\
& + 3 \sum_{a=1}^3 m_{u_a} \sum_{b=1}^6 B_0 \left( p^2, m_{u_a}^2, m_{\tilde{d}_b}^2 \right) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a, \tilde{d}_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a, \tilde{d}_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\chi}_j^+, h_a, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^+, h_a, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^+, H_a^-, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^+, H_a^-, \tilde{\chi}_b^0}^R
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^5 \sum_{b=1}^6 B_0(p^2, m_{e_b}^2, m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\chi}_j^+}^{L*} \Gamma_{\tilde{\nu}_a^*, e_b}^{R*} m_{e_b} \Gamma_{\tilde{\chi}_i^+}^R \Gamma_{\tilde{\nu}_a^*, e_b}^R \\
& + 3 \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^+}^{L*} \Gamma_{\tilde{u}_a^*, d_b}^{R*} m_{d_b} \Gamma_{\tilde{\chi}_i^+}^R \Gamma_{\tilde{u}_a^*, d_b}^R \\
& + \sum_{a=1}^{12} \sum_{b=1}^5 B_0(p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^+}^{L*} \Gamma_{\tilde{e}_a, \nu_b}^{R*} m_{\nu_b} \Gamma_{\tilde{\chi}_i^+}^R \Gamma_{\tilde{e}_a, \nu_b}^R \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^-}^2, 0) \right) \Gamma_{\tilde{\chi}_j^+, \gamma, \tilde{\chi}_b^-}^{R*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^+, \gamma, \tilde{\chi}_b^-}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_Z^2) \right) \Gamma_{\tilde{\chi}_j^+, Z, \tilde{\chi}_b^-}^{R*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\chi}_i^+, Z, \tilde{\chi}_b^-}^L \\
& - 4 \sum_{b=1}^6 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2) \right) \Gamma_{\tilde{\chi}_j^+, W^-, \tilde{\chi}_b^0}^{R*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\chi}_i^+, W^-, \tilde{\chi}_b^0}^L \tag{278}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) & = -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{\chi}_a^-, A_b^0}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{\chi}_a^-, A_b^0}^R \\
& - \frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{u_a}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a, \tilde{d}_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a, \tilde{d}_b}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{h_a}^2) \Gamma_{\tilde{\chi}_j^+, h_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^+, h_a, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2) \Gamma_{\tilde{\chi}_j^+, H_a^-, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^+, H_a^-, \tilde{\chi}_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^6 B_1(p^2, m_{e_b}^2, m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{\nu}_a^*, e_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{\nu}_a^*, e_b}^R \\
& - \frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a^*, d_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a^*, d_b}^R \\
& - \frac{1}{2} \sum_{a=1}^{12} \sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{e}_a, \nu_b}^{R*} \Gamma_{\tilde{\chi}_i^+, \tilde{e}_a, \nu_b}^R - \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, 0) \Gamma_{\tilde{\chi}_j^+, \gamma, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^+, \gamma, \tilde{\chi}_b^-}^L \\
& - \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_Z^2) \Gamma_{\tilde{\chi}_j^+, Z, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^+, Z, \tilde{\chi}_b^-}^L - \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2) \Gamma_{\tilde{\chi}_j^+, W^-, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, W^-, \tilde{\chi}_b^0}^L \tag{279}
\end{aligned}$$

$$\Sigma_{i,j}^L(p^2) = -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{A_b^0}^2) \Gamma_{\tilde{\chi}_j^+, \tilde{\chi}_a^-, A_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{\chi}_a^-, A_b^0}^L$$

$$\begin{aligned}
& -\frac{3}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1 \left( p^2, m_{u_a}^2, m_{\bar{d}_b}^2 \right) \Gamma_{\tilde{\chi}_j^+, \bar{u}_a, \bar{d}_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \bar{u}_a, \bar{d}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\chi}_j^+, h_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\chi}_i^+, h_a, \tilde{\chi}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\chi}_j^+, H_a^-, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\chi}_i^+, H_a^-, \tilde{\chi}_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{\chi}_j^+, \tilde{\nu}_a^*, e_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{\nu}_a^*, e_b}^L \\
& -\frac{3}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1 \left( p^2, m_{d_b}^2, m_{\tilde{u}_a}^2 \right) \Gamma_{\tilde{\chi}_j^+, \tilde{u}_a^*, d_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{u}_a^*, d_b}^L \\
& -\frac{1}{2} \sum_{a=1}^{12} \sum_{b=1}^5 B_1 \left( p^2, m_{\nu_b}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\chi}_j^+, \tilde{e}_a^*, \nu_b}^{L*} \Gamma_{\tilde{\chi}_i^+, \tilde{e}_a^*, \nu_b}^L - \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, 0 \right) \Gamma_{\tilde{\chi}_j^+, \gamma, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^+, \gamma, \tilde{\chi}_b^-}^R \\
& - \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_Z^2 \right) \Gamma_{\tilde{\chi}_j^+, Z, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\chi}_i^+, Z, \tilde{\chi}_b^-}^R - \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{W^-}^2 \right) \Gamma_{\tilde{\chi}_j^+, W^-, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\chi}_i^+, W^-, \tilde{\chi}_b^0}^R \quad (280)
\end{aligned}$$

• Self-Energy for Neutrinos ( $\nu$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) &= + \sum_{a=1}^4 \sum_{b=1}^5 B_0 \left( p^2, m_{\nu_b}^2, m_{h_a}^2 \right) \Gamma_{\tilde{\nu}_j, h_a, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{\nu}_i, h_a, \nu_b}^R \\
& + 2 \sum_{a=1}^4 \sum_{b=1}^6 B_0 \left( p^2, m_{e_b}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{\nu}_j, H_a^+, e_b}^{L*} m_{e_b} \Gamma_{\tilde{\nu}_i, H_a^+, e_b}^R \\
& + \sum_{a=1}^5 m_{\nu_a} \sum_{b=1}^4 B_0 \left( p^2, m_{\nu_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{\nu}_j, \nu_a, A_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \nu_a, A_b^0}^R \\
& + 2 \sum_{a=1}^5 \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{\nu}_j, \tilde{\nu}_a^*, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{\nu}_i, \tilde{\nu}_a^*, \tilde{\chi}_b^0}^R \\
& + 2 \sum_{a=1}^{12} \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{\nu}_j, \tilde{e}_a^*, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{\nu}_i, \tilde{e}_a^*, \tilde{\chi}_b^-}^R \\
& - 4 \sum_{b=1}^5 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\nu_b}^2, m_Z^2 \right) \right) \Gamma_{\tilde{\nu}_j, Z, \nu_b}^{R*} m_{\nu_b} \Gamma_{\tilde{\nu}_i, Z, \nu_b}^L \\
& - 8 \sum_{b=1}^6 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{e_b}^2, m_{W^-}^2 \right) \right) \Gamma_{\tilde{\nu}_j, W^+, e_b}^{R*} m_{e_b} \Gamma_{\tilde{\nu}_i, W^+, e_b}^L \quad (281)
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) = & -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_{h_a}^2) \Gamma_{\tilde{\nu}_j, h_a, \nu_b}^{R*} \Gamma_{\tilde{\nu}_i, h_a, \nu_b}^R \\
& - \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{e_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{\nu}_j, H_a^+, e_b}^{R*} \Gamma_{\tilde{\nu}_i, H_a^+, e_b}^R \\
& - \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^4 B_1(p^2, m_{\nu_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j, \nu_a, A_b^0}^{R*} \Gamma_{\tilde{\nu}_i, \nu_a, A_b^0}^R \\
& - \sum_{a=1}^5 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\nu}_j, \tilde{\nu}_a^*, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{\nu}_i, \tilde{\nu}_a^*, \tilde{\chi}_b^0}^R \\
& - \sum_{a=1}^{12} \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{e}_a^-}^2) \Gamma_{\tilde{\nu}_j, \tilde{e}_a^*, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{\nu}_i, \tilde{e}_a^*, \tilde{\chi}_b^-}^R - \sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_Z^2) \Gamma_{\tilde{\nu}_j, Z, \nu_b}^{L*} \Gamma_{\tilde{\nu}_i, Z, \nu_b}^L \\
& - 2 \sum_{b=1}^6 B_1(p^2, m_{e_b}^2, m_{W^-}^2) \Gamma_{\tilde{\nu}_j, W^+, e_b}^{L*} \Gamma_{\tilde{\nu}_i, W^+, e_b}^L \tag{282}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) = & -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_{h_a}^2) \Gamma_{\tilde{\nu}_j, h_a, \nu_b}^{L*} \Gamma_{\tilde{\nu}_i, h_a, \nu_b}^L \\
& - \sum_{a=1}^4 \sum_{b=1}^6 B_1(p^2, m_{e_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{\nu}_j, H_a^+, e_b}^{L*} \Gamma_{\tilde{\nu}_i, H_a^+, e_b}^L \\
& - \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^4 B_1(p^2, m_{\nu_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{\nu}_j, \nu_a, A_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \nu_a, A_b^0}^L \\
& - \sum_{a=1}^5 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{\nu}_a}^2) \Gamma_{\tilde{\nu}_j, \tilde{\nu}_a^*, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{\nu}_i, \tilde{\nu}_a^*, \tilde{\chi}_b^0}^L \\
& - \sum_{a=1}^{12} \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{e}_a^-}^2) \Gamma_{\tilde{\nu}_j, \tilde{e}_a^*, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{\nu}_i, \tilde{e}_a^*, \tilde{\chi}_b^-}^L - \sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_Z^2) \Gamma_{\tilde{\nu}_j, Z, \nu_b}^{R*} \Gamma_{\tilde{\nu}_i, Z, \nu_b}^R \\
& - 2 \sum_{b=1}^6 B_1(p^2, m_{e_b}^2, m_{W^-}^2) \Gamma_{\tilde{\nu}_j, W^+, e_b}^{R*} \Gamma_{\tilde{\nu}_i, W^+, e_b}^R \tag{283}
\end{aligned}$$

• Self-Energy for Leptons ( $e$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^4 \sum_{b=1}^5 B_0(p^2, m_{\nu_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{L*} m_{\nu_b} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^6 B_0(p^2, m_{e_b}^2, m_{h_a}^2) \Gamma_{\tilde{e}_j, h_a, e_b}^{L*} m_{e_b} \Gamma_{\tilde{e}_i, h_a, e_b}^R
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^5 \sum_{b=1}^3 B_0 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{e}_j, \tilde{\nu}_a, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{e}_i, \tilde{\nu}_a, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^6 m_{e_a} \sum_{b=1}^4 B_0 \left( p^2, m_{e_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{L*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^R \\
& + \sum_{a=1}^{12} \sum_{b=1}^6 B_0 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^R \\
& - 4 \sum_{b=1}^5 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{\nu_b}^2, m_{W^-}^2 \right) \right) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{R*} m_{\nu_b} \Gamma_{\tilde{e}_i, W^-, \nu_b}^L \\
& - 4 \sum_{b=1}^6 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{e_b}^2, 0 \right) \right) \Gamma_{\tilde{e}_j, \gamma, e_b}^{R*} m_{e_b} \Gamma_{\tilde{e}_i, \gamma, e_b}^L - 4 \sum_{b=1}^6 \left( -\frac{1}{2} \text{rMS} + B_0 \left( p^2, m_{e_b}^2, m_Z^2 \right) \right) \Gamma_{\tilde{e}_j, Z, e_b}^{R*} m_{e_b} \Gamma_{\tilde{e}_i, Z, e_b}^L
\end{aligned} \tag{284}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) & = -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^5 B_1 \left( p^2, m_{\nu_b}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{R*} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, m_{h_a}^2 \right) \Gamma_{\tilde{e}_j, h_a, e_b}^{R*} \Gamma_{\tilde{e}_i, h_a, e_b}^R \\
& - \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{e}_j, \tilde{\nu}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{e}_i, \tilde{\nu}_a, \tilde{\chi}_b^-}^R \\
& - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1 \left( p^2, m_{e_a}^2, m_{A_b^0}^2 \right) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{R*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^{12} \sum_{b=1}^6 B_1 \left( p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2 \right) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^R \\
& - \sum_{b=1}^5 B_1 \left( p^2, m_{\nu_b}^2, m_{W^-}^2 \right) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{L*} \Gamma_{\tilde{e}_i, W^-, \nu_b}^L - \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, 0 \right) \Gamma_{\tilde{e}_j, \gamma, e_b}^{L*} \Gamma_{\tilde{e}_i, \gamma, e_b}^L \\
& - \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, m_Z^2 \right) \Gamma_{\tilde{e}_j, Z, e_b}^{L*} \Gamma_{\tilde{e}_i, Z, e_b}^L
\end{aligned} \tag{285}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) & = -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^5 B_1 \left( p^2, m_{\nu_b}^2, m_{H_a^-}^2 \right) \Gamma_{\tilde{e}_j, H_a^-, \nu_b}^{L*} \Gamma_{\tilde{e}_i, H_a^-, \nu_b}^L \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^6 B_1 \left( p^2, m_{e_b}^2, m_{h_a}^2 \right) \Gamma_{\tilde{e}_j, h_a, e_b}^{L*} \Gamma_{\tilde{e}_i, h_a, e_b}^L \\
& - \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^3 B_1 \left( p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{e}_j, \tilde{\nu}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{e}_i, \tilde{\nu}_a, \tilde{\chi}_b^-}^L
\end{aligned}$$

$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^4 B_1(p^2, m_{e_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{e}_j, e_a, A_b^0}^{L*} \Gamma_{\tilde{e}_i, e_a, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^{12} \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{e}_a}^2) \Gamma_{\tilde{e}_j, \tilde{e}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{e}_i, \tilde{e}_a, \tilde{\chi}_b^0}^L \\
& -\sum_{b=1}^5 B_1(p^2, m_{\nu_b}^2, m_{W^-}^2) \Gamma_{\tilde{e}_j, W^-, \nu_b}^{R*} \Gamma_{\tilde{e}_i, W^-, \nu_b}^R - \sum_{b=1}^6 B_1(p^2, m_{e_b}^2, 0) \Gamma_{\tilde{e}_j, \gamma, e_b}^{R*} \Gamma_{\tilde{e}_i, \gamma, e_b}^R \\
& -\sum_{b=1}^6 B_1(p^2, m_{e_b}^2, m_Z^2) \Gamma_{\tilde{e}_j, Z, e_b}^{R*} \Gamma_{\tilde{e}_i, Z, e_b}^R
\end{aligned} \tag{286}$$

• Self-Energy for Down-Quarks (d)

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^3 m_{d_a} \sum_{b=1}^4 B_0(p^2, m_{d_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j, d_a, A_b^0}^{L*} \Gamma_{\tilde{d}_i, d_a, A_b^0}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{h_a}^2) \Gamma_{\tilde{d}_j, h_a, d_b}^{L*} m_{d_b} \Gamma_{\tilde{d}_i, h_a, d_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{L*} m_{u_b} \Gamma_{\tilde{d}_i, H_a^-, u_b}^R \\
& + \frac{4}{3} \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{g}_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_b}^{L*} m_{\tilde{g}_b} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_b}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\chi}_b^-}^{L*} m_{\tilde{\chi}_b^-} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\chi}_b^-}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^R \\
& - \frac{16}{3} \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, 0) \right) \Gamma_{\tilde{d}_j, g, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, g, d_b}^L - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, 0) \right) \Gamma_{\tilde{d}_j, \gamma, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, \gamma, d_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, m_{W^-}^2) \right) \Gamma_{\tilde{d}_j, W^-, u_b}^{R*} m_{u_b} \Gamma_{\tilde{d}_i, W^-, u_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{d_b}^2, m_Z^2) \right) \Gamma_{\tilde{d}_j, Z, d_b}^{R*} m_{d_b} \Gamma_{\tilde{d}_i, Z, d_b}^L
\end{aligned} \tag{287}$$

$$\Sigma_{i,j}^R(p^2) = -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{d_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j, d_a, A_b^0}^{R*} \Gamma_{\tilde{d}_i, d_a, A_b^0}^R$$



$$\begin{aligned}
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{h_a}^2) \Gamma_{\tilde{d}_j, h_a, d_b}^{R*} \Gamma_{\tilde{d}_i, h_a, d_b}^R \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{R*} \Gamma_{\tilde{d}_i, H_a^-, u_b}^R \\
& -\frac{2}{3} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_b}^{R*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_b}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\chi}_b^-}^{R*} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\chi}_b^-}^R \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^R - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, g, d_b}^{L*} \Gamma_{\tilde{d}_i, g, d_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, \gamma, d_b}^{L*} \Gamma_{\tilde{d}_i, \gamma, d_b}^L - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{W^-}^2) \Gamma_{\tilde{d}_j, W^-, u_b}^{L*} \Gamma_{\tilde{d}_i, W^-, u_b}^L \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_Z^2) \Gamma_{\tilde{d}_j, Z, d_b}^{L*} \Gamma_{\tilde{d}_i, Z, d_b}^L \tag{288}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{d_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{d}_j, d_a, A_b^0}^{L*} \Gamma_{\tilde{d}_i, d_a, A_b^0}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{h_a}^2) \Gamma_{\tilde{d}_j, h_a, d_b}^{L*} \Gamma_{\tilde{d}_i, h_a, d_b}^L \\
& -\frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{d}_j, H_a^-, u_b}^{L*} \Gamma_{\tilde{d}_i, H_a^-, u_b}^L \\
& -\frac{2}{3} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{g}_b}^{L*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{g}_b}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{\tilde{\chi}_b^-}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{d}_j, \tilde{u}_a, \tilde{\chi}_b^-}^{L*} \Gamma_{\tilde{d}_i, \tilde{u}_a, \tilde{\chi}_b^-}^L \\
& -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{d}_j, \tilde{d}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{d}_i, \tilde{d}_a, \tilde{\chi}_b^0}^L - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, g, d_b}^{R*} \Gamma_{\tilde{d}_i, g, d_b}^R \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, 0) \Gamma_{\tilde{d}_j, \gamma, d_b}^{R*} \Gamma_{\tilde{d}_i, \gamma, d_b}^R - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{W^-}^2) \Gamma_{\tilde{d}_j, W^-, u_b}^{R*} \Gamma_{\tilde{d}_i, W^-, u_b}^R \\
& -\sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_Z^2) \Gamma_{\tilde{d}_j, Z, d_b}^{R*} \Gamma_{\tilde{d}_i, Z, d_b}^R \tag{289}
\end{aligned}$$

• Self-Energy for Up-Quarks ( $u$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) = & + \sum_{a=1}^3 m_{u_a} \sum_{b=1}^4 B_0(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j, u_a, A_b^0}^{L*} \Gamma_{\tilde{u}_i, u_a, A_b^0}^R \\
& + \sum_{a=1}^3 m_{\tilde{\chi}_a^-} \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^+, \tilde{d}_b}^{L*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^+, \tilde{d}_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{\tilde{d}_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{u}_j, H_a^+, \tilde{d}_b}^{L*} m_{\tilde{d}_b} \Gamma_{\tilde{u}_i, H_a^+, \tilde{d}_b}^R \\
& + \sum_{a=1}^4 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\tilde{u}_j, h_a, u_b}^{L*} m_{u_b} \Gamma_{\tilde{u}_i, h_a, u_b}^R \\
& + \frac{4}{3} \sum_{a=1}^6 \sum_{b=1}^2 B_0(p^2, m_{\tilde{g}_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_b}^{L*} m_{\tilde{g}_b} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_b}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^6 B_0(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{L*} m_{\tilde{\chi}_b^0} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^R \\
& - \frac{16}{3} \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, 0) \right) \Gamma_{\tilde{u}_j, g, u_b}^{R*} m_{u_b} \Gamma_{\tilde{u}_i, g, u_b}^L - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, 0) \right) \Gamma_{\tilde{u}_j, \gamma, u_b}^{R*} m_{u_b} \Gamma_{\tilde{u}_i, \gamma, u_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{u_b}^2, m_Z^2) \right) \Gamma_{\tilde{u}_j, Z, u_b}^{R*} m_{u_b} \Gamma_{\tilde{u}_i, Z, u_b}^L \\
& - 4 \sum_{b=1}^3 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{d}_b}^2, m_{W^-}^2) \right) \Gamma_{\tilde{u}_j, W^+, \tilde{d}_b}^{R*} m_{\tilde{d}_b} \Gamma_{\tilde{u}_i, W^+, \tilde{d}_b}^L \tag{290}
\end{aligned}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) = & -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j, u_a, A_b^0}^{R*} \Gamma_{\tilde{u}_i, u_a, A_b^0}^R \\
& - \frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{d}_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^+, \tilde{d}_b}^{R*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^+, \tilde{d}_b}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{\tilde{d}_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{u}_j, H_a^+, \tilde{d}_b}^{R*} \Gamma_{\tilde{u}_i, H_a^+, \tilde{d}_b}^R \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\tilde{u}_j, h_a, u_b}^{R*} \Gamma_{\tilde{u}_i, h_a, u_b}^R \\
& - \frac{2}{3} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_b}^{R*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_b}^R \\
& - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{R*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^R - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, g, u_b}^{L*} \Gamma_{\tilde{u}_i, g, u_b}^L
\end{aligned}$$

$$\begin{aligned}
& - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, \gamma, u_b}^{L*} \Gamma_{\tilde{u}_i, \gamma, u_b}^L - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_Z^2) \Gamma_{\tilde{u}_j, Z, u_b}^{L*} \Gamma_{\tilde{u}_i, Z, u_b}^L \\
& - \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{W^-}^2) \Gamma_{\tilde{u}_j, W^+, d_b}^{L*} \Gamma_{\tilde{u}_i, W^+, d_b}^L
\end{aligned} \tag{291}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^4 B_1(p^2, m_{u_a}^2, m_{A_b^0}^2) \Gamma_{\tilde{u}_j, u_a, A_b^0}^{L*} \Gamma_{\tilde{u}_i, u_a, A_b^0}^L \\
& - \frac{1}{2} \sum_{a=1}^3 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_a^-}^2, m_{d_b}^2) \Gamma_{\tilde{u}_j, \tilde{\chi}_a^+, \tilde{d}_b}^{L*} \Gamma_{\tilde{u}_i, \tilde{\chi}_a^+, \tilde{d}_b}^L \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{H_a^-}^2) \Gamma_{\tilde{u}_j, H_a^+, d_b}^{L*} \Gamma_{\tilde{u}_i, H_a^+, d_b}^L \\
& - \frac{1}{2} \sum_{a=1}^4 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{h_a}^2) \Gamma_{\tilde{u}_j, h_a, u_b}^{L*} \Gamma_{\tilde{u}_i, h_a, u_b}^L \\
& - \frac{2}{3} \sum_{a=1}^6 \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{g}_b}^{L*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{g}_b}^L \\
& - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 B_1(p^2, m_{\tilde{\chi}_b^0}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{u}_j, \tilde{u}_a, \tilde{\chi}_b^0}^{L*} \Gamma_{\tilde{u}_i, \tilde{u}_a, \tilde{\chi}_b^0}^L - \frac{4}{3} \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, g, u_b}^{R*} \Gamma_{\tilde{u}_i, g, u_b}^R \\
& - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, 0) \Gamma_{\tilde{u}_j, \gamma, u_b}^{R*} \Gamma_{\tilde{u}_i, \gamma, u_b}^R - \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_Z^2) \Gamma_{\tilde{u}_j, Z, u_b}^{R*} \Gamma_{\tilde{u}_i, Z, u_b}^R \\
& - \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{W^-}^2) \Gamma_{\tilde{u}_j, W^+, d_b}^{R*} \Gamma_{\tilde{u}_i, W^+, d_b}^R
\end{aligned} \tag{292}$$

• **Self-Energy for Gluino** ( $\tilde{g}$ )

$$\begin{aligned}
\Sigma_{i,j}^S(p^2) &= + \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{g}_j, \tilde{d}_a^*, d_b}^{L*} m_{d_b} \Gamma_{\tilde{g}_i, \tilde{d}_a^*, d_b}^R \\
& + \sum_{a=1}^6 \sum_{b=1}^3 B_0(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{L*} m_{u_b} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^R \\
& + 3 \sum_{b=1}^2 B_0(p^2, m_{\tilde{g}_b}^2, m_{\phi_o}^2) \Gamma_{\tilde{g}_j, \phi_o, \tilde{g}_b}^{L*} m_{\tilde{g}_b} \Gamma_{\tilde{g}_i, \phi_o, \tilde{g}_b}^R + 3 \sum_{b=1}^2 B_0(p^2, m_{\tilde{g}_b}^2, m_{\sigma_o}^2) \Gamma_{\tilde{g}_j, \sigma_o, \tilde{g}_b}^{L*} m_{\tilde{g}_b} \Gamma_{\tilde{g}_i, \sigma_o, \tilde{g}_b}^R \\
& - 12 \sum_{b=1}^2 \left( -\frac{1}{2} \text{rMS} + B_0(p^2, m_{\tilde{g}_b}^2, 0) \right) \Gamma_{\tilde{g}_j, g, \tilde{g}_b}^{R*} m_{\tilde{g}_b} \Gamma_{\tilde{g}_i, g, \tilde{g}_b}^L
\end{aligned} \tag{293}$$

$$\begin{aligned}
\Sigma_{i,j}^R(p^2) &= -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{g}_j, \tilde{d}_a^*, d_b}^{R*} \Gamma_{\tilde{g}_i, \tilde{d}_a^*, d_b}^R \\
&\quad - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{R*} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^R - \frac{3}{2} \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\phi_o}^2) \Gamma_{\tilde{g}_j, \phi_o, \tilde{g}_b}^{R*} \Gamma_{\tilde{g}_i, \phi_o, \tilde{g}_b}^R \\
&\quad - \frac{3}{2} \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\sigma_o}^2) \Gamma_{\tilde{g}_j, \sigma_o, \tilde{g}_b}^{R*} \Gamma_{\tilde{g}_i, \sigma_o, \tilde{g}_b}^R - 3 \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, 0) \Gamma_{\tilde{g}_j, g, \tilde{g}_b}^{L*} \Gamma_{\tilde{g}_i, g, \tilde{g}_b}^L
\end{aligned} \tag{294}$$

$$\begin{aligned}
\Sigma_{i,j}^L(p^2) &= -\frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{d_b}^2, m_{\tilde{d}_a}^2) \Gamma_{\tilde{g}_j, \tilde{d}_a^*, d_b}^{L*} \Gamma_{\tilde{g}_i, \tilde{d}_a^*, d_b}^L \\
&\quad - \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^3 B_1(p^2, m_{u_b}^2, m_{\tilde{u}_a}^2) \Gamma_{\tilde{g}_j, \tilde{u}_a^*, u_b}^{L*} \Gamma_{\tilde{g}_i, \tilde{u}_a^*, u_b}^L - \frac{3}{2} \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\phi_o}^2) \Gamma_{\tilde{g}_j, \phi_o, \tilde{g}_b}^{L*} \Gamma_{\tilde{g}_i, \phi_o, \tilde{g}_b}^L \\
&\quad - \frac{3}{2} \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, m_{\sigma_o}^2) \Gamma_{\tilde{g}_j, \sigma_o, \tilde{g}_b}^{L*} \Gamma_{\tilde{g}_i, \sigma_o, \tilde{g}_b}^L - 3 \sum_{b=1}^2 B_1(p^2, m_{\tilde{g}_b}^2, 0) \Gamma_{\tilde{g}_j, g, \tilde{g}_b}^{R*} \Gamma_{\tilde{g}_i, g, \tilde{g}_b}^R
\end{aligned} \tag{295}$$

• **Self-Energy for sigmaO** ( $\sigma_o$ )

$$\begin{aligned}
\Pi(p^2) &= -\frac{1}{2} C A_0 (m_{\phi_o}^2) \Gamma_{\sigma_o, \sigma_o, \phi_o, \phi_o} + 3 |\Gamma_{\sigma_o, g, \sigma_o}|^2 F_0(p^2, m_{\sigma_o}^2, 0) \\
&\quad + \frac{3}{2} \sum_{a=1}^2 \sum_{b=1}^2 \left( |\Gamma_{\sigma_o, \tilde{g}_a, \tilde{g}_b}^L|^2 + |\Gamma_{\sigma_o, \tilde{g}_a, \tilde{g}_b}^R|^2 \right) G_0(p^2, m_{\tilde{g}_a}^2, m_{\tilde{g}_b}^2) \\
&\quad - 3 \sum_{a=1}^2 m_{\tilde{g}_a} \sum_{b=1}^2 B_0(p^2, m_{\tilde{g}_a}^2, m_{\tilde{g}_b}^2) m_{\tilde{g}_b} \left( \Gamma_{\sigma_o, \tilde{g}_a, \tilde{g}_b}^{L*} \Gamma_{\sigma_o, \tilde{g}_a, \tilde{g}_b}^R + \Gamma_{\sigma_o, \tilde{g}_a, \tilde{g}_b}^{R*} \Gamma_{\sigma_o, \tilde{g}_a, \tilde{g}_b}^L \right) \\
&\quad + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{\sigma_o, \tilde{d}_a^*, \tilde{d}_b}|^2 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{\sigma_o, \tilde{u}_a^*, \tilde{u}_b}|^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2)
\end{aligned} \tag{296}$$

• **Self-Energy for phiO** ( $\phi_o$ )

$$\begin{aligned}
\Pi(p^2) &= -\frac{1}{2} C A_0 (m_{\sigma_o}^2) \Gamma_{\phi_o, \phi_o, \sigma_o, \sigma_o} + 3 |\Gamma_{\phi_o, g, \phi_o}|^2 F_0(p^2, m_{\phi_o}^2, 0) \\
&\quad + \frac{3}{2} \sum_{a=1}^2 \sum_{b=1}^2 \left( |\Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_b}^L|^2 + |\Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_b}^R|^2 \right) G_0(p^2, m_{\tilde{g}_a}^2, m_{\tilde{g}_b}^2) \\
&\quad - 3 \sum_{a=1}^2 m_{\tilde{g}_a} \sum_{b=1}^2 B_0(p^2, m_{\tilde{g}_a}^2, m_{\tilde{g}_b}^2) m_{\tilde{g}_b} \left( \Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_b}^{L*} \Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_b}^R + \Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_b}^{R*} \Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_b}^L \right) \\
&\quad + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{\phi_o, \tilde{d}_a^*, \tilde{d}_b}|^2 B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{\phi_o, \tilde{u}_a^*, \tilde{u}_b}|^2 B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2)
\end{aligned} \tag{297}$$

• **Self-Energy for Z-Boson** ( $Z$ )

$$\begin{aligned}
\Pi(p^2) = & + |\Gamma_{Z,\eta^-, \eta^-}|^2 B_{00}(p^2, m_{\eta^-}^2, m_{\eta^-}^2) + |\Gamma_{Z,\eta^+, \eta^+}|^2 B_{00}(p^2, m_{\eta^+}^2, m_{\eta^+}^2) \\
& - |\Gamma_{Z,W^+, W^-}|^2 \left( 10B_{00}(p^2, m_{W^-}^2, m_{W^-}^2) + 2A_0(m_{W^-}^2) - 2\text{rMS}(2m_{W^-}^2 - \frac{1}{3}p^2) + B_0(p^2, m_{W^-}^2, m_{W^-}^2) (2m_{W^-}^2 + 4p^2) \right) \\
& + \sum_{a=1}^3 \sum_{b=1}^3 \left[ (|\Gamma_{Z,\tilde{\chi}_a^+, \tilde{\chi}_b^-}^L|^2 + |\Gamma_{Z,\tilde{\chi}_a^+, \tilde{\chi}_b^-}^R|^2) H_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) \right. \\
& \left. + 4B_0(p^2, m_{\tilde{\chi}_a^-}^2, m_{\tilde{\chi}_b^-}^2) m_{\tilde{\chi}_a^-} m_{\tilde{\chi}_b^-} \Re(\Gamma_{Z,\tilde{\chi}_a^+, \tilde{\chi}_b^-}^{L*} \Gamma_{Z,\tilde{\chi}_a^+, \tilde{\chi}_b^-}^R) \right] \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ (|\Gamma_{Z,\tilde{d}_a, d_b}^L|^2 + |\Gamma_{Z,\tilde{d}_a, d_b}^R|^2) H_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) \right. \\
& \left. + 4B_0(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) m_{\tilde{d}_a} m_{\tilde{d}_b} \Re(\Gamma_{Z,\tilde{d}_a, d_b}^{L*} \Gamma_{Z,\tilde{d}_a, d_b}^R) \right] \\
& + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ (|\Gamma_{Z,\tilde{u}_a, u_b}^L|^2 + |\Gamma_{Z,\tilde{u}_a, u_b}^R|^2) H_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) \right. \\
& \left. + 4B_0(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) m_{\tilde{u}_a} m_{\tilde{u}_b} \Re(\Gamma_{Z,\tilde{u}_a, u_b}^{L*} \Gamma_{Z,\tilde{u}_a, u_b}^R) \right] \\
& + \frac{1}{2} \sum_{a=1}^4 A_0(m_{A_a^0}^2) \Gamma_{Z,Z,A_a^0, A_a^0} + \sum_{a=1}^4 A_0(m_{H_a^-}^2) \Gamma_{Z,Z,H_a^+, H_a^-} + \frac{1}{2} \sum_{a=1}^4 A_0(m_{h_a}^2) \Gamma_{Z,Z,h_a, h_a} \\
& - 4 \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{Z,h_a, A_b^0}|^2 B_{00}(p^2, m_{A_b^0}^2, m_{h_a}^2) - 4 \sum_{a=1}^4 \sum_{b=1}^4 |\Gamma_{Z,H_a^+, H_b^-}|^2 B_{00}(p^2, m_{H_a^-}^2, m_{H_b^-}^2) \\
& + \sum_{a=1}^5 A_0(m_{\tilde{\nu}_a}^2) \Gamma_{Z,Z,\tilde{\nu}_a^*, \tilde{\nu}_a} - 4 \sum_{a=1}^5 \sum_{b=1}^5 |\Gamma_{Z,\tilde{\nu}_a^*, \tilde{\nu}_b}|^2 B_{00}(p^2, m_{\tilde{\nu}_a}^2, m_{\tilde{\nu}_b}^2) \\
& + \frac{1}{2} \sum_{a=1}^5 \sum_{b=1}^5 \left[ (|\Gamma_{Z,\nu_a, \nu_b}^L|^2 + |\Gamma_{Z,\nu_a, \nu_b}^R|^2) H_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) \right. \\
& \left. + 4B_0(p^2, m_{\nu_a}^2, m_{\nu_b}^2) m_{\nu_a} m_{\nu_b} \Re(\Gamma_{Z,\nu_a, \nu_b}^{L*} \Gamma_{Z,\nu_a, \nu_b}^R) \right] \\
& + 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{Z,Z,\tilde{d}_a^*, \tilde{d}_a} + 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{Z,Z,\tilde{u}_a^*, \tilde{u}_a} \\
& - 12 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{Z,\tilde{d}_a^*, \tilde{d}_b}|^2 B_{00}(p^2, m_{\tilde{d}_a}^2, m_{\tilde{d}_b}^2) - 12 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{Z,\tilde{u}_a^*, \tilde{u}_b}|^2 B_{00}(p^2, m_{\tilde{u}_a}^2, m_{\tilde{u}_b}^2) \\
& + \sum_{a=1}^6 \sum_{b=1}^6 \left[ (|\Gamma_{Z,\tilde{e}_a, e_b}^L|^2 + |\Gamma_{Z,\tilde{e}_a, e_b}^R|^2) H_0(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2) \right. \\
& \left. + 4B_0(p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2) m_{\tilde{e}_a} m_{\tilde{e}_b} \Re(\Gamma_{Z,\tilde{e}_a, e_b}^{L*} \Gamma_{Z,\tilde{e}_a, e_b}^R) \right]
\end{aligned}$$

$$\begin{aligned}
& + \frac{1}{2} \sum_{a=1}^6 \sum_{b=1}^6 \left[ \left( |\Gamma_{Z, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^L|^2 + |\Gamma_{Z, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R|^2 \right) H_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2 \right) \right. \\
& + 4B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^0}^2 \right) m_{\tilde{\chi}_a^0} m_{\tilde{\chi}_b^0} \Re \left( \Gamma_{Z, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^{L*} \Gamma_{Z, \tilde{\chi}_a^0, \tilde{\chi}_b^0}^R \right) \left. \right] \\
& + \sum_{a=1}^{12} A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{Z, Z, \tilde{e}_a^*, \tilde{e}_a} - 4 \sum_{a=1}^{12} \sum_{b=1}^{12} |\Gamma_{Z, \tilde{e}_a^*, \tilde{e}_b}|^2 B_{00} \left( p^2, m_{\tilde{e}_a}^2, m_{\tilde{e}_b}^2 \right) \\
& + 2 \sum_{b=1}^4 |\Gamma_{Z, W^+, H_b^-}|^2 B_0 \left( p^2, m_{W^-}^2, m_{H_b^-}^2 \right) + \sum_{b=1}^4 |\Gamma_{Z, Z, h_b}|^2 B_0 \left( p^2, m_Z^2, m_{h_b}^2 \right) + 2\text{rMS} m_{W^-}^2 \Gamma_{Z, Z, W^+, W^-}^1 \\
& - A_0 \left( m_{W^-}^2 \right) \left( 4\Gamma_{Z, Z, W^+, W^-}^1 + \Gamma_{Z, Z, W^+, W^-}^2 + \Gamma_{Z, Z, W^+, W^-}^3 \right) \tag{298}
\end{aligned}$$

• **Self-Energy for W-Boson ( $W^-$ )**

$$\begin{aligned}
\Pi(p^2) = & -12 \sum_{a=1}^6 \sum_{b=1}^6 |\Gamma_{W^+, \tilde{u}_a^*, \tilde{d}_b}|^2 B_{00} \left( p^2, m_{\tilde{d}_b}^2, m_{\tilde{u}_a}^2 \right) + 2\text{rMS} m_{W^-}^2 \Gamma_{W^-, W^+, W^+, W^-}^1 + 3 \sum_{a=1}^3 \sum_{b=1}^3 \left[ \left( |\Gamma_{W^+, \tilde{u}_a, \tilde{d}_b}^L|^2 + |\Gamma_{W^+, \tilde{u}_a, \tilde{d}_b}^R|^2 \right) \right. \\
& + 4B_0 \left( p^2, m_{\tilde{u}_a}^2, m_{\tilde{d}_b}^2 \right) m_{\tilde{d}_b} m_{\tilde{u}_a} \Re \left( \Gamma_{W^+, \tilde{u}_a, \tilde{d}_b}^{L*} \Gamma_{W^+, \tilde{u}_a, \tilde{d}_b}^R \right) \left. \right] + 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{d}_a}^2 \right) \Gamma_{W^-, W^+, \tilde{d}_a^*, \tilde{d}_a} + 3 \sum_{a=1}^6 A_0 \left( m_{\tilde{u}_a}^2 \right) \Gamma_{W^-, W^+, \tilde{u}_a^*, \tilde{u}_a} \\
& + 4B_0 \left( p^2, m_{\nu_a}^2, m_{e_b}^2 \right) m_{e_b} m_{\nu_a} \Re \left( \Gamma_{W^+, \nu_a, e_b}^{L*} \Gamma_{W^+, \nu_a, e_b}^R \right) + \sum_{a=1}^6 \sum_{b=1}^3 \left[ \left( |\Gamma_{W^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}|^2 + |\Gamma_{W^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^R|^2 \right) H_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^-}^2 \right) \right. \\
& + 4B_0 \left( p^2, m_{\tilde{\chi}_a^0}^2, m_{\tilde{\chi}_b^-}^2 \right) m_{\tilde{\chi}_b^-} m_{\tilde{\chi}_a^0} \Re \left( \Gamma_{W^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^{L*} \Gamma_{W^+, \tilde{\chi}_a^0, \tilde{\chi}_b^-}^R \right) \left. \right] + \sum_{a=1}^{12} A_0 \left( m_{\tilde{e}_a}^2 \right) \Gamma_{W^-, W^+, \tilde{e}_a^*, \tilde{e}_a} + \sum_{b=1}^4 |\Gamma_{W^+, \gamma, H_b^-}|^2 B_0 \left( p^2, 0, m_{H_b^-}^2 \right) \tag{299}
\end{aligned}$$

## 8.2 Tadpoles

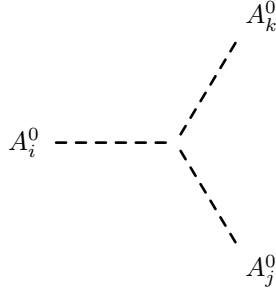
$$\begin{aligned}
\delta t_h^{(1)} = & + A_0 \left( m_{\eta^-}^2 \right) \Gamma_{\tilde{h}_i, \eta^-, \eta^-} + A_0 \left( m_{\eta^+}^2 \right) \Gamma_{\tilde{h}_i, \eta^+, \eta^+} + A_0 \left( m_{\eta^z}^2 \right) \Gamma_{\tilde{h}_i, \eta^z, \eta^z} \\
& + 4\Gamma_{\tilde{h}_i, W^+, W^-} \left( -\frac{1}{2} \text{rMS} m_{W^-}^2 + A_0 \left( m_{W^-}^2 \right) \right) + 2\Gamma_{\tilde{h}_i, Z, Z} \left( -\frac{1}{2} \text{rMS} m_Z^2 + A_0 \left( m_Z^2 \right) \right) \\
& + 2 \sum_{a=1}^3 A_0 \left( m_{\tilde{\chi}_a^-}^2 \right) m_{\tilde{\chi}_a^-} \left( \Gamma_{\tilde{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_a^-}^L + \Gamma_{\tilde{h}_i, \tilde{\chi}_a^+, \tilde{\chi}_a^-}^R \right) \\
& + 6 \sum_{a=1}^3 A_0 \left( m_{\tilde{d}_a}^2 \right) m_{\tilde{d}_a} \left( \Gamma_{\tilde{h}_i, \tilde{d}_a^+, \tilde{d}_a}^L + \Gamma_{\tilde{h}_i, \tilde{d}_a^+, \tilde{d}_a}^R \right) \\
& + 6 \sum_{a=1}^3 A_0 \left( m_{\tilde{u}_a}^2 \right) m_{\tilde{u}_a} \left( \Gamma_{\tilde{h}_i, \tilde{u}_a^+, \tilde{u}_a}^L + \Gamma_{\tilde{h}_i, \tilde{u}_a^+, \tilde{u}_a}^R \right) - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{A_a^0}^2 \right) \Gamma_{\tilde{h}_i, A_a^0, A_a^0} \\
& - \sum_{a=1}^4 A_0 \left( m_{H_a^-}^2 \right) \Gamma_{\tilde{h}_i, H_a^+, H_a^-} - \frac{1}{2} \sum_{a=1}^4 A_0 \left( m_{h_a}^2 \right) \Gamma_{\tilde{h}_i, h_a, h_a} - \sum_{a=1}^5 A_0 \left( m_{\tilde{\nu}_a}^2 \right) \Gamma_{\tilde{h}_i, \tilde{\nu}_a^*, \tilde{\nu}_a}
\end{aligned}$$

$$\begin{aligned}
& + \sum_{a=1}^5 A_0(m_{\nu_a}^2) m_{\nu_a} \left( \Gamma_{\tilde{h}_i, \nu_a, \nu_a}^L + \Gamma_{\tilde{h}_i, \nu_a, \nu_a}^R \right) - 3 \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\tilde{h}_i, \tilde{d}_a^*, \tilde{d}_a} \\
& - 3 \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\tilde{h}_i, \tilde{u}_a^*, \tilde{u}_a} + 2 \sum_{a=1}^6 A_0(m_{e_a}^2) m_{e_a} \left( \Gamma_{\tilde{h}_i, \bar{e}_a, e_a}^L + \Gamma_{\tilde{h}_i, \bar{e}_a, e_a}^R \right) \\
& + \sum_{a=1}^6 A_0(m_{\tilde{\chi}_a^0}^2) m_{\tilde{\chi}_a^0} \left( \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_a^0}^L + \Gamma_{\tilde{h}_i, \tilde{\chi}_a^0, \tilde{\chi}_a^0}^R \right) - \sum_{a=1}^{12} A_0(m_{\tilde{e}_a}^2) \Gamma_{\tilde{h}_i, \tilde{e}_a^*, \tilde{e}_a}
\end{aligned} \tag{300}$$

$$\begin{aligned}
\delta t_{\phi_o}^{(1)} & = + 3 \sum_{a=1}^2 A_0(m_{\tilde{g}_a}^2) m_{\tilde{g}_a} \left( \Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_a}^L + \Gamma_{\phi_o, \tilde{g}_a, \tilde{g}_a}^R \right) - \frac{1}{2} \sum_{a=1}^6 A_0(m_{\tilde{d}_a}^2) \Gamma_{\phi_o, \tilde{d}_a^*, \tilde{d}_a} \\
& - \frac{1}{2} \sum_{a=1}^6 A_0(m_{\tilde{u}_a}^2) \Gamma_{\phi_o, \tilde{u}_a^*, \tilde{u}_a}
\end{aligned} \tag{301}$$

## 9 Interactions for eigenstates 'EWSB'

### 9.1 Three Scalar-Interaction

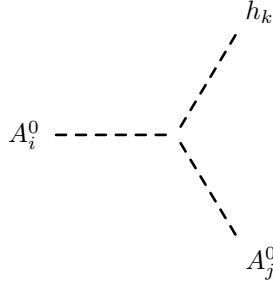


$$\begin{aligned}
& \frac{1}{8} \left( -4g_1 M_D^B Z_{i1}^A Z_{j3}^A Z_{k1}^A - 2\sqrt{2} v_T \lambda \Lambda_T^* Z_{i1}^A Z_{j3}^A Z_{k1}^A + 4g_1 M_D^{B,*} Z_{i1}^A Z_{j3}^A Z_{k1}^A \right. \\
& + 2\sqrt{2} \Lambda_T v_T \lambda^* Z_{i1}^A Z_{j3}^A Z_{k1}^A + 4\sqrt{2} \mu \lambda^* Z_{i1}^A Z_{j3}^A Z_{k1}^A - 4\sqrt{2} \lambda \mu^* Z_{i1}^A Z_{j3}^A Z_{k1}^A \\
& - \sqrt{2} \Lambda_T v_T \lambda_T^* Z_{i2}^A Z_{j3}^A Z_{k1}^A + \sqrt{2} \lambda_T v_T \Lambda_T^* Z_{i2}^A Z_{j3}^A Z_{k1}^A + 2\sqrt{2} \lambda M_S^* Z_{i2}^A Z_{j3}^A Z_{k1}^A \\
& - 2\sqrt{2} M_S \lambda^* Z_{i2}^A Z_{j3}^A Z_{k1}^A + 4g_2 M_D^W Z_{i1}^A Z_{j4}^A Z_{k1}^A + 2\sqrt{2} v_s \lambda \Lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k1}^A \\
& - 4\mu \Lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k1}^A - 4g_2 M_D^{W,*} Z_{i1}^A Z_{j4}^A Z_{k1}^A - 2\sqrt{2} \Lambda_T v_s \lambda^* Z_{i1}^A Z_{j4}^A Z_{k1}^A \\
& + 4\Lambda_T \mu^* Z_{i1}^A Z_{j4}^A Z_{k1}^A - \sqrt{2} \Lambda_T v_s \lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k1}^A + 2v_T \lambda \lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k1}^A \\
& + \sqrt{2} \lambda_T v_s \Lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k1}^A - 2\lambda_T v_T \lambda^* Z_{i2}^A Z_{j4}^A Z_{k1}^A - \sqrt{2} \Lambda_T v_T \lambda_T^* Z_{i1}^A Z_{j3}^A Z_{k2}^A \\
& + \sqrt{2} \lambda_T v_T \Lambda_T^* Z_{i1}^A Z_{j3}^A Z_{k2}^A + 2\sqrt{2} \lambda M_S^* Z_{i1}^A Z_{j3}^A Z_{k2}^A - 2\sqrt{2} M_S \lambda^* Z_{i1}^A Z_{j3}^A Z_{k2}^A \\
& + 4g_1 M_D^B Z_{i2}^A Z_{j3}^A Z_{k2}^A - 2\sqrt{2} v_T \lambda \Lambda_T^* Z_{i2}^A Z_{j3}^A Z_{k2}^A - 4g_1 M_D^{B,*} Z_{i2}^A Z_{j3}^A Z_{k2}^A \\
& \left. + 2\sqrt{2} \Lambda_T v_T \lambda^* Z_{i2}^A Z_{j3}^A Z_{k2}^A + 4\sqrt{2} \mu \lambda^* Z_{i2}^A Z_{j3}^A Z_{k2}^A - 4\sqrt{2} \lambda \mu^* Z_{i2}^A Z_{j3}^A Z_{k2}^A \right)
\end{aligned}$$

$$\begin{aligned}
& -\sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k2}^A + 2v_T \lambda \lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k2}^A + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k2}^A \\
& - 2\lambda_T v_T \lambda^* Z_{i1}^A Z_{j4}^A Z_{k2}^A - 4g_2 M_D^W Z_{i2}^A Z_{j4}^A Z_{k2}^A + 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k2}^A \\
& - 4\mu \Lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k2}^A + 4g_2 M_D^{W,*} Z_{i2}^A Z_{j4}^A Z_{k2}^A - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{i2}^A Z_{j4}^A Z_{k2}^A \\
& + 4\Lambda_T \mu^* Z_{i2}^A Z_{j4}^A Z_{k2}^A - 4g_1 M_D^B Z_{i1}^A Z_{j1}^A Z_{k3}^A - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{i1}^A Z_{j1}^A Z_{k3}^A \\
& + 4g_1 M_D^{B,*} Z_{i1}^A Z_{j1}^A Z_{k3}^A + 2\sqrt{2}\Lambda_T v_T \lambda^* Z_{i1}^A Z_{j1}^A Z_{k3}^A + 4\sqrt{2}\mu \lambda^* Z_{i1}^A Z_{j1}^A Z_{k3}^A \\
& - 4\sqrt{2}\lambda \mu^* Z_{i1}^A Z_{j1}^A Z_{k3}^A - \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{i2}^A Z_{j1}^A Z_{k3}^A + \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{i2}^A Z_{j1}^A Z_{k3}^A \\
& + 2\sqrt{2}\lambda M_S^* Z_{i2}^A Z_{j1}^A Z_{k3}^A - 2\sqrt{2}M_S \lambda^* Z_{i2}^A Z_{j1}^A Z_{k3}^A - \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{i1}^A Z_{j2}^A Z_{k3}^A \\
& + \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{i1}^A Z_{j2}^A Z_{k3}^A + 2\sqrt{2}\lambda M_S^* Z_{i1}^A Z_{j2}^A Z_{k3}^A - 2\sqrt{2}M_S \lambda^* Z_{i1}^A Z_{j2}^A Z_{k3}^A \\
& + 4g_1 M_D^B Z_{i2}^A Z_{j2}^A Z_{k3}^A - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{i2}^A Z_{j2}^A Z_{k3}^A - 4g_1 M_D^{B,*} Z_{i2}^A Z_{j2}^A Z_{k3}^A \\
& + 2\sqrt{2}\Lambda_T v_T \lambda^* Z_{i2}^A Z_{j2}^A Z_{k3}^A + 4\sqrt{2}\mu \lambda^* Z_{i2}^A Z_{j2}^A Z_{k3}^A - 4\sqrt{2}\lambda \mu^* Z_{i2}^A Z_{j2}^A Z_{k3}^A \\
& + \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k3}^A - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k3}^A + \sqrt{2}\Lambda_T v_d \lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k3}^A \\
& - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k3}^A + 4g_2 M_D^W Z_{i1}^A Z_{j1}^A Z_{k4}^A + 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{i1}^A Z_{j1}^A Z_{k4}^A \\
& - 4\mu \Lambda_T^* Z_{i1}^A Z_{j1}^A Z_{k4}^A - 4g_2 M_D^{W,*} Z_{i1}^A Z_{j1}^A Z_{k4}^A - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{i1}^A Z_{j1}^A Z_{k4}^A \\
& + 4\Lambda_T \mu^* Z_{i1}^A Z_{j1}^A Z_{k4}^A - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i2}^A Z_{j1}^A Z_{k4}^A + 2v_T \lambda \lambda_T^* Z_{i2}^A Z_{j1}^A Z_{k4}^A \\
& + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i2}^A Z_{j1}^A Z_{k4}^A - 2\lambda_T v_T \lambda^* Z_{i2}^A Z_{j1}^A Z_{k4}^A - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i1}^A Z_{j2}^A Z_{k4}^A \\
& + 2v_T \lambda \lambda_T^* Z_{i1}^A Z_{j2}^A Z_{k4}^A + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i1}^A Z_{j2}^A Z_{k4}^A - 2\lambda_T v_T \lambda^* Z_{i1}^A Z_{j2}^A Z_{k4}^A \\
& - 4g_2 M_D^W Z_{i2}^A Z_{j2}^A Z_{k4}^A + 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{i2}^A Z_{j2}^A Z_{k4}^A - 4\mu \Lambda_T^* Z_{i2}^A Z_{j2}^A Z_{k4}^A \\
& + 4g_2 M_D^{W,*} Z_{i2}^A Z_{j2}^A Z_{k4}^A - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{i2}^A Z_{j2}^A Z_{k4}^A + 4\Lambda_T \mu^* Z_{i2}^A Z_{j2}^A Z_{k4}^A \\
& + \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i1}^A Z_{j3}^A Z_{k4}^A - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i1}^A Z_{j3}^A Z_{k4}^A + \sqrt{2}\Lambda_T v_d \lambda_T^* Z_{i2}^A Z_{j3}^A Z_{k4}^A \\
& - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{i2}^A Z_{j3}^A Z_{k4}^A - 2v_u \lambda \lambda_T^* Z_{i1}^A Z_{j4}^A Z_{k4}^A + 2\lambda_T v_u \lambda^* Z_{i1}^A Z_{j4}^A Z_{k4}^A \\
& - 2v_d \lambda \lambda_T^* Z_{i2}^A Z_{j4}^A Z_{k4}^A + 2\lambda_T v_d \lambda^* Z_{i2}^A Z_{j4}^A Z_{k4}^A \\
& + Z_{i3}^A \left( \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j2}^A Z_{k1}^A + 2\sqrt{2}\lambda M_S^* Z_{j2}^A Z_{k1}^A - 2\sqrt{2}M_S \lambda^* Z_{j2}^A Z_{k1}^A \right. \\
& - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j4}^A Z_{k1}^A + 4g_1 M_D^B Z_{j2}^A Z_{k2}^A - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{j2}^A Z_{k2}^A - 4g_1 M_D^{B,*} Z_{j2}^A Z_{k2}^A \\
& + 2\sqrt{2}\Lambda_T v_T \lambda^* Z_{j2}^A Z_{k2}^A + 4\sqrt{2}\mu \lambda^* Z_{j2}^A Z_{k2}^A - 4\sqrt{2}\lambda \mu^* Z_{j2}^A Z_{k2}^A \\
& \left. - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j4}^A Z_{k2}^A - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j2}^A Z_{k4}^A + 2\sqrt{2}\lambda_T M_S^* Z_{j4}^A Z_{k4}^A \right) \\
& + \sqrt{2}\lambda_T^* \left( Z_{j2}^A \left( \Lambda_T v_d Z_{k4}^A - \Lambda_T v_T Z_{k1}^A \right) + Z_{j4}^A \left( -2M_S Z_{k4}^A + \Lambda_T v_d Z_{k2}^A + \Lambda_T v_u Z_{k1}^A \right) \right) \\
& + Z_{j1}^A \left( \left( 2\sqrt{2}\Lambda_T v_T \lambda^* - 2\sqrt{2}v_T \lambda \Lambda_T^* - 4g_1 M_D^B + 4g_1 M_D^{B,*} - 4\sqrt{2}\lambda \mu^* + 4\sqrt{2}\mu \lambda^* \right) Z_{k1}^A \right. \\
& \left. + \sqrt{2} \left( 2 \left( \lambda M_S^* - M_S \lambda^* \right) Z_{k2}^A + \lambda_T^* \left( -\Lambda_T v_T Z_{k2}^A + \Lambda_T v_u Z_{k4}^A \right) + \lambda_T \Lambda_T^* \left( v_T Z_{k2}^A - v_u Z_{k4}^A \right) \right) \right) \\
& + Z_{i4}^A \left( \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{j2}^A Z_{k1}^A - 2\lambda_T v_T \lambda^* Z_{j2}^A Z_{k1}^A - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j3}^A Z_{k1}^A \right. \\
& \left. + 2\lambda_T v_u \lambda^* Z_{j4}^A Z_{k1}^A - 4g_2 M_D^W Z_{j2}^A Z_{k2}^A + 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{j2}^A Z_{k2}^A - 4\mu \Lambda_T^* Z_{j2}^A Z_{k2}^A \right)
\end{aligned}$$

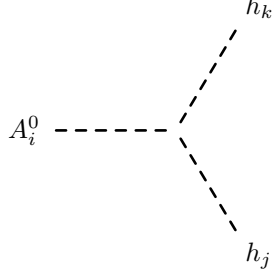


$$\begin{aligned}
& + 4g_2 M_D^{W,*} Z_{j_2}^A Z_{k_2}^A - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{j_2}^A Z_{k_2}^A + 4\Lambda_T \mu^* Z_{j_2}^A Z_{k_2}^A - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j_3}^A Z_{k_2}^A \\
& + 2\lambda_T v_d \lambda^* Z_{j_4}^A Z_{k_2}^A - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j_2}^A Z_{k_3}^A + 2\sqrt{2}\lambda_T M_S^* Z_{j_4}^A Z_{k_3}^A + 2\lambda_T v_d \lambda^* Z_{j_2}^A Z_{k_4}^A \\
& + 2\sqrt{2}\lambda_T M_S^* Z_{j_3}^A Z_{k_4}^A \\
& + \lambda_T^* \left( -2Z_{j_4}^A \left( \sqrt{2}M_S Z_{k_3}^A + v_d \lambda Z_{k_2}^A + v_u \lambda Z_{k_1}^A \right) + \sqrt{2}Z_{j_3}^A \left( -2M_S Z_{k_4}^A + \Lambda_T v_d Z_{k_2}^A + \Lambda_T v_u Z_{k_1}^A \right) \right) \\
& + Z_{j_2}^A \left( \left( 2v_T \lambda - \sqrt{2}\Lambda_T v_s \right) Z_{k_1}^A + v_d \left( -2\lambda Z_{k_4}^A + \sqrt{2}\Lambda_T Z_{k_3}^A \right) \right) \\
& + Z_{j_1}^A \left( 2 \left( -2g_2 M_D^{W,*} + 2g_2 M_D^W + 2\Lambda_T \mu^* + \left( -2\mu + \sqrt{2}v_s \lambda \right) \Lambda_T^* - \sqrt{2}\Lambda_T v_s \lambda^* \right) Z_{k_1}^A \right. \\
& + \lambda_T \left( 2\lambda^* \left( -v_T Z_{k_2}^A + v_u Z_{k_4}^A \right) + \sqrt{2}\Lambda_T^* \left( v_s Z_{k_2}^A - v_u Z_{k_3}^A \right) \right) \\
& \left. + \lambda_T^* \left( \left( 2v_T \lambda - \sqrt{2}\Lambda_T v_s \right) Z_{k_2}^A + v_u \left( -2\lambda Z_{k_4}^A + \sqrt{2}\Lambda_T Z_{k_3}^A \right) \right) \right) \tag{302}
\end{aligned}$$



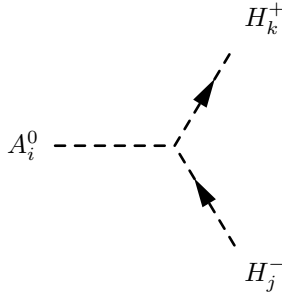
$$\begin{aligned}
& \frac{i}{8} \left( \sqrt{2}\Lambda_T v_T \lambda^* Z_{i_3}^A Z_{j_2}^A Z_{k_1}^H + \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{i_3}^A Z_{j_2}^A Z_{k_1}^H - 2\sqrt{2}\lambda M_S^* Z_{i_3}^A Z_{j_2}^A Z_{k_1}^H \right. \\
& - 2\sqrt{2}M_S \lambda^* Z_{i_3}^A Z_{j_2}^A Z_{k_1}^H + \sqrt{2}\Lambda_T v_s \lambda^* Z_{i_4}^A Z_{j_2}^A Z_{k_1}^H - 2v_T \lambda \lambda^* Z_{i_4}^A Z_{j_2}^A Z_{k_1}^H \\
& + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i_4}^A Z_{j_2}^A Z_{k_1}^H - 2\lambda_T v_T \lambda^* Z_{i_4}^A Z_{j_2}^A Z_{k_1}^H - 8v_d |\lambda|^2 Z_{i_3}^A Z_{j_3}^A Z_{k_1}^H \\
& - \sqrt{2}\Lambda_T v_u \lambda^* Z_{i_4}^A Z_{j_3}^A Z_{k_1}^H - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i_4}^A Z_{j_3}^A Z_{k_1}^H \\
& + 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{i_4}^A Z_{j_3}^A Z_{k_1}^H + 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{i_4}^A Z_{j_3}^A Z_{k_1}^H - \sqrt{2}\Lambda_T v_u \lambda^* Z_{i_3}^A Z_{j_4}^A Z_{k_1}^H \\
& - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i_3}^A Z_{j_4}^A Z_{k_1}^H + 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{i_3}^A Z_{j_4}^A Z_{k_1}^H + 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{i_3}^A Z_{j_4}^A Z_{k_1}^H \\
& - 4v_d |\Lambda_T|^2 Z_{i_4}^A Z_{j_4}^A Z_{k_1}^H + 2v_u \lambda \lambda^* Z_{i_4}^A Z_{j_4}^A Z_{k_1}^H + 2\lambda_T v_u \lambda^* Z_{i_4}^A Z_{j_4}^A Z_{k_1}^H \\
& + \sqrt{2}\Lambda_T v_T \lambda^* Z_{i_3}^A Z_{j_1}^A Z_{k_2}^H + \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{i_3}^A Z_{j_1}^A Z_{k_2}^H - 2\sqrt{2}\lambda M_S^* Z_{i_3}^A Z_{j_1}^A Z_{k_2}^H \\
& - 2\sqrt{2}M_S \lambda^* Z_{i_3}^A Z_{j_1}^A Z_{k_2}^H + \sqrt{2}\Lambda_T v_s \lambda^* Z_{i_4}^A Z_{j_1}^A Z_{k_2}^H - 2v_T \lambda \lambda^* Z_{i_4}^A Z_{j_1}^A Z_{k_2}^H \\
& + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i_4}^A Z_{j_1}^A Z_{k_2}^H - 2\lambda_T v_T \lambda^* Z_{i_4}^A Z_{j_1}^A Z_{k_2}^H - 8v_u |\lambda|^2 Z_{i_3}^A Z_{j_3}^A Z_{k_2}^H \\
& - \sqrt{2}\Lambda_T v_d \lambda^* Z_{i_4}^A Z_{j_3}^A Z_{k_2}^H - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{i_4}^A Z_{j_3}^A Z_{k_2}^H \\
& + 2\sqrt{2}v_u \lambda \Lambda_T^* Z_{i_4}^A Z_{j_3}^A Z_{k_2}^H + 2\sqrt{2}\Lambda_T v_u \lambda^* Z_{i_4}^A Z_{j_3}^A Z_{k_2}^H - \sqrt{2}\Lambda_T v_d \lambda^* Z_{i_3}^A Z_{j_4}^A Z_{k_2}^H \\
& - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{i_3}^A Z_{j_4}^A Z_{k_2}^H + 2\sqrt{2}v_u \lambda \Lambda_T^* Z_{i_3}^A Z_{j_4}^A Z_{k_2}^H + 2\sqrt{2}\Lambda_T v_u \lambda^* Z_{i_3}^A Z_{j_4}^A Z_{k_2}^H \\
& \left. - 4v_u |\Lambda_T|^2 Z_{i_4}^A Z_{j_4}^A Z_{k_2}^H + 2v_d \lambda \lambda^* Z_{i_4}^A Z_{j_4}^A Z_{k_2}^H + 2\lambda_T v_d \lambda^* Z_{i_4}^A Z_{j_4}^A Z_{k_2}^H \right)
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^H + \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^H + \sqrt{2}\Lambda_T v_d \lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^H \\
& + \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^H - 8v_s |\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k3}^H + 2\sqrt{2}M_S \lambda_T^* Z_{i4}^A Z_{j4}^A Z_{k3}^H \\
& + 2\sqrt{2}\lambda_T M_S^* Z_{i4}^A Z_{j4}^A Z_{k3}^H + \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^H + \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^H \\
& - 2v_u \lambda \lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k4}^H - 2\lambda_T v_u \lambda^* Z_{i4}^A Z_{j1}^A Z_{k4}^H + \sqrt{2}\Lambda_T v_d \lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^H \\
& + \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^H - 2v_d \lambda \lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k4}^H - 2\lambda_T v_d \lambda^* Z_{i4}^A Z_{j2}^A Z_{k4}^H \\
& - 8v_T |\lambda_T|^2 Z_{i3}^A Z_{j3}^A Z_{k4}^H - 2\sqrt{2}M_S \lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k4}^H - 2\sqrt{2}\lambda_T M_S^* Z_{i4}^A Z_{j3}^A Z_{k4}^H \\
& - 2\sqrt{2}M_S \lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k4}^H - 2\sqrt{2}\lambda_T M_S^* Z_{i3}^A Z_{j4}^A Z_{k4}^H - 4v_T |\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k4}^H \\
& + Z_{i2}^A \left( \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j3}^A Z_{k1}^H - 2\sqrt{2}\lambda M_S^* Z_{j3}^A Z_{k1}^H - 2\sqrt{2}M_S \lambda^* Z_{j3}^A Z_{k1}^H \right. \\
& + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{j4}^A Z_{k1}^H - 2\lambda_T v_T \lambda^* Z_{j4}^A Z_{k1}^H - \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j1}^A Z_{k3}^H \\
& + 2\sqrt{2}\lambda M_S^* Z_{j1}^A Z_{k3}^H + 2\sqrt{2}M_S \lambda^* Z_{j1}^A Z_{k3}^H + \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j4}^A Z_{k3}^H \\
& - \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{j1}^A Z_{k4}^H + 2\lambda_T v_T \lambda^* Z_{j1}^A Z_{k4}^H + \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j3}^A Z_{k4}^H \\
& \left. - 2\lambda_T v_d \lambda^* Z_{j4}^A Z_{k4}^H \right) \\
& + 2Z_{j2}^A \left( v_d \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k1}^H - \left( g_1^2 + g_2^2 \right) v_u Z_{k2}^H - 2g_1 M_D^B Z_{k3}^H - 4v_s |\lambda|^2 Z_{k3}^H \right. \\
& + \sqrt{2}v_T \lambda \Lambda_T^* Z_{k3}^H - 2g_1 M_D^{B,*} Z_{k3}^H + \sqrt{2}\Lambda_T v_T \lambda^* Z_{k3}^H + 2\sqrt{2}\mu \lambda^* Z_{k3}^H + 2\sqrt{2}\lambda \mu^* Z_{k3}^H \\
& + 2g_2 M_D^W Z_{k4}^H - 2v_T |\Lambda_T|^2 Z_{k4}^H + \sqrt{2}v_s \lambda \Lambda_T^* Z_{k4}^H - 2\mu \Lambda_T^* Z_{k4}^H + 2g_2 M_D^{W,*} Z_{k4}^H \\
& \left. + \sqrt{2}\Lambda_T v_s \lambda^* Z_{k4}^H - 2\Lambda_T \mu^* Z_{k4}^H \right) \\
& + \lambda_T^* \left( \sqrt{2}\Lambda_T Z_{j3}^A \left( v_d Z_{k4}^H + v_T Z_{k1}^H \right) - Z_{j1}^A \left( \left( -2v_T \lambda + \sqrt{2}\Lambda_T v_s \right) Z_{k4}^H + \sqrt{2}\Lambda_T v_T Z_{k3}^H \right) \right. \\
& \left. + Z_{j4}^A \left( \left( -2v_T \lambda + \sqrt{2}\Lambda_T v_s \right) Z_{k1}^H + v_d \left( -2\lambda Z_{k4}^H + \sqrt{2}\Lambda_T Z_{k3}^H \right) \right) \right) \\
& + Z_{i1}^A \left( \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j3}^A Z_{k2}^H - 2\sqrt{2}\lambda M_S^* Z_{j3}^A Z_{k2}^H - 2\sqrt{2}M_S \lambda^* Z_{j3}^A Z_{k2}^H \right. \\
& + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{j4}^A Z_{k2}^H - 2\lambda_T v_T \lambda^* Z_{j4}^A Z_{k2}^H - \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j2}^A Z_{k3}^H \\
& + 2\sqrt{2}\lambda M_S^* Z_{j2}^A Z_{k3}^H + 2\sqrt{2}M_S \lambda^* Z_{j2}^A Z_{k3}^H + \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j4}^A Z_{k3}^H \\
& - \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{j2}^A Z_{k4}^H + 2\lambda_T v_T \lambda^* Z_{j2}^A Z_{k4}^H + \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j3}^A Z_{k4}^H \\
& \left. - 2\lambda_T v_u \lambda^* Z_{j4}^A Z_{k4}^H \right) \\
& - 2Z_{j1}^A \left( \left( g_1^2 + g_2^2 \right) v_d Z_{k1}^H - v_u \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H - 2g_1 M_D^B Z_{k3}^H + 4v_s |\lambda|^2 Z_{k3}^H \right. \\
& - \sqrt{2}v_T \lambda \Lambda_T^* Z_{k3}^H - 2g_1 M_D^{B,*} Z_{k3}^H - \sqrt{2}\Lambda_T v_T \lambda^* Z_{k3}^H - 2\sqrt{2}\mu \lambda^* Z_{k3}^H - 2\sqrt{2}\lambda \mu^* Z_{k3}^H \\
& + 2g_2 M_D^W Z_{k4}^H + 2v_T |\Lambda_T|^2 Z_{k4}^H - \sqrt{2}v_s \lambda \Lambda_T^* Z_{k4}^H + 2\mu \Lambda_T^* Z_{k4}^H + 2g_2 M_D^{W,*} Z_{k4}^H \\
& \left. - \sqrt{2}\Lambda_T v_s \lambda^* Z_{k4}^H + 2\Lambda_T \mu^* Z_{k4}^H \right) \\
& + \lambda_T^* \left( \sqrt{2}\Lambda_T Z_{j3}^A \left( v_T Z_{k2}^H + v_u Z_{k4}^H \right) - Z_{j2}^A \left( \left( -2v_T \lambda + \sqrt{2}\Lambda_T v_s \right) Z_{k4}^H + \sqrt{2}\Lambda_T v_T Z_{k3}^H \right) \right. \\
& \left. + Z_{j4}^A \left( \left( -2v_T \lambda + \sqrt{2}\Lambda_T v_s \right) Z_{k2}^H + v_u \left( -2\lambda Z_{k4}^H + \sqrt{2}\Lambda_T Z_{k3}^H \right) \right) \right)
\end{aligned} \tag{303}$$



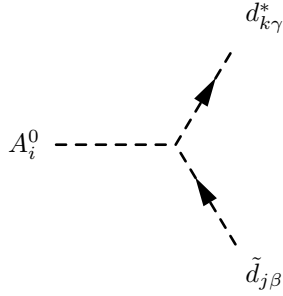
$$\begin{aligned}
& \frac{1}{8i} \left( -\sqrt{2}\Lambda_T v_T \lambda_T^* Z_{i2}^A Z_{j3}^H Z_{k1}^H + \sqrt{2}\Lambda_T v_T \Lambda_T^* Z_{i2}^A Z_{j3}^H Z_{k1}^H + 2\sqrt{2}\lambda M_S^* Z_{i2}^A Z_{j3}^H Z_{k1}^H \right. \\
& - 2\sqrt{2}M_S \lambda^* Z_{i2}^A Z_{j3}^H Z_{k1}^H - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i2}^A Z_{j4}^H Z_{k1}^H + 2v_T \lambda \lambda_T^* Z_{i2}^A Z_{j4}^H Z_{k1}^H \\
& + \sqrt{2}\Lambda_T v_s \Lambda_T^* Z_{i2}^A Z_{j4}^H Z_{k1}^H - 2\Lambda_T v_T \lambda^* Z_{i2}^A Z_{j4}^H Z_{k1}^H - \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{i1}^A Z_{j3}^H Z_{k2}^H \\
& + \sqrt{2}\Lambda_T v_T \Lambda_T^* Z_{i1}^A Z_{j3}^H Z_{k2}^H + 2\sqrt{2}\lambda M_S^* Z_{i1}^A Z_{j3}^H Z_{k2}^H - 2\sqrt{2}M_S \lambda^* Z_{i1}^A Z_{j3}^H Z_{k2}^H \\
& - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i1}^A Z_{j4}^H Z_{k2}^H + 2v_T \lambda \lambda_T^* Z_{i1}^A Z_{j4}^H Z_{k2}^H + \sqrt{2}\Lambda_T v_s \Lambda_T^* Z_{i1}^A Z_{j4}^H Z_{k2}^H \\
& - 2\Lambda_T v_T \lambda^* Z_{i1}^A Z_{j4}^H Z_{k2}^H - \sqrt{2}\Lambda_T v_T \Lambda_T^* Z_{i2}^A Z_{j1}^H Z_{k3}^H + \sqrt{2}\Lambda_T v_T \Lambda_T^* Z_{i2}^A Z_{j1}^H Z_{k3}^H \\
& + 2\sqrt{2}\lambda M_S^* Z_{i2}^A Z_{j1}^H Z_{k3}^H - 2\sqrt{2}M_S \lambda^* Z_{i2}^A Z_{j1}^H Z_{k3}^H - \sqrt{2}\Lambda_T v_T \Lambda_T^* Z_{i1}^A Z_{j2}^H Z_{k3}^H \\
& + \sqrt{2}\Lambda_T v_T \Lambda_T^* Z_{i1}^A Z_{j2}^H Z_{k3}^H + 2\sqrt{2}\lambda M_S^* Z_{i1}^A Z_{j2}^H Z_{k3}^H - 2\sqrt{2}M_S \lambda^* Z_{i1}^A Z_{j2}^H Z_{k3}^H \\
& - \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i1}^A Z_{j4}^H Z_{k3}^H + \sqrt{2}\Lambda_T v_u \Lambda_T^* Z_{i1}^A Z_{j4}^H Z_{k3}^H \\
& - \sqrt{2}\Lambda_T v_d \lambda_T^* Z_{i2}^A Z_{j4}^H Z_{k3}^H + \sqrt{2}\Lambda_T v_d \Lambda_T^* Z_{i2}^A Z_{j4}^H Z_{k3}^H \\
& - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i2}^A Z_{j1}^H Z_{k4}^H + 2v_T \lambda \lambda_T^* Z_{i2}^A Z_{j1}^H Z_{k4}^H + \sqrt{2}\Lambda_T v_s \Lambda_T^* Z_{i2}^A Z_{j1}^H Z_{k4}^H \\
& - 2\Lambda_T v_T \lambda^* Z_{i2}^A Z_{j1}^H Z_{k4}^H - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i1}^A Z_{j2}^H Z_{k4}^H + 2v_T \lambda \lambda_T^* Z_{i1}^A Z_{j2}^H Z_{k4}^H \\
& + \sqrt{2}\Lambda_T v_s \Lambda_T^* Z_{i1}^A Z_{j2}^H Z_{k4}^H - 2\Lambda_T v_T \lambda^* Z_{i1}^A Z_{j2}^H Z_{k4}^H - \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i1}^A Z_{j3}^H Z_{k4}^H \\
& + \sqrt{2}\Lambda_T v_u \Lambda_T^* Z_{i1}^A Z_{j3}^H Z_{k4}^H - \sqrt{2}\Lambda_T v_d \lambda_T^* Z_{i2}^A Z_{j3}^H Z_{k4}^H + \sqrt{2}\Lambda_T v_d \Lambda_T^* Z_{i2}^A Z_{j3}^H Z_{k4}^H \\
& + 2v_u \lambda \lambda_T^* Z_{i1}^A Z_{j4}^H Z_{k4}^H - 2\Lambda_T v_u \lambda^* Z_{i1}^A Z_{j4}^H Z_{k4}^H + 2v_d \lambda \lambda_T^* Z_{i2}^A Z_{j4}^H Z_{k4}^H \\
& - 2\Lambda_T v_d \lambda^* Z_{i2}^A Z_{j4}^H Z_{k4}^H \\
& + Z_{i4}^A \left( -\sqrt{2}\Lambda_T v_s \Lambda_T^* Z_{j2}^H Z_{k1}^H + 2\Lambda_T v_T \lambda^* Z_{j2}^H Z_{k1}^H - \sqrt{2}\Lambda_T v_u \Lambda_T^* Z_{j3}^H Z_{k1}^H \right. \\
& + 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{j3}^H Z_{k1}^H - 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{j3}^H Z_{k1}^H + 2\Lambda_T v_u \lambda^* Z_{j4}^H Z_{k1}^H - 4g_2 M_D^W Z_{j2}^H Z_{k2}^H \\
& + 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{j2}^H Z_{k2}^H - 4\mu \Lambda_T^* Z_{j2}^H Z_{k2}^H + 4g_2 M_D^{W,*} Z_{j2}^H Z_{k2}^H - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{j2}^H Z_{k2}^H \\
& + 4\Lambda_T \mu^* Z_{j2}^H Z_{k2}^H - \sqrt{2}\Lambda_T v_d \Lambda_T^* Z_{j3}^H Z_{k2}^H + 2\sqrt{2}v_u \lambda \Lambda_T^* Z_{j3}^H Z_{k2}^H \\
& - 2\sqrt{2}\Lambda_T v_u \lambda^* Z_{j3}^H Z_{k2}^H + 2\Lambda_T v_d \lambda^* Z_{j4}^H Z_{k2}^H - \sqrt{2}\Lambda_T v_d \Lambda_T^* Z_{j2}^H Z_{k3}^H \\
& + 2\sqrt{2}v_u \lambda \Lambda_T^* Z_{j2}^H Z_{k3}^H - 2\sqrt{2}\Lambda_T v_u \lambda^* Z_{j2}^H Z_{k3}^H + 2\sqrt{2}\Lambda_T M_S^* Z_{j4}^H Z_{k3}^H \\
& \left. + 2\Lambda_T v_d \lambda^* Z_{j2}^H Z_{k4}^H + 2\sqrt{2}\Lambda_T M_S^* Z_{j3}^H Z_{k4}^H \right)
\end{aligned}$$

$$\begin{aligned}
& + Z_{j1}^H \left( 2 \left( -2g_2 M_D^{W,*} + 2g_2 M_D^W + 2\Lambda_T \mu^* + \left( -2\mu + \sqrt{2}v_s \lambda \right) \Lambda_T^* - \sqrt{2}\Lambda_T v_s \lambda^* \right) Z_{k1}^H - \sqrt{2}\Lambda_T v_s \Lambda_T^* Z_{k2}^H \right. \\
& + 2\lambda_T v_T \lambda^* Z_{k2}^H - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{k3}^H + 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{k3}^H - 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{k3}^H \\
& + 2\lambda_T v_u \lambda^* Z_{k4}^H + \lambda_T^* \left( -2v_T \lambda Z_{k2}^H - 2v_u \lambda Z_{k4}^H + \sqrt{2}\Lambda_T v_s Z_{k2}^H + \sqrt{2}\Lambda_T v_u Z_{k3}^H \right) \left. \right) \\
& + \lambda_T^* \left( -2Z_{j4}^H \left( \sqrt{2}M_S Z_{k3}^H + v_d \lambda Z_{k2}^H + v_u \lambda Z_{k1}^H \right) + \sqrt{2}Z_{j3}^H \left( -2M_S Z_{k4}^H + \Lambda_T v_d Z_{k2}^H + \Lambda_T v_u Z_{k1}^H \right) \right. \\
& + Z_{j2}^H \left( \left( -2v_T \lambda + \sqrt{2}\Lambda_T v_s \right) Z_{k1}^H + v_d \left( -2\lambda Z_{k4}^H + \sqrt{2}\Lambda_T Z_{k3}^H \right) \right) \left. \right) \\
& + Z_{i3}^A \left( -\sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j2}^H Z_{k1}^H - 2\sqrt{2}\lambda M_S^* Z_{j2}^H Z_{k1}^H + 2\sqrt{2}M_S \lambda^* Z_{j2}^H Z_{k1}^H \right. \\
& - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j4}^H Z_{k1}^H - 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{j4}^H Z_{k1}^H + 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{j4}^H Z_{k1}^H \\
& + 4g_1 M_D^B Z_{j2}^H Z_{k2}^H - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{j2}^H Z_{k2}^H - 4g_1 M_D^{B,*} Z_{j2}^H Z_{k2}^H + 2\sqrt{2}\Lambda_T v_T \lambda^* Z_{j2}^H Z_{k2}^H \\
& + 4\sqrt{2}\mu \lambda^* Z_{j2}^H Z_{k2}^H - 4\sqrt{2}\lambda \mu^* Z_{j2}^H Z_{k2}^H - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j4}^H Z_{k2}^H \\
& - 2\sqrt{2}v_u \lambda \Lambda_T^* Z_{j4}^H Z_{k2}^H + 2\sqrt{2}\Lambda_T v_u \lambda^* Z_{j4}^H Z_{k2}^H - \sqrt{2}\lambda_T v_d \Lambda_T^* Z_{j2}^H Z_{k4}^H \\
& - 2\sqrt{2}v_u \lambda \Lambda_T^* Z_{j2}^H Z_{k4}^H + 2\sqrt{2}\Lambda_T v_u \lambda^* Z_{j2}^H Z_{k4}^H - 2\sqrt{2}\lambda_T M_S^* Z_{j4}^H Z_{k4}^H \\
& + \sqrt{2}\lambda_T^* \left( \Lambda_T Z_{j2}^H \left( v_d Z_{k4}^H + v_T Z_{k1}^H \right) + Z_{j4}^H \left( 2M_S Z_{k4}^H + \Lambda_T v_d Z_{k2}^H + \Lambda_T v_u Z_{k1}^H \right) \right) \\
& + Z_{j1}^H \left( \left( 2\sqrt{2}\Lambda_T v_T \lambda^* - 2\sqrt{2}v_T \lambda \Lambda_T^* - 4g_1 M_D^B + 4g_1 M_D^{B,*} - 4\sqrt{2}\lambda \mu^* + 4\sqrt{2}\mu \lambda^* \right) Z_{k1}^H \right. \\
& + \sqrt{2} \left( -2\lambda M_S^* Z_{k2}^H + 2M_S \lambda^* Z_{k2}^H + 2\Lambda_T v_d \lambda^* Z_{k4}^H + \Lambda_T \lambda_T^* \left( v_T Z_{k2}^H + v_u Z_{k4}^H \right) \right. \\
& \left. \left. - \Lambda_T^* \left( \left( 2v_d \lambda + \lambda_T v_u \right) Z_{k4}^H + \lambda_T v_T Z_{k2}^H \right) \right) \right) \left. \right) \left. \right) \left. \right) \tag{304}
\end{aligned}$$



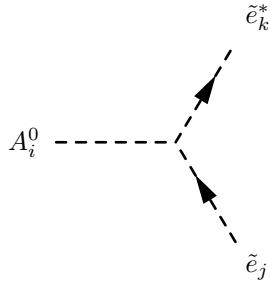
$$\begin{aligned}
& \frac{1}{4} \left( g_2^2 v_u Z_{i1}^A Z_{j2}^+ Z_{k1}^+ + v_u |\Lambda_T|^2 Z_{i1}^A Z_{j2}^+ Z_{k1}^+ - 2v_u |\lambda|^2 Z_{i1}^A Z_{j2}^+ Z_{k1}^+ \right. \\
& + g_2^2 v_d Z_{i2}^A Z_{j2}^+ Z_{k1}^+ + v_d |\Lambda_T|^2 Z_{i2}^A Z_{j2}^+ Z_{k1}^+ - 2v_d |\lambda|^2 Z_{i2}^A Z_{j2}^+ Z_{k1}^+ \\
& + 2\sqrt{2}g_2 M_D^W Z_{i1}^A Z_{j3}^+ Z_{k1}^+ + \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j3}^+ Z_{k1}^+ - \sqrt{2}v_T |\Lambda_T|^2 Z_{i1}^A Z_{j3}^+ Z_{k1}^+ \\
& - 2\Lambda_T v_s \lambda^* Z_{i1}^A Z_{j3}^+ Z_{k1}^+ + 2\sqrt{2}\Lambda_T \mu^* Z_{i1}^A Z_{j3}^+ Z_{k1}^+ + 2\lambda_T v_s \Lambda_T^* Z_{i2}^A Z_{j3}^+ Z_{k1}^+ \\
& - \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j4}^+ Z_{k1}^+ + \sqrt{2}v_T |\Lambda_T|^2 Z_{i1}^A Z_{j4}^+ Z_{k1}^+ - 2v_s \lambda \Lambda_T^* Z_{i1}^A Z_{j4}^+ Z_{k1}^+ \\
& \left. + 2\sqrt{2}\mu \Lambda_T^* Z_{i1}^A Z_{j4}^+ Z_{k1}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{i1}^A Z_{j4}^+ Z_{k1}^+ - g_2^2 v_u Z_{i1}^A Z_{j1}^+ Z_{k2}^+ \right)
\end{aligned}$$

$$\begin{aligned}
& -v_u|\Lambda_T|^2 Z_{i1}^A Z_{j1}^+ Z_{k2}^+ + 2v_u|\lambda|^2 Z_{i1}^A Z_{j1}^+ Z_{k2}^+ - g_2^2 v_d Z_{i2}^A Z_{j1}^+ Z_{k2}^+ \\
& -v_d|\Lambda_T|^2 Z_{i2}^A Z_{j1}^+ Z_{k2}^+ + 2v_d|\lambda|^2 Z_{i2}^A Z_{j1}^+ Z_{k2}^+ - 2\sqrt{2}g_2 M_D^W Z_{i2}^A Z_{j3}^+ Z_{k2}^+ \\
& -\sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j3}^+ Z_{k2}^+ + \sqrt{2}v_T|\Lambda_T|^2 Z_{i2}^A Z_{j3}^+ Z_{k2}^+ - 2\Lambda_T v_s \lambda^* Z_{i2}^A Z_{j3}^+ Z_{k2}^+ \\
& + 2\sqrt{2}\Lambda_T \mu^* Z_{i2}^A Z_{j3}^+ Z_{k2}^+ + 2\Lambda_T v_s \lambda_T^* Z_{i1}^A Z_{j4}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j4}^+ Z_{k2}^+ \\
& -\sqrt{2}v_T|\Lambda_T|^2 Z_{i2}^A Z_{j4}^+ Z_{k2}^+ - 2v_s \lambda \Lambda_T^* Z_{i2}^A Z_{j4}^+ Z_{k2}^+ + 2\sqrt{2}\mu \Lambda_T^* Z_{i2}^A Z_{j4}^+ Z_{k2}^+ \\
& - 2\sqrt{2}g_2 M_D^{W,*} Z_{i2}^A Z_{j4}^+ Z_{k2}^+ - \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j1}^+ Z_{k3}^+ + \sqrt{2}v_T|\Lambda_T|^2 Z_{i1}^A Z_{j1}^+ Z_{k3}^+ \\
& + 2v_s \lambda \Lambda_T^* Z_{i1}^A Z_{j1}^+ Z_{k3}^+ - 2\sqrt{2}\mu \Lambda_T^* Z_{i1}^A Z_{j1}^+ Z_{k3}^+ - 2\sqrt{2}g_2 M_D^{W,*} Z_{i1}^A Z_{j1}^+ Z_{k3}^+ \\
& - 2\Lambda_T v_s \lambda_T^* Z_{i2}^A Z_{j1}^+ Z_{k3}^+ + \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j2}^+ Z_{k3}^+ - \sqrt{2}v_T|\Lambda_T|^2 Z_{i2}^A Z_{j2}^+ Z_{k3}^+ \\
& + 2v_s \lambda \Lambda_T^* Z_{i2}^A Z_{j2}^+ Z_{k3}^+ - 2\sqrt{2}\mu \Lambda_T^* Z_{i2}^A Z_{j2}^+ Z_{k3}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{i2}^A Z_{j2}^+ Z_{k3}^+ \\
& + 2v_u \lambda \lambda_T^* Z_{i1}^A Z_{j4}^+ Z_{k3}^+ + 2v_d \lambda \lambda_T^* Z_{i2}^A Z_{j4}^+ Z_{k3}^+ - 2\sqrt{2}g_2 M_D^W Z_{i1}^A Z_{j1}^+ Z_{k4}^+ \\
& + \sqrt{2}g_2^2 v_T Z_{i1}^A Z_{j1}^+ Z_{k4}^+ - \sqrt{2}v_T|\Lambda_T|^2 Z_{i1}^A Z_{j1}^+ Z_{k4}^+ + 2\Lambda_T v_s \lambda^* Z_{i1}^A Z_{j1}^+ Z_{k4}^+ \\
& - 2\sqrt{2}\Lambda_T \mu^* Z_{i1}^A Z_{j1}^+ Z_{k4}^+ - 2\lambda_T v_s \Lambda_T^* Z_{i1}^A Z_{j2}^+ Z_{k4}^+ + 2\sqrt{2}g_2 M_D^W Z_{i2}^A Z_{j2}^+ Z_{k4}^+ \\
& - \sqrt{2}g_2^2 v_T Z_{i2}^A Z_{j2}^+ Z_{k4}^+ + \sqrt{2}v_T|\Lambda_T|^2 Z_{i2}^A Z_{j2}^+ Z_{k4}^+ + 2\Lambda_T v_s \lambda^* Z_{i2}^A Z_{j2}^+ Z_{k4}^+ \\
& - 2\sqrt{2}\Lambda_T \mu^* Z_{i2}^A Z_{j2}^+ Z_{k4}^+ - 2\lambda_T v_u \lambda^* Z_{i1}^A Z_{j3}^+ Z_{k4}^+ - 2\lambda_T v_d \lambda^* Z_{i2}^A Z_{j3}^+ Z_{k4}^+ \\
& + Z_{i3}^A \left( -2\sqrt{2}M_S \lambda^* Z_{j2}^+ Z_{k1}^+ + 2\Lambda_T v_d \lambda^* Z_{j3}^+ Z_{k1}^+ + 2g_1 M_D^B Z_{j2}^+ Z_{k2}^+ - 2g_1 M_D^{B,*} Z_{j2}^+ Z_{k2}^+ \right. \\
& - \sqrt{2}\Lambda_T v_T \lambda^* Z_{j2}^+ Z_{k2}^+ + 2\sqrt{2}\mu \lambda^* Z_{j2}^+ Z_{k2}^+ - 2\sqrt{2}\lambda \mu^* Z_{j2}^+ Z_{k2}^+ - 2\Lambda_T v_u \lambda^* Z_{j3}^+ Z_{k2}^+ \\
& - 2\Lambda_T v_d \lambda^* Z_{j4}^+ Z_{k2}^+ + 2\sqrt{2}M_S \lambda_T^* Z_{j4}^+ Z_{k3}^+ - 2\Lambda_T v_u \lambda^* Z_{j2}^+ Z_{k4}^+ - 2\sqrt{2}\lambda_T M_S^* Z_{j3}^+ Z_{k4}^+ \\
& \left. + Z_{j1}^+ \left( (-2g_1 M_D^B + 2g_1 M_D^{B,*} - 2\sqrt{2}\lambda \mu^* + 2\sqrt{2}\mu \lambda^* - \sqrt{2}\Lambda_T v_T \lambda^* + \sqrt{2}v_T \lambda \Lambda_T^*) Z_{k1}^+ \right. \right. \\
& \left. \left. + \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{k2}^+ + 2\sqrt{2}\lambda M_S^* Z_{k2}^+ + 2\Lambda_T v_u \lambda_T^* Z_{k3}^+ - 2v_d \lambda \Lambda_T^* Z_{k3}^+ + 2\Lambda_T v_d \lambda^* Z_{k4}^+ \right) \right) \\
& + \Lambda_T^* \left( -2 \left( \lambda_T v_u Z_{j3}^+ Z_{k1}^+ + \lambda Z_{j4}^+ (v_d Z_{k1}^+ - v_u Z_{k2}^+) \right) \right. \\
& \left. + Z_{j2}^+ \left( 2\lambda_T v_d Z_{k4}^+ + 2v_u \lambda Z_{k3}^+ - \sqrt{2}\lambda_T v_T Z_{k1}^+ + \sqrt{2}v_T \lambda Z_{k2}^+ \right) \right) \\
& + Z_{i4}^A \left( -2\lambda_T v_T \lambda^* Z_{j2}^+ Z_{k1}^+ - \sqrt{2}g_2^2 v_d Z_{j3}^+ Z_{k1}^+ - \sqrt{2}g_2^2 v_d Z_{j4}^+ Z_{k1}^+ + 2g_2 M_D^W Z_{j2}^+ Z_{k2}^+ \right. \\
& - 2g_2 M_D^{W,*} Z_{j2}^+ Z_{k2}^+ + \sqrt{2}\Lambda_T v_s \lambda^* Z_{j2}^+ Z_{k2}^+ - 2\Lambda_T \mu^* Z_{j2}^+ Z_{k2}^+ - \sqrt{2}g_2^2 v_u Z_{j3}^+ Z_{k2}^+ \\
& - \sqrt{2}g_2^2 v_u Z_{j4}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_u Z_{j2}^+ Z_{k3}^+ - 4g_2^2 v_T Z_{j4}^+ Z_{k3}^+ + 2v_T |\lambda_T|^2 Z_{j4}^+ Z_{k3}^+ \\
& + \sqrt{2}g_2^2 v_u Z_{j2}^+ Z_{k4}^+ + 4g_2^2 v_T Z_{j3}^+ Z_{k4}^+ - 2v_T |\lambda_T|^2 Z_{j3}^+ Z_{k4}^+ \\
& \left. + Z_{j1}^+ \left( (-2g_2 M_D^W + 2g_2 M_D^{W,*} - 2\Lambda_T \mu^* + (2\mu - \sqrt{2}v_s \lambda) \Lambda_T^* + \sqrt{2}\Lambda_T v_s \lambda^*) Z_{k1}^+ \right. \right. \\
& \left. \left. + (2v_T \lambda + \sqrt{2}\Lambda_T v_s) \lambda_T^* Z_{k2}^+ + \sqrt{2}v_d \left( -|\Lambda_T|^2 + g_2^2 \right) (Z_{k3}^+ + Z_{k4}^+) \right) \right) \\
& + \Lambda_T^* \left( \sqrt{2}\Lambda_T (Z_{j3}^+ + Z_{j4}^+) (v_d Z_{k1}^+ + v_u Z_{k2}^+) \right. \\
& \left. - Z_{j2}^+ \left( (-2\mu + \sqrt{2}v_s \lambda) Z_{k2}^+ + \sqrt{2}\lambda_T v_s Z_{k1}^+ + \sqrt{2}\Lambda_T v_u (Z_{k3}^+ + Z_{k4}^+) \right) \right) \Big) \Big)
\end{aligned} \tag{305}$$



$$\begin{aligned}
& \frac{1}{12} \delta_{\beta\gamma} \left( 6\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^A - 3\sqrt{2}\Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^A \right. \\
& + 6v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^A - 6\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^A \\
& + 2g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i3}^A - 2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i3}^A + 4g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D Z_{i3}^A \\
& - 4g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D Z_{i3}^A + 6v_u \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i3}^A \\
& - 6\lambda^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D (v_s Z_{i2}^A + v_u Z_{i3}^A) - 6g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i4}^A \\
& + 6g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D Z_{i4}^A - 3\sqrt{2}\Lambda_T v_u \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i4}^A \\
& \left. + 3\sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D (v_T Z_{i2}^A + v_u Z_{i4}^A) \right) \tag{306}
\end{aligned}$$


---



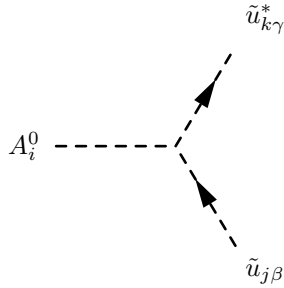
$$\begin{aligned}
& \frac{1}{4} \left( 2\sqrt{2}\mu_R^* Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i1}^A - \sqrt{2}\Lambda_T v_T Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i1}^A \right. \\
& + 2v_s \lambda Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i1}^A - 2\sqrt{2}\mu Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i1}^A \\
& + 2v_u \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i1}^A - 2v_u \lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i1}^A \\
& - 2v_s Z_{j7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i1}^A - 2\sqrt{2} Z_{j7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \mu_{E,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i1}^A \\
& - 2v_s \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i1}^A \\
& - 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 \mu_{E,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i1}^A \\
& + 2v_s \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{kc}^E Z_{i1}^A + 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \mu_{E,ab} Z_{kc}^E Z_{i1}^A \\
& - \sqrt{2} v_T \Lambda_T^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^A + 2v_s \lambda^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^A \\
& - 2\sqrt{2} \mu^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^A + 2\sqrt{2} \mu_R Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i2}^A \\
& + 2\lambda_{SR} v_s Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i2}^A + \sqrt{2} \lambda_{TR} v_T Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i2}^A \\
& + 2v_d \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i2}^A + \sqrt{2} \Lambda_T v_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i2}^A \\
& - 2v_s \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i2}^A + 2\sqrt{2} \mu \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i2}^A \\
& - 2v_s Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}arE,a}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i2}^A - 2v_d \lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i2}^A \\
& - 2\sqrt{2} Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}arE,a}^* \mu_{E,ba} Z_{k8+b}^E Z_{i2}^A - \sqrt{2} v_T \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^A \\
& + 2v_s \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^A - 2\sqrt{2} \mu^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^A \\
& + \sqrt{2} v_T \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^A - 2v_s \lambda^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^A
\end{aligned}$$

$$\begin{aligned}
& + 2\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^A - \sqrt{2}\Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^A \\
& + 2v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^A - 2\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^A \\
& + 4g_1 M_D^B \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E Z_{i3}^A - 4g_1 M_D^{B,*} \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E Z_{i3}^A \\
& + 2v_u \lambda^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i3}^A - 2\lambda_{SR} v_u Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a} Z_{k10+a}^E Z_{i3}^A \\
& + 2v_d \lambda Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{k10+a}^E Z_{i3}^A - 4g_1 M_D^B \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{i3}^A \\
& + 4g_1 M_D^{B,*} \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{i3}^A - 2g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i3}^A \\
& + 2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i3}^A + 4g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^A \\
& - 4g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^A + 2\sqrt{2}M_S \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i3}^A \\
& - 2v_u \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i3}^A + 2v_u Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}arE,a}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^A \\
& - 2\sqrt{2}M_S^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^A + 2v_u \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i3}^A \\
& + 2v_d Z_{j7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i3}^A - 2v_u \lambda^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i3}^A \\
& + 2v_u \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i3}^A + 2\sqrt{2} \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \mu_{E,ca}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^A \\
& - 2\sqrt{2} \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ca}^* \mu_{E,ba} Z_{k8+b}^E Z_{i3}^A \\
& + 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 \mu_{E,ac}^* \lambda_{SE,ab} Z_{k10+c}^E Z_{i3}^A \\
& - 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* \mu_{E,ab} Z_{k10+c}^E Z_{i3}^A \\
& + 2v_d \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i3}^A
\end{aligned}$$

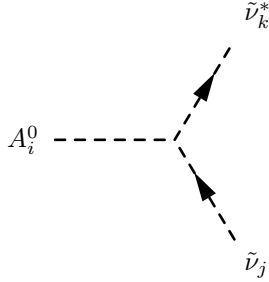


$$\begin{aligned}
& -2v_d \sum_{c=1}^3 \sum_{b=1}^2 Z_{j_{10+b}}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{kc}^E Z_{i3}^A - \sqrt{2}v_u \Lambda_T^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i4}^A \\
& - \sqrt{2}\lambda_{TR} v_u Z_{j7}^{E,*} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{k_{10+a}}^E Z_{i4}^A - \sqrt{2}\Lambda_T v_d Z_{j8}^{E,*} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{k_{10+a}}^E Z_{i4}^A \\
& - 2g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i4}^A + 2g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i4}^A \\
& + 2\lambda_T v_T \sum_{b=1}^2 Z_{j_{8+b}}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k_{10+a}}^E Z_{i4}^A + \sqrt{2}\Lambda_T v_u \sum_{b=1}^2 Z_{j_{8+b}}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i4}^A \\
& - 2v_T \lambda_T^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j_{10+a}}^{E,*} \lambda_{SE,ba} Z_{k_{8+b}}^E Z_{i4}^A - \sqrt{2}v_u \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k_{8+b}}^E Z_{i4}^A \\
& + \sqrt{2}v_u \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k_{3+a}}^E Z_{i4}^A - \sqrt{2}\Lambda_T v_u \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j_{3+a}}^{E,*} Z_{kb}^E Z_{i4}^A \\
& + 2v_s \sum_{b=1}^2 Z_{j_{10+b}}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i1}^A Z_{k7}^E + 2\sqrt{2} \sum_{b=1}^2 Z_{j_{10+b}}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \mu_{E,ab} Z_{i1}^A Z_{k7}^E \\
& + \sqrt{2}\Lambda_T v_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i2}^A Z_{k7}^E - 2v_s \lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i2}^A Z_{k7}^E \\
& + 2\sqrt{2}\mu \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i2}^A Z_{k7}^E - 2\sqrt{2}\mu^* \sum_{a=1}^2 Z_{j_{10+a}}^{E,*} Y_{B\hat{a}rE,a} Z_{i2}^A Z_{k7}^E \\
& - 2g_1 M_D^B Z_{j7}^{E,*} Z_{i3}^A Z_{k7}^E + 2g_1 M_D^{B,*} Z_{j7}^{E,*} Z_{i3}^A Z_{k7}^E + 2\sqrt{2}\lambda_{SR} \mu_R^* Z_{j7}^{E,*} Z_{i3}^A Z_{k7}^E \\
& - 2v_u \lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i3}^A Z_{k7}^E - 2v_d \sum_{b=1}^2 Z_{j_{10+b}}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i3}^A Z_{k7}^E \\
& - 2g_2 M_D^W Z_{j7}^{E,*} Z_{i4}^A Z_{k7}^E + 2g_2 M_D^{W,*} Z_{j7}^{E,*} Z_{i4}^A Z_{k7}^E + 2\lambda_{TR} \mu_R^* Z_{j7}^{E,*} Z_{i4}^A Z_{k7}^E \\
& + \sqrt{2}\Lambda_T v_u \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i4}^A Z_{k7}^E - \lambda_{TR} v_u \Lambda_T^* Z_{j7}^{E,*} Z_{i1}^A Z_{k8}^E \\
& + 2\lambda_{SR} v_u \lambda^* Z_{j7}^{E,*} Z_{i1}^A Z_{k8}^E - 2\sqrt{2}\mu_R \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i1}^A Z_{k8}^E \\
& - 2\lambda_{SR} v_s \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i1}^A Z_{k8}^E - \sqrt{2}\lambda_{TR} v_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j_{8+a}}^{E,*} Z_{i1}^A Z_{k8}^E \\
& + \sqrt{2}v_T \Lambda_T^* \sum_{a=1}^2 Z_{j_{10+a}}^{E,*} Y_{B\hat{a}rE,a} Z_{i1}^A Z_{k8}^E - 2v_s \lambda^* \sum_{a=1}^2 Z_{j_{10+a}}^{E,*} Y_{B\hat{a}rE,a} Z_{i1}^A Z_{k8}^E \\
& + 2\sqrt{2}\mu^* \sum_{a=1}^2 Z_{j_{10+a}}^{E,*} Y_{B\hat{a}rE,a} Z_{i1}^A Z_{k8}^E - \lambda_{TR} v_d \Lambda_T^* Z_{j7}^{E,*} Z_{i2}^A Z_{k8}^E + 2\lambda_{SR} v_d \lambda^* Z_{j7}^{E,*} Z_{i2}^A Z_{k8}^E
\end{aligned}$$

$$\begin{aligned}
& + 2v_s \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{B\hat{a}rE,a} Z_{i2}^A Z_{k8}^E + 2\sqrt{2} \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \mu_{E,ba}^* Y_{B\hat{a}rE,a} Z_{i2}^A Z_{k8}^E \\
& + \sqrt{2} \lambda_{TR} v_T \lambda_T^* Z_{j7}^{E,*} Z_{i3}^A Z_{k8}^E + 2\sqrt{2} \lambda_{SR} M_S^* Z_{j7}^{E,*} Z_{i3}^A Z_{k8}^E + 2g_1 M_D^B Z_{j8}^{E,*} Z_{i3}^A Z_{k8}^E \\
& - 2g_1 M_D^{B,*} Z_{j8}^{E,*} Z_{i3}^A Z_{k8}^E + 2\sqrt{2} \lambda_{SR} \mu_R^* Z_{j8}^{E,*} Z_{i3}^A Z_{k8}^E + 2\lambda_{SR} v_d \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i3}^A Z_{k8}^E \\
& - 2v_d \lambda^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{i3}^A Z_{k8}^E - 2v_u \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{B\hat{a}rE,a} Z_{i3}^A Z_{k8}^E \\
& + \sqrt{2} \lambda_{TR} v_s \lambda_T^* Z_{j7}^{E,*} Z_{i4}^A Z_{k8}^E + 2\lambda_{SR} v_T \lambda_T^* Z_{j7}^{E,*} Z_{i4}^A Z_{k8}^E + 2g_2 M_D^W Z_{j8}^{E,*} Z_{i4}^A Z_{k8}^E \\
& - 2g_2 M_D^{W,*} Z_{j8}^{E,*} Z_{i4}^A Z_{k8}^E + 2\lambda_{TR} \mu_R^* Z_{j8}^{E,*} Z_{i4}^A Z_{k8}^E + \sqrt{2} \lambda_{TR} v_d \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i4}^A Z_{k8}^E \\
& + \sqrt{2} v_d \Lambda_T^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{i4}^A Z_{k8}^E \\
& + \lambda_{TR}^* \left( \left( \sqrt{2} \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} \left( -v_T Z_{i2}^A + v_u Z_{i4}^A \right) + Z_{j7}^{E,*} \left( - \left( 2\mu_R + \sqrt{2} \lambda_{SR} v_s \right) Z_{i4}^A + \sqrt{2} \lambda_{SR} v_T Z_{i3}^A \right) \right) Z_{k7}^E \right. \\
& + Z_{j8}^{E,*} \left( \sqrt{2} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \left( -v_d Z_{i4}^A + v_T Z_{i1}^A \right) + \Lambda_T v_u Z_{i1}^A Z_{k7}^E + \Lambda_T v_d Z_{i2}^A Z_{k7}^E \right. \\
& - \sqrt{2} \lambda_T v_T Z_{i3}^A Z_{k7}^E - \sqrt{2} \lambda_T v_s Z_{i4}^A Z_{k7}^E + \sqrt{2} \lambda_{SR} v_T Z_{i3}^A Z_{k8}^E - 2\mu_R Z_{i4}^A Z_{k8}^E \\
& \left. \left. - \sqrt{2} \lambda_{SR} v_s Z_{i4}^A Z_{k8}^E \right) \right) \\
& + \lambda_{SR}^* \left( \left( \sqrt{2} Z_{j7}^{E,*} \left( - \left( 2\mu_R + \lambda_{TR} v_T \right) Z_{i3}^A + \lambda_{TR} v_s Z_{i4}^A \right) + \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} \left( -2v_s Z_{i2}^A + 2v_u Z_{i3}^A \right) \right) Z_{k7}^E \right. \\
& + Z_{j8}^{E,*} \left( 2 \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \left( -v_d Z_{i3}^A + v_s Z_{i1}^A \right) - 2v_u \lambda Z_{i1}^A Z_{k7}^E - 2v_d \lambda Z_{i2}^A Z_{k7}^E - 2\sqrt{2} M_S Z_{i3}^A Z_{k7}^E \right. \\
& \left. \left. - 2\lambda_T v_T Z_{i4}^A Z_{k7}^E - 2\sqrt{2} \mu_R Z_{i3}^A Z_{k8}^E - \sqrt{2} \lambda_{TR} v_T Z_{i3}^A Z_{k8}^E + \sqrt{2} \lambda_{TR} v_s Z_{i4}^A Z_{k8}^E \right) \right) \Bigg) \Bigg) \quad (307)
\end{aligned}$$

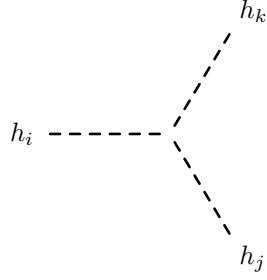


$$\begin{aligned}
& \frac{1}{12} \delta_{\beta\gamma} \left( 6\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{i1}^A - 3\sqrt{2}\Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab} Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^A \right. \\
& + 6v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab} Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^A - 6\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab} Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^A \\
& + 2g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i3}^A - 2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i3}^A - 8g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U Z_{i3}^A \\
& + 8g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U Z_{i3}^A + 6v_d \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab} Z_{j3+a}^{U,*} Z_{kb}^U Z_{i3}^A \\
& - 6\lambda^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \left( v_d Z_{i3}^A + v_s Z_{i1}^A \right) + 6g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i4}^A \\
& - 6g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U Z_{i4}^A - 3\sqrt{2}\Lambda_T v_d \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab} Z_{j3+a}^{U,*} Z_{kb}^U Z_{i4}^A \\
& \left. + 3\sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \left( v_d Z_{i4}^A + v_T Z_{i1}^A \right) \right) \tag{308}
\end{aligned}$$



$$\begin{aligned}
& \frac{1}{4} \left( -2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V \left( g_1 \left( -M_D^{B,*} + M_D^B \right) Z_{i3}^A + g_2 \left( -M_D^W + M_D^{W,*} \right) Z_{i4}^A \right) + \Lambda_T v_u \lambda_{TR}^* Z_{j5}^{V,*} Z_{i1}^A Z_{k4}^V \right. \\
& + \Lambda_T v_d \lambda_{TR}^* Z_{j5}^{V,*} Z_{i2}^A Z_{k4}^V - 2g_1 M_D^B Z_{j4}^{V,*} Z_{i3}^A Z_{k4}^V - \sqrt{2}\lambda_{SR} v_T \lambda_{TR}^* Z_{j4}^{V,*} Z_{i3}^A Z_{k4}^V \\
& + 2g_1 M_D^{B,*} Z_{j4}^{V,*} Z_{i3}^A Z_{k4}^V + 2\sqrt{2}\lambda_{SR} \mu^* Z_{j4}^{V,*} Z_{i3}^A Z_{k4}^V - \sqrt{2}\lambda_T v_T \lambda_{TR}^* Z_{j5}^{V,*} Z_{i3}^A Z_{k4}^V \\
& + 2g_2 M_D^W Z_{j4}^{V,*} Z_{i4}^A Z_{k4}^V + 2\mu_R \lambda_{TR}^* Z_{j4}^{V,*} Z_{i4}^A Z_{k4}^V + \sqrt{2}\lambda_{SR} v_s \lambda_{TR}^* Z_{j4}^{V,*} Z_{i4}^A Z_{k4}^V \\
& - 2g_2 M_D^{W,*} Z_{j4}^{V,*} Z_{i4}^A Z_{k4}^V - 2\lambda_{TR} \mu^* Z_{j4}^{V,*} Z_{i4}^A Z_{k4}^V - \sqrt{2}\lambda_T v_s \lambda_{TR}^* Z_{j5}^{V,*} Z_{i4}^A Z_{k4}^V \\
& - \lambda_{TR} v_u \Lambda_T^* Z_{j4}^{V,*} Z_{i1}^A Z_{k5}^V - 2\lambda_{SR} v_u \lambda^* Z_{j4}^{V,*} Z_{i1}^A Z_{k5}^V - \lambda_{TR} v_d \Lambda_T^* Z_{j4}^{V,*} Z_{i2}^A Z_{k5}^V \\
& - 2\lambda_{SR} v_d \lambda^* Z_{j4}^{V,*} Z_{i2}^A Z_{k5}^V + \sqrt{2}\lambda_{TR} v_T \lambda_T^* Z_{j4}^{V,*} Z_{i3}^A Z_{k5}^V - 2\sqrt{2}\lambda_{SR} M_S^* Z_{j4}^{V,*} Z_{i3}^A Z_{k5}^V \\
& \left. + 2g_1 M_D^B Z_{j5}^{V,*} Z_{i3}^A Z_{k5}^V - \sqrt{2}\lambda_{SR} v_T \lambda_{TR}^* Z_{j5}^{V,*} Z_{i3}^A Z_{k5}^V - 2g_1 M_D^{B,*} Z_{j5}^{V,*} Z_{i3}^A Z_{k5}^V \right)
\end{aligned}$$

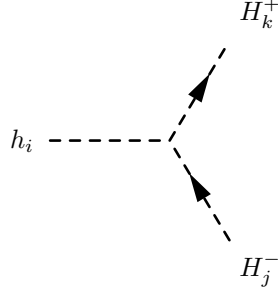
$$\begin{aligned}
& + 2\sqrt{2}\lambda_{SR}\mu_R^* Z_{j_5}^{V,*} Z_{i_3}^A Z_{k_5}^V + \sqrt{2}\lambda_{TR}v_s \lambda_T^* Z_{j_4}^{V,*} Z_{i_4}^A Z_{k_5}^V - 2\lambda_{SR}v_T \lambda_T^* Z_{j_4}^{V,*} Z_{i_4}^A Z_{k_5}^V \\
& - 2g_2 M_D^W Z_{j_5}^{V,*} Z_{i_4}^A Z_{k_5}^V + 2\mu_R \lambda_{TR}^* Z_{j_5}^{V,*} Z_{i_4}^A Z_{k_5}^V + \sqrt{2}\lambda_{SR}v_s \lambda_{TR}^* Z_{j_5}^{V,*} Z_{i_4}^A Z_{k_5}^V \\
& + 2g_2 M_D^{W,*} Z_{j_5}^{V,*} Z_{i_4}^A Z_{k_5}^V - 2\lambda_{TR}\mu_R^* Z_{j_5}^{V,*} Z_{i_4}^A Z_{k_5}^V \\
& + \lambda_{SR}^* \left( \sqrt{2} Z_{j_4}^{V,*} \left( \left( -2\mu_R + \lambda_{TR}v_T \right) Z_{i_3}^A - \lambda_{TR}v_s Z_{i_4}^A \right) Z_{k_4}^V \right. \\
& + Z_{j_5}^{V,*} \left( 2v_u \lambda Z_{i_1}^A Z_{k_4}^V + 2v_d \lambda Z_{i_2}^A Z_{k_4}^V + 2\sqrt{2}M_S Z_{i_3}^A Z_{k_4}^V + 2\lambda_T v_T Z_{i_4}^A Z_{k_4}^V - 2\sqrt{2}\mu_R Z_{i_3}^A Z_{k_5}^V \right. \\
& \left. \left. + \sqrt{2}\lambda_{TR}v_T Z_{i_3}^A Z_{k_5}^V - \sqrt{2}\lambda_{TR}v_s Z_{i_4}^A Z_{k_5}^V \right) \right) \tag{309}
\end{aligned}$$



$$\begin{aligned}
& - \frac{i}{8} \left( -4g_1 M_D^B Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H + 8v_s |\lambda|^2 Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H \right. \\
& - 4g_1 M_D^{B,*} Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H - 2\sqrt{2}\Lambda_T v_T \lambda^* Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H - 4\sqrt{2}\mu \lambda^* Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H \\
& - 4\sqrt{2}\lambda \mu^* Z_{i_3}^H Z_{j_1}^H Z_{k_1}^H + 4g_2 M_D^W Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H + 4v_T |\Lambda_T|^2 Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H \\
& - 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H + 4\mu \Lambda_T^* Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H + 4g_2 M_D^{W,*} Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H \\
& - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H + 4\Lambda_T \mu^* Z_{i_4}^H Z_{j_1}^H Z_{k_1}^H - \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{i_3}^H Z_{j_2}^H Z_{k_1}^H \\
& - \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{i_3}^H Z_{j_2}^H Z_{k_1}^H + 2\sqrt{2}\lambda M_S^* Z_{i_3}^H Z_{j_2}^H Z_{k_1}^H + 2\sqrt{2}M_S \lambda^* Z_{i_3}^H Z_{j_2}^H Z_{k_1}^H \\
& - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i_4}^H Z_{j_2}^H Z_{k_1}^H + 2v_T \lambda \lambda_T^* Z_{i_4}^H Z_{j_2}^H Z_{k_1}^H - \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i_4}^H Z_{j_2}^H Z_{k_1}^H \\
& + 2\lambda_T v_T \lambda^* Z_{i_4}^H Z_{j_2}^H Z_{k_1}^H + 8v_d |\lambda|^2 Z_{i_3}^H Z_{j_3}^H Z_{k_1}^H - \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i_4}^H Z_{j_3}^H Z_{k_1}^H \\
& - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i_4}^H Z_{j_3}^H Z_{k_1}^H - 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{i_4}^H Z_{j_3}^H Z_{k_1}^H \\
& - 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{i_4}^H Z_{j_3}^H Z_{k_1}^H - \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{i_3}^H Z_{j_4}^H Z_{k_1}^H \\
& - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{i_3}^H Z_{j_4}^H Z_{k_1}^H - 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{i_3}^H Z_{j_4}^H Z_{k_1}^H \\
& - 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{i_3}^H Z_{j_4}^H Z_{k_1}^H + 4v_d |\Lambda_T|^2 Z_{i_4}^H Z_{j_4}^H Z_{k_1}^H + 2v_u \lambda \lambda_T^* Z_{i_4}^H Z_{j_4}^H Z_{k_1}^H \\
& + 2\lambda_T v_u \lambda^* Z_{i_4}^H Z_{j_4}^H Z_{k_1}^H - \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{i_3}^H Z_{j_1}^H Z_{k_2}^H - \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{i_3}^H Z_{j_1}^H Z_{k_2}^H \\
& + 2\sqrt{2}\lambda M_S^* Z_{i_3}^H Z_{j_1}^H Z_{k_2}^H + 2\sqrt{2}M_S \lambda^* Z_{i_3}^H Z_{j_1}^H Z_{k_2}^H - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{i_4}^H Z_{j_1}^H Z_{k_2}^H \\
& + 2v_T \lambda \lambda_T^* Z_{i_4}^H Z_{j_1}^H Z_{k_2}^H - \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{i_4}^H Z_{j_1}^H Z_{k_2}^H + 2\lambda_T v_T \lambda^* Z_{i_4}^H Z_{j_1}^H Z_{k_2}^H \\
& + 4g_1 M_D^B Z_{i_3}^H Z_{j_2}^H Z_{k_2}^H + 8v_s |\lambda|^2 Z_{i_3}^H Z_{j_2}^H Z_{k_2}^H - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{i_3}^H Z_{j_2}^H Z_{k_2}^H
\end{aligned}$$

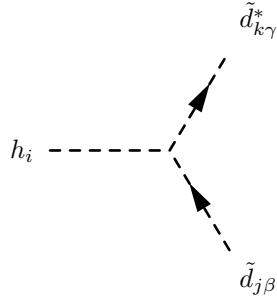
$$\begin{aligned}
& + 4g_1 M_D^{B,*} Z_{i3}^H Z_{j2}^H Z_{k2}^H - 2\sqrt{2} \Lambda_T v_T \lambda^* Z_{i3}^H Z_{j2}^H Z_{k2}^H - 4\sqrt{2} \mu \lambda^* Z_{i3}^H Z_{j2}^H Z_{k2}^H \\
& - 4\sqrt{2} \lambda \mu^* Z_{i3}^H Z_{j2}^H Z_{k2}^H - 4g_2 M_D^W Z_{i4}^H Z_{j2}^H Z_{k2}^H + 4v_T |\Lambda_T|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^H \\
& - 2\sqrt{2} v_s \lambda \Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k2}^H + 4\mu \Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k2}^H - 4g_2 M_D^{W,*} Z_{i4}^H Z_{j2}^H Z_{k2}^H \\
& - 2\sqrt{2} \Lambda_T v_s \lambda^* Z_{i4}^H Z_{j2}^H Z_{k2}^H + 4\Lambda_T \mu^* Z_{i4}^H Z_{j2}^H Z_{k2}^H + 8v_u |\lambda|^2 Z_{i3}^H Z_{j3}^H Z_{k2}^H \\
& - \sqrt{2} \Lambda_T v_d \lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k2}^H - \sqrt{2} \lambda_T v_d \Lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k2}^H \\
& - 2\sqrt{2} v_u \lambda \Lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k2}^H - 2\sqrt{2} \Lambda_T v_u \lambda^* Z_{i4}^H Z_{j3}^H Z_{k2}^H \\
& - \sqrt{2} \Lambda_T v_d \lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k2}^H - \sqrt{2} \lambda_T v_d \Lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k2}^H \\
& - 2\sqrt{2} v_u \lambda \Lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k2}^H - 2\sqrt{2} \Lambda_T v_u \lambda^* Z_{i3}^H Z_{j4}^H Z_{k2}^H + 4v_u |\Lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k2}^H \\
& + 2v_d \lambda \lambda_T^* Z_{i4}^H Z_{j4}^H Z_{k2}^H + 2\lambda_T v_d \lambda^* Z_{i4}^H Z_{j4}^H Z_{k2}^H + 8v_d |\lambda|^2 Z_{i3}^H Z_{j1}^H Z_{k3}^H \\
& - \sqrt{2} \Lambda_T v_u \lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k3}^H - \sqrt{2} \lambda_T v_u \Lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k3}^H \\
& - 2\sqrt{2} v_d \lambda \Lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k3}^H - 2\sqrt{2} \Lambda_T v_d \lambda^* Z_{i4}^H Z_{j1}^H Z_{k3}^H + 8v_u |\lambda|^2 Z_{i3}^H Z_{j2}^H Z_{k3}^H \\
& - \sqrt{2} \Lambda_T v_d \lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k3}^H - \sqrt{2} \lambda_T v_d \Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k3}^H \\
& - 2\sqrt{2} v_u \lambda \Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k3}^H - 2\sqrt{2} \Lambda_T v_u \lambda^* Z_{i4}^H Z_{j2}^H Z_{k3}^H + 8v_T |\lambda_T|^2 Z_{i4}^H Z_{j3}^H Z_{k3}^H \\
& + 8v_T |\lambda_T|^2 Z_{i3}^H Z_{j4}^H Z_{k3}^H + 8v_s |\lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k3}^H + 2\sqrt{2} M_S \lambda_T^* Z_{i4}^H Z_{j4}^H Z_{k3}^H \\
& + 2\sqrt{2} \lambda_T M_S^* Z_{i4}^H Z_{j4}^H Z_{k3}^H - \sqrt{2} \Lambda_T v_u \lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k4}^H - \sqrt{2} \Lambda_T v_u \Lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k4}^H \\
& - 2\sqrt{2} v_d \lambda \Lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k4}^H - 2\sqrt{2} \Lambda_T v_d \lambda^* Z_{i3}^H Z_{j1}^H Z_{k4}^H + 4v_d |\Lambda_T|^2 Z_{i4}^H Z_{j1}^H Z_{k4}^H \\
& + 2v_u \lambda \lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k4}^H + 2\lambda_T v_u \lambda^* Z_{i4}^H Z_{j1}^H Z_{k4}^H - \sqrt{2} \Lambda_T v_d \lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k4}^H \\
& - \sqrt{2} \lambda_T v_d \Lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k4}^H - 2\sqrt{2} v_u \lambda \Lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k4}^H \\
& - 2\sqrt{2} \Lambda_T v_u \lambda^* Z_{i3}^H Z_{j2}^H Z_{k4}^H + 4v_u |\Lambda_T|^2 Z_{i4}^H Z_{j2}^H Z_{k4}^H + 2v_d \lambda \lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k4}^H \\
& + 2\lambda_T v_d \lambda^* Z_{i4}^H Z_{j2}^H Z_{k4}^H + 8v_T |\lambda_T|^2 Z_{i3}^H Z_{j3}^H Z_{k4}^H + 8v_s |\lambda_T|^2 Z_{i4}^H Z_{j3}^H Z_{k4}^H \\
& + 2\sqrt{2} M_S \lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k4}^H + 2\sqrt{2} \lambda_T M_S^* Z_{i4}^H Z_{j3}^H Z_{k4}^H + 8v_s |\lambda_T|^2 Z_{i3}^H Z_{j4}^H Z_{k4}^H \\
& + 2\sqrt{2} M_S \lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k4}^H + 2\sqrt{2} \lambda_T M_S^* Z_{i3}^H Z_{j4}^H Z_{k4}^H + 12v_T |\lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k4}^H \\
& - Z_{i2}^H \left( \sqrt{2} \Lambda_T v_T \lambda_T^* Z_{j3}^H Z_{k1}^H + \sqrt{2} \lambda_T v_T \Lambda_T^* Z_{j3}^H Z_{k1}^H - 2\sqrt{2} \lambda M_S^* Z_{j3}^H Z_{k1}^H \right. \\
& - 2\sqrt{2} M_S \lambda^* Z_{j3}^H Z_{k1}^H + \sqrt{2} \Lambda_T v_s \lambda_T^* Z_{j4}^H Z_{k1}^H - 2v_T \lambda \lambda_T^* Z_{j4}^H Z_{k1}^H \\
& \left. + \sqrt{2} \lambda_T v_s \Lambda_T^* Z_{j4}^H Z_{k1}^H - 2\lambda_T v_T \lambda^* Z_{j4}^H Z_{k1}^H - 4g_1 M_D^B Z_{j3}^H Z_{k2}^H - 8v_s |\lambda|^2 Z_{j3}^H Z_{k2}^H \right. \\
& + 2\sqrt{2} v_T \lambda \Lambda_T^* Z_{j3}^H Z_{k2}^H - 4g_1 M_D^{B,*} Z_{j3}^H Z_{k2}^H + 2\sqrt{2} \Lambda_T v_T \lambda^* Z_{j3}^H Z_{k2}^H + 4\sqrt{2} \mu \lambda^* Z_{j3}^H Z_{k2}^H \\
& + 4\sqrt{2} \lambda \mu^* Z_{j3}^H Z_{k2}^H + 4g_2 M_D^W Z_{j4}^H Z_{k2}^H - 4v_T |\Lambda_T|^2 Z_{j4}^H Z_{k2}^H + 2\sqrt{2} v_s \lambda \Lambda_T^* Z_{j4}^H Z_{k2}^H \\
& - 4\mu \Lambda_T^* Z_{j4}^H Z_{k2}^H + 4g_2 M_D^{W,*} Z_{j4}^H Z_{k2}^H + 2\sqrt{2} \Lambda_T v_s \lambda^* Z_{j4}^H Z_{k2}^H - 4\Lambda_T \mu^* Z_{j4}^H Z_{k2}^H \\
& - 8v_u |\lambda|^2 Z_{j3}^H Z_{k3}^H + \sqrt{2} \Lambda_T v_d \lambda_T^* Z_{j4}^H Z_{k3}^H + \sqrt{2} \lambda_T v_d \Lambda_T^* Z_{j4}^H Z_{k3}^H \\
& + 2\sqrt{2} v_u \lambda \Lambda_T^* Z_{j4}^H Z_{k3}^H + 2\sqrt{2} \Lambda_T v_u \lambda^* Z_{j4}^H Z_{k3}^H + \sqrt{2} \Lambda_T v_d \lambda_T^* Z_{j3}^H Z_{k4}^H \\
& \left. + \sqrt{2} \lambda_T v_d \Lambda_T^* Z_{j3}^H Z_{k4}^H + 2\sqrt{2} v_u \lambda \Lambda_T^* Z_{j3}^H Z_{k4}^H + 2\sqrt{2} \Lambda_T v_u \lambda^* Z_{j3}^H Z_{k4}^H \right)
\end{aligned}$$

$$\begin{aligned}
& -4v_u|\Lambda_T|^2 Z_{j_4}^H Z_{k_4}^H - 2v_d\lambda\lambda_T^* Z_{j_4}^H Z_{k_4}^H - 2\lambda_T v_d \lambda^* Z_{j_4}^H Z_{k_4}^H \\
& + Z_{j_1}^H \left( 2v_u \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^H + 2v_d \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^H \right. \\
& + \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{k_3}^H + \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{k_3}^H - 2\sqrt{2}\lambda M_S^* Z_{k_3}^H - 2\sqrt{2}M_S \lambda^* Z_{k_3}^H \\
& + \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{k_4}^H - 2v_T \lambda \lambda_T^* Z_{k_4}^H + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{k_4}^H - 2\lambda_T v_T \lambda^* Z_{k_4}^H \left. \right) \\
& + 2Z_{j_2}^H \left( v_d \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^H - 3 \left( g_1^2 + g_2^2 \right) v_u Z_{k_2}^H - 2g_1 M_D^B Z_{k_3}^H - 4v_s |\lambda|^2 Z_{k_3}^H \right. \\
& + \sqrt{2}v_T \lambda \Lambda_T^* Z_{k_3}^H - 2g_1 M_D^{B,*} Z_{k_3}^H + \sqrt{2}\Lambda_T v_T \lambda^* Z_{k_3}^H + 2\sqrt{2}\mu \lambda^* Z_{k_3}^H + 2\sqrt{2}\lambda \mu^* Z_{k_3}^H \\
& + 2g_2 M_D^W Z_{k_4}^H - 2v_T |\Lambda_T|^2 Z_{k_4}^H + \sqrt{2}v_s \lambda \Lambda_T^* Z_{k_4}^H - 2\mu \Lambda_T^* Z_{k_4}^H + 2g_2 M_D^{W,*} Z_{k_4}^H \\
& \left. + \sqrt{2}\Lambda_T v_s \lambda^* Z_{k_4}^H - 2\Lambda_T \mu^* Z_{k_4}^H \right) \\
& + Z_{i_1}^H \left( -4g_1 M_D^B Z_{j_3}^H Z_{k_1}^H + 8v_s |\lambda|^2 Z_{j_3}^H Z_{k_1}^H - 2\sqrt{2}v_T \lambda \Lambda_T^* Z_{j_3}^H Z_{k_1}^H - 4g_1 M_D^{B,*} Z_{j_3}^H Z_{k_1}^H \right. \\
& - 2\sqrt{2}\Lambda_T v_T \lambda^* Z_{j_3}^H Z_{k_1}^H - 4\sqrt{2}\mu \lambda^* Z_{j_3}^H Z_{k_1}^H - 4\sqrt{2}\lambda \mu^* Z_{j_3}^H Z_{k_1}^H + 4g_2 M_D^W Z_{j_4}^H Z_{k_1}^H \\
& + 4v_T |\Lambda_T|^2 Z_{j_4}^H Z_{k_1}^H - 2\sqrt{2}v_s \lambda \Lambda_T^* Z_{j_4}^H Z_{k_1}^H + 4\mu \Lambda_T^* Z_{j_4}^H Z_{k_1}^H + 4g_2 M_D^{W,*} Z_{j_4}^H Z_{k_1}^H \\
& - 2\sqrt{2}\Lambda_T v_s \lambda^* Z_{j_4}^H Z_{k_1}^H + 4\Lambda_T \mu^* Z_{j_4}^H Z_{k_1}^H - \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{j_3}^H Z_{k_2}^H \\
& - \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{j_3}^H Z_{k_2}^H + 2\sqrt{2}\lambda M_S^* Z_{j_3}^H Z_{k_2}^H + 2\sqrt{2}M_S \lambda^* Z_{j_3}^H Z_{k_2}^H \\
& - \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{j_4}^H Z_{k_2}^H + 2v_T \lambda \lambda_T^* Z_{j_4}^H Z_{k_2}^H - \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{j_4}^H Z_{k_2}^H \\
& + 2\lambda_T v_T \lambda^* Z_{j_4}^H Z_{k_2}^H + 8v_d |\lambda|^2 Z_{j_3}^H Z_{k_3}^H - \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{j_4}^H Z_{k_3}^H \\
& - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j_4}^H Z_{k_3}^H - 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{j_4}^H Z_{k_3}^H - 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{j_4}^H Z_{k_3}^H \\
& - \sqrt{2}\Lambda_T v_u \lambda_T^* Z_{j_3}^H Z_{k_4}^H - \sqrt{2}\lambda_T v_u \Lambda_T^* Z_{j_3}^H Z_{k_4}^H - 2\sqrt{2}v_d \lambda \Lambda_T^* Z_{j_3}^H Z_{k_4}^H \\
& - 2\sqrt{2}\Lambda_T v_d \lambda^* Z_{j_3}^H Z_{k_4}^H + 4v_d |\Lambda_T|^2 Z_{j_4}^H Z_{k_4}^H + 2v_u \lambda \lambda_T^* Z_{j_4}^H Z_{k_4}^H + 2\lambda_T v_u \lambda^* Z_{j_4}^H Z_{k_4}^H \\
& - Z_{j_2}^H \left( 2v_u \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^H + 2v_d \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^H \right. \\
& + \sqrt{2}\Lambda_T v_T \lambda_T^* Z_{k_3}^H + \sqrt{2}\lambda_T v_T \Lambda_T^* Z_{k_3}^H - 2\sqrt{2}\lambda M_S^* Z_{k_3}^H - 2\sqrt{2}M_S \lambda^* Z_{k_3}^H \\
& + \sqrt{2}\Lambda_T v_s \lambda_T^* Z_{k_4}^H - 2v_T \lambda \lambda_T^* Z_{k_4}^H + \sqrt{2}\lambda_T v_s \Lambda_T^* Z_{k_4}^H - 2\lambda_T v_T \lambda^* Z_{k_4}^H \left. \right) \\
& + Z_{j_1}^H \left( 6 \left( g_1^2 + g_2^2 \right) v_d Z_{k_1}^H \right. \\
& - 2 \left( v_u \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^H \right. \\
& + \left( 2g_1 M_D^{B,*} + 2g_1 M_D^B + 2\sqrt{2}\lambda \mu^* + 2\sqrt{2}\mu \lambda^* - 4v_s |\lambda|^2 + \sqrt{2}\Lambda_T v_T \lambda^* + \sqrt{2}v_T \lambda \Lambda_T^* \right) Z_{k_3}^H \\
& \left. \left. + \left( -2g_2 M_D^{W,*} - 2g_2 M_D^W - 2\Lambda_T \mu^* + \left( -2\Lambda_T v_T - 2\mu + \sqrt{2}v_s \lambda \right) \Lambda_T^* + \sqrt{2}\Lambda_T v_s \lambda^* \right) Z_{k_4}^H \right) \right) \right) \quad (310)
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( -2g_1 M_D^B Z_{i3}^H Z_{j1}^+ Z_{k1}^+ + 4v_s |\lambda|^2 Z_{i3}^H Z_{j1}^+ Z_{k1}^+ + \sqrt{2} v_T \lambda \Lambda_T^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ \right. \\
& - 2g_1 M_D^{B,*} Z_{i3}^H Z_{j1}^+ Z_{k1}^+ + \sqrt{2} \Lambda_T v_T \lambda^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ - 2\sqrt{2} \mu \lambda^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ \\
& - 2\sqrt{2} \lambda \mu^* Z_{i3}^H Z_{j1}^+ Z_{k1}^+ - 2g_2 M_D^W Z_{i4}^H Z_{j1}^+ Z_{k1}^+ + 2v_T |\Lambda_T|^2 Z_{i4}^H Z_{j1}^+ Z_{k1}^+ \\
& + \sqrt{2} v_s \lambda \Lambda_T^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - 2\mu \Lambda_T^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - 2g_2 M_D^{W,*} Z_{i4}^H Z_{j1}^+ Z_{k1}^+ \\
& + \sqrt{2} \Lambda_T v_s \lambda^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - 2\Lambda_T \mu^* Z_{i4}^H Z_{j1}^+ Z_{k1}^+ - \sqrt{2} \lambda_T v_T \Lambda_T^* Z_{i3}^H Z_{j2}^+ Z_{k1}^+ \\
& - 2\sqrt{2} M_S \lambda^* Z_{i3}^H Z_{j2}^+ Z_{k1}^+ - \sqrt{2} \lambda_T v_s \Lambda_T^* Z_{i4}^H Z_{j2}^+ Z_{k1}^+ - 2\lambda_T v_T \lambda^* Z_{i4}^H Z_{j2}^+ Z_{k1}^+ \\
& - 2\lambda_T v_u \Lambda_T^* Z_{i3}^H Z_{j3}^+ Z_{k1}^+ - 2\Lambda_T v_d \lambda^* Z_{i3}^H Z_{j3}^+ Z_{k1}^+ + \sqrt{2} g_2^2 v_d Z_{i4}^H Z_{j3}^+ Z_{k1}^+ \\
& - \sqrt{2} v_d |\Lambda_T|^2 Z_{i4}^H Z_{j3}^+ Z_{k1}^+ - 2v_d \lambda \Lambda_T^* Z_{i3}^H Z_{j4}^+ Z_{k1}^+ - \sqrt{2} g_2^2 v_d Z_{i4}^H Z_{j4}^+ Z_{k1}^+ \\
& + \sqrt{2} v_d |\Lambda_T|^2 Z_{i4}^H Z_{j4}^+ Z_{k1}^+ - \sqrt{2} \Lambda_T v_T \lambda^* Z_{i3}^H Z_{j1}^+ Z_{k2}^+ - 2\sqrt{2} \lambda M_S^* Z_{i3}^H Z_{j1}^+ Z_{k2}^+ \\
& - \sqrt{2} \Lambda_T v_s \lambda_T^* Z_{i4}^H Z_{j1}^+ Z_{k2}^+ - 2v_T \lambda \lambda_T^* Z_{i4}^H Z_{j1}^+ Z_{k2}^+ + 2g_1 M_D^B Z_{i3}^H Z_{j2}^+ Z_{k2}^+ \\
& + 4v_s |\lambda|^2 Z_{i3}^H Z_{j2}^+ Z_{k2}^+ + \sqrt{2} v_T \lambda \Lambda_T^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ + 2g_1 M_D^{B,*} Z_{i3}^H Z_{j2}^+ Z_{k2}^+ \\
& + \sqrt{2} \Lambda_T v_T \lambda^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ - 2\sqrt{2} \mu \lambda^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ - 2\sqrt{2} \lambda \mu^* Z_{i3}^H Z_{j2}^+ Z_{k2}^+ \\
& + 2g_2 M_D^W Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + 2v_T |\Lambda_T|^2 Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + \sqrt{2} v_s \lambda \Lambda_T^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ \\
& - 2\mu \Lambda_T^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + 2g_2 M_D^{W,*} Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + \sqrt{2} \Lambda_T v_s \lambda^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ \\
& - 2\Lambda_T \mu^* Z_{i4}^H Z_{j2}^+ Z_{k2}^+ + 2\Lambda_T v_u \lambda^* Z_{i3}^H Z_{j3}^+ Z_{k2}^+ + \sqrt{2} g_2^2 v_u Z_{i4}^H Z_{j3}^+ Z_{k2}^+ \\
& - \sqrt{2} v_u |\Lambda_T|^2 Z_{i4}^H Z_{j3}^+ Z_{k2}^+ + 2\Lambda_T v_d \lambda_T^* Z_{i3}^H Z_{j4}^+ Z_{k2}^+ + 2v_u \lambda \Lambda_T^* Z_{i3}^H Z_{j4}^+ Z_{k2}^+ \\
& - \sqrt{2} g_2^2 v_u Z_{i4}^H Z_{j4}^+ Z_{k2}^+ + \sqrt{2} v_u |\Lambda_T|^2 Z_{i4}^H Z_{j4}^+ Z_{k2}^+ - 2\Lambda_T v_u \lambda_T^* Z_{i3}^H Z_{j1}^+ Z_{k3}^+ \\
& - 2v_d \lambda \Lambda_T^* Z_{i3}^H Z_{j1}^+ Z_{k3}^+ + \sqrt{2} g_2^2 v_d Z_{i4}^H Z_{j1}^+ Z_{k3}^+ - \sqrt{2} v_d |\Lambda_T|^2 Z_{i4}^H Z_{j1}^+ Z_{k3}^+ \\
& + 2v_u \lambda \Lambda_T^* Z_{i3}^H Z_{j2}^+ Z_{k3}^+ + \sqrt{2} g_2^2 v_u Z_{i4}^H Z_{j2}^+ Z_{k3}^+ - \sqrt{2} v_u |\Lambda_T|^2 Z_{i4}^H Z_{j2}^+ Z_{k3}^+ \\
& + 4v_s |\lambda_T|^2 Z_{i3}^H Z_{j3}^+ Z_{k3}^+ + 4g_2^2 v_T Z_{i4}^H Z_{j3}^+ Z_{k3}^+ + 2\sqrt{2} M_S \lambda_T^* Z_{i3}^H Z_{j4}^+ Z_{k3}^+ \\
& - 4g_2^2 v_T Z_{i4}^H Z_{j4}^+ Z_{k3}^+ + 2v_T |\lambda_T|^2 Z_{i4}^H Z_{j4}^+ Z_{k3}^+ - 2\Lambda_T v_d \lambda^* Z_{i3}^H Z_{j1}^+ Z_{k4}^+ \\
& - \sqrt{2} g_2^2 v_d Z_{i4}^H Z_{j1}^+ Z_{k4}^+ + \sqrt{2} v_d |\Lambda_T|^2 Z_{i4}^H Z_{j1}^+ Z_{k4}^+ + 2\lambda_T v_d \Lambda_T^* Z_{i3}^H Z_{j2}^+ Z_{k4}^+ \\
& + 2\Lambda_T v_u \lambda^* Z_{i3}^H Z_{j2}^+ Z_{k4}^+ - \sqrt{2} g_2^2 v_u Z_{i4}^H Z_{j2}^+ Z_{k4}^+ + \sqrt{2} v_u |\Lambda_T|^2 Z_{i4}^H Z_{j2}^+ Z_{k4}^+ \\
& + 2\sqrt{2} \lambda_T M_S^* Z_{i3}^H Z_{j3}^+ Z_{k4}^+ - 4g_2^2 v_T Z_{i4}^H Z_{j3}^+ Z_{k4}^+ + 2v_T |\lambda_T|^2 Z_{i4}^H Z_{j3}^+ Z_{k4}^+
\end{aligned}$$

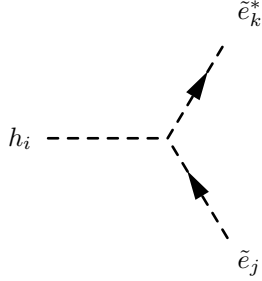
$$\begin{aligned}
& + 4v_s|\lambda_T|^2 Z_{i3}^H Z_{j4}^+ Z_{k4}^+ + 4g_2^2 v_T Z_{i4}^H Z_{j4}^+ Z_{k4}^+ \\
& + Z_{i2}^H \left( - 2\lambda_T v_s \Lambda_T^* Z_{j3}^+ Z_{k1}^+ + 2\sqrt{2}g_2 M_D^W Z_{j3}^+ Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{j3}^+ Z_{k2}^+ \right. \\
& - \sqrt{2}v_T |\Lambda_T|^2 Z_{j3}^+ Z_{k2}^+ + 2\Lambda_T v_s \lambda^* Z_{j3}^+ Z_{k2}^+ - 2\sqrt{2}\Lambda_T \mu^* Z_{j3}^+ Z_{k2}^+ \\
& - \sqrt{2}g_2^2 v_T Z_{j4}^+ Z_{k2}^+ + \sqrt{2}v_T |\Lambda_T|^2 Z_{j4}^+ Z_{k2}^+ + 2v_s \lambda \Lambda_T^* Z_{j4}^+ Z_{k2}^+ \\
& - 2\sqrt{2}\mu \Lambda_T^* Z_{j4}^+ Z_{k2}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{j4}^+ Z_{k2}^+ + 2g_2^2 v_u Z_{j3}^+ Z_{k3}^+ + 2v_d \lambda \Lambda_T^* Z_{j4}^+ Z_{k3}^+ \\
& \left. + Z_{j1}^+ \left( - 2\Lambda_T v_s \lambda_T^* Z_{k3}^+ + v_d \left( - 2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k2}^+ + v_u \left( 4|\Lambda_T|^2 - g_1^2 + g_2^2 \right) Z_{k1}^+ \right) \right. \\
& + 2\lambda_T v_d \lambda^* Z_{j3}^+ Z_{k4}^+ - 2g_2^2 v_u Z_{j4}^+ Z_{k4}^+ + 4v_u |\Lambda_T|^2 Z_{j4}^+ Z_{k4}^+ \\
& + Z_{j2}^+ \left( v_d \left( - 2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k1}^+ + \left( g_1^2 + g_2^2 \right) v_u Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{k3}^+ - \sqrt{2}v_T |\Lambda_T|^2 Z_{k3}^+ \right. \\
& + 2v_s \lambda \Lambda_T^* Z_{k3}^+ - 2\sqrt{2}\mu \Lambda_T^* Z_{k3}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{k3}^+ + 2\sqrt{2}g_2 M_D^W Z_{k4}^+ - \sqrt{2}g_2^2 v_T Z_{k4}^+ \\
& \left. + \sqrt{2}v_T |\Lambda_T|^2 Z_{k4}^+ + 2\Lambda_T v_s \lambda^* Z_{k4}^+ - 2\sqrt{2}\Lambda_T \mu^* Z_{k4}^+ \right) \left. \right) \\
& + Z_{i1}^H \left( 2\sqrt{2}g_2 M_D^W Z_{j3}^+ Z_{k1}^+ + \sqrt{2}g_2^2 v_T Z_{j3}^+ Z_{k1}^+ - \sqrt{2}v_T |\Lambda_T|^2 Z_{j3}^+ Z_{k1}^+ \right. \\
& - 2\Lambda_T v_s \lambda^* Z_{j3}^+ Z_{k1}^+ + 2\sqrt{2}\Lambda_T \mu^* Z_{j3}^+ Z_{k1}^+ - \sqrt{2}g_2^2 v_T Z_{j4}^+ Z_{k1}^+ \\
& + \sqrt{2}v_T |\Lambda_T|^2 Z_{j4}^+ Z_{k1}^+ - 2v_s \lambda \Lambda_T^* Z_{j4}^+ Z_{k1}^+ + 2\sqrt{2}\mu \Lambda_T^* Z_{j4}^+ Z_{k1}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{j4}^+ Z_{k1}^+ \\
& + 2\Lambda_T v_s \lambda_T^* Z_{j4}^+ Z_{k2}^+ - 2g_2^2 v_d Z_{j3}^+ Z_{k3}^+ + 4v_d |\Lambda_T|^2 Z_{j3}^+ Z_{k3}^+ + 2v_u \lambda \Lambda_T^* Z_{j4}^+ Z_{k3}^+ \\
& + 2\lambda_T v_u \lambda^* Z_{j3}^+ Z_{k4}^+ + 2g_2^2 v_d Z_{j4}^+ Z_{k4}^+ \\
& + Z_{j2}^+ \left( 2\lambda_T v_s \Lambda_T^* Z_{k4}^+ + v_d \left( 4|\Lambda_T|^2 - g_1^2 + g_2^2 \right) Z_{k2}^+ + v_u \left( - 2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k1}^+ \right) \\
& + Z_{j1}^+ \left( \left( g_1^2 + g_2^2 \right) v_d Z_{k1}^+ + v_u \left( - 2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k2}^+ + \sqrt{2}g_2^2 v_T Z_{k3}^+ - \sqrt{2}v_T |\Lambda_T|^2 Z_{k3}^+ \right. \\
& - 2v_s \lambda \Lambda_T^* Z_{k3}^+ + 2\sqrt{2}\mu \Lambda_T^* Z_{k3}^+ + 2\sqrt{2}g_2 M_D^{W,*} Z_{k3}^+ + 2\sqrt{2}g_2 M_D^W Z_{k4}^+ - \sqrt{2}g_2^2 v_T Z_{k4}^+ \\
& \left. + \sqrt{2}v_T |\Lambda_T|^2 Z_{k4}^+ - 2\Lambda_T v_s \lambda^* Z_{k4}^+ + 2\sqrt{2}\Lambda_T \mu^* Z_{k4}^+ \right) \left. \right) \left. \right) \tag{311}
\end{aligned}$$



$$\frac{i}{12} \delta_{\beta\gamma} \left( 2g_1 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \left( - 2 \left( M_D^B + M_D^{B,*} \right) Z_{i3}^H + g_1 v_d Z_{i1}^H - g_1 v_u Z_{i2}^H \right) \right)$$



$$\begin{aligned}
& + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \left( (3g_2^2 + g_1^2) v_d Z_{i1}^H - (3g_2^2 + g_1^2) v_u Z_{i2}^H - 2g_1 M_D^B Z_{i3}^H - 2g_1 M_D^{B,*} Z_{i3}^H + 6g_2 M_D^W Z_{i4}^H \right. \\
& \left. + 6g_2 M_D^{W,*} Z_{i4}^H \right) \\
& + 3 \left( -4v_d \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{k3+b}^D Z_{i1}^H - 4v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{kc}^D Z_{i1}^H \right. \\
& + \sqrt{2} v_T \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^H - 2v_s \lambda^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^H \\
& + 2\sqrt{2} \mu^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i2}^H + \sqrt{2} \Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^H \\
& - 2v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^H + 2\sqrt{2} \mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i2}^H \\
& - 2v_u \lambda^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i3}^H - 2v_u \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i3}^H \\
& \left. + \sqrt{2} v_u \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D Z_{i4}^H + \sqrt{2} \Lambda_T v_u \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{kb}^D Z_{i4}^H \right) \tag{312}
\end{aligned}$$



$$\begin{aligned}
& - \frac{i}{4} \left( \sqrt{2} v_T \lambda_{TR}^* Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i1}^H + 2\sqrt{2} \mu_R^* Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i1}^H \right. \\
& - \sqrt{2} \Lambda_T v_T Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i1}^H + 2v_s \lambda Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i1}^H \\
& - 2\sqrt{2} \mu Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i1}^H + 2g_1^2 v_d \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{i1}^H \\
& \left. + g_1^2 v_d \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i1}^H - g_2^2 v_d \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i1}^H \right)
\end{aligned}$$

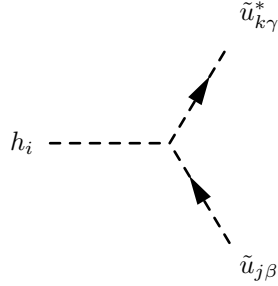
$$\begin{aligned}
& -2g_1^2 v_d \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i1}^H + 4v_d \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{j8+b}^{E,*} Z_{i1}^H \\
& + 2v_u \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i1}^H + 2v_u \lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i1}^H \\
& - 2v_s Z_{j7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i1}^H - 2\sqrt{2} Z_{j7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \mu_{E,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i1}^H \\
& + 4v_d Z_{j7}^{E,*} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{kb}^E Z_{i1}^H + 4v_d \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ac}^* Y_{L,ab} Z_{k8+b}^E Z_{i1}^H \\
& - 4v_d \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{L,ac}^* Y_{e,ba} Z_{k3+b}^E Z_{i1}^H \\
& - 2v_s \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i1}^H \\
& - 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 \mu_{E,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i1}^H \\
& - 4v_d \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{e,ca}^* Y_{L,ab} Z_{k8+b}^E Z_{i1}^H \\
& + 4v_d \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{k3+b}^E Z_{i1}^H \\
& - 2v_s \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{kc}^E Z_{i1}^H \\
& - 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \mu_{E,ab} Z_{kc}^E Z_{i1}^H + 4v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{kc}^E Z_{i1}^H \\
& + 4v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^E Z_{i1}^H + g_1^2 v_d Z_{j7}^{E,*} Z_{k7}^E Z_{i1}^H \\
& - g_2^2 v_d Z_{j7}^{E,*} Z_{k7}^E Z_{i1}^H + \Lambda_T v_u \lambda_{TR}^* Z_{j8}^{E,*} Z_{k7}^E Z_{i1}^H + 4v_d Z_{j7}^{E,*} \sum_{a=1}^2 |Y_{\hat{E},a}|^2 Z_{k7}^E Z_{i1}^H \\
& - 2v_s \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{k7}^E Z_{i1}^H - 2\sqrt{2} \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \mu_{E,ab} Z_{k7}^E Z_{i1}^H \\
& + 4v_d \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{k7}^E Z_{i1}^H + \lambda_{TR} v_u \Lambda_T^* Z_{j7}^{E,*} Z_{k8}^E Z_{i1}^H \\
& - 2\lambda_{SR} v_u \lambda^* Z_{j7}^{E,*} Z_{k8}^E Z_{i1}^H - g_1^2 v_d Z_{j8}^{E,*} Z_{k8}^E Z_{i1}^H + g_2^2 v_d Z_{j8}^{E,*} Z_{k8}^E Z_{i1}^H
\end{aligned}$$

$$\begin{aligned}
& + 2\sqrt{2}\mu_R \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k8}^E Z_{i1}^H + 2\lambda_{SR} v_s \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k8}^E Z_{i1}^H \\
& + \sqrt{2}\lambda_{TR} v_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k8}^E Z_{i1}^H - \sqrt{2}v_T \Lambda_T^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i1}^H \\
& + 2v_s \lambda^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i1}^H - 2\sqrt{2}\mu^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i1}^H \\
& + \sqrt{2}v_T \Lambda_T^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^H - 2v_s \lambda^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^H \\
& + 2\sqrt{2}\mu^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^H - 2\sqrt{2}\mu_R Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i2}^H \\
& - 2\lambda_{SR} v_s Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i2}^H - \sqrt{2}\lambda_{TR} v_T Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i2}^H \\
& - 2g_1^2 v_u \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{i2}^H - g_1^2 v_u \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i2}^H \\
& + g_2^2 v_u \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i2}^H + 2g_1^2 v_u \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i2}^H \\
& + 2v_d \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i2}^H + \sqrt{2}\Lambda_T v_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i2}^H \\
& - 2v_s \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i2}^H + 2\sqrt{2}\mu \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i2}^H \\
& + 2v_s Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i2}^H + 2v_d \lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i2}^H \\
& + 2\sqrt{2}Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \mu_{E,ba} Z_{k8+b}^E Z_{i2}^H + \sqrt{2}v_T \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^H \\
& - 2v_s \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^H + 2\sqrt{2}\mu^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^H \\
& + 4v_u \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} \sum_{b=1}^2 Y_{\hat{B}\hat{a}rE,b}^* Z_{k10+b}^E Z_{i2}^H - \sqrt{2}v_T \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^H \\
& + 2v_s \lambda^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^H - 2\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^H \\
& - \sqrt{2}\Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^H + 2v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^H
\end{aligned}$$

$$\begin{aligned}
& - 2\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i2}^H - g_1^2 v_u Z_{j7}^{E,*} Z_{k7}^E Z_{i2}^H + g_2^2 v_u Z_{j7}^{E,*} Z_{k7}^E Z_{i2}^H \\
& + \Lambda_T v_d \lambda_{TR}^* Z_{j8}^{E,*} Z_{k7}^E Z_{i2}^H + \sqrt{2} \Lambda_T v_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k7}^E Z_{i2}^H \\
& - 2v_s \lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k7}^E Z_{i2}^H + 2\sqrt{2}\mu \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k7}^E Z_{i2}^H \\
& - \sqrt{2} v_T \lambda_{TR}^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{k7}^E Z_{i2}^H - 2\sqrt{2}\mu_R^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{k7}^E Z_{i2}^H \\
& + \lambda_{TR} v_d \Lambda_T^* Z_{j7}^{E,*} Z_{k8}^E Z_{i2}^H - 2\lambda_{SR} v_d \lambda^* Z_{j7}^{E,*} Z_{k8}^E Z_{i2}^H + g_1^2 v_u Z_{j8}^{E,*} Z_{k8}^E Z_{i2}^H \\
& - g_2^2 v_u Z_{j8}^{E,*} Z_{k8}^E Z_{i2}^H + 4v_u Z_{j8}^{E,*} \sum_{a=1}^2 |Y_{\hat{B}\hat{a}rE,a}|^2 Z_{k8}^E Z_{i2}^H \\
& + 2v_s \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i2}^H + 2\sqrt{2} \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \mu_{E,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i2}^H \\
& - 2v_u \lambda^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i3}^H - 2\lambda_{SR} v_u Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i3}^H \\
& + 2v_d \lambda Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i3}^H - 4g_1 M_D^B \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{i3}^H \\
& - 4g_1 M_D^{B,*} \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{i3}^H - 2g_1 M_D^B \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i3}^H \\
& - 2g_1 M_D^{B,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i3}^H + 4g_1 M_D^B \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^H \\
& + 4g_1 M_D^{B,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{i3}^H + 2\sqrt{2} M_S \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i3}^H \\
& - 2v_u \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i3}^H + 2v_u Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^H \\
& + 2\sqrt{2} M_S^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^H - 2v_u \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i3}^H \\
& - 2v_d Z_{j7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i3}^H + 2v_u \lambda^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i3}^H \\
& + 2v_u \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i3}^H + 4v_s \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ca}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^H
\end{aligned}$$

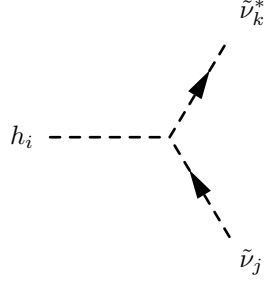
$$\begin{aligned}
& + 2\sqrt{2} \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \mu_{E,ca}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i3}^H + 2\sqrt{2} \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ca}^* \mu_{E,ba} Z_{k8+b}^E Z_{i3}^H \\
& + 4v_s \sum_{c=1}^2 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* \lambda_{SE,ab} Z_{k10+c}^E Z_{i3}^H \\
& + 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 \mu_{E,ac}^* \lambda_{SE,ab} Z_{k10+c}^E Z_{i3}^H \\
& + 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* \mu_{E,ab} Z_{k10+c}^E Z_{i3}^H \\
& - 2v_d \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i3}^H \\
& - 2v_d \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{kc}^E Z_{i3}^H - 2g_1 M_D^B Z_{j7}^{E,*} Z_{k7}^E Z_{i3}^H \\
& + \sqrt{2} \lambda_{SR} v_T \lambda_{TR}^* Z_{j7}^{E,*} Z_{k7}^E Z_{i3}^H - 2g_1 M_D^{B,*} Z_{j7}^{E,*} Z_{k7}^E Z_{i3}^H + 2\sqrt{2} \lambda_{SR} \mu_R^* Z_{j7}^{E,*} Z_{k7}^E Z_{i3}^H \\
& - \sqrt{2} \lambda_T v_T \lambda_{TR}^* Z_{j8}^{E,*} Z_{k7}^E Z_{i3}^H - 2v_u \lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k7}^E Z_{i3}^H \\
& - 2v_d \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{k7}^E Z_{i3}^H - \sqrt{2} \lambda_{TR} v_T \lambda_T^* Z_{j7}^{E,*} Z_{k8}^E Z_{i3}^H \\
& - 2\sqrt{2} \lambda_{SR} M_S^* Z_{j7}^{E,*} Z_{k8}^E Z_{i3}^H + 2g_1 M_D^B Z_{j8}^{E,*} Z_{k8}^E Z_{i3}^H + \sqrt{2} \lambda_{SR} v_T \lambda_{TR}^* Z_{j8}^{E,*} Z_{k8}^E Z_{i3}^H \\
& + 2g_1 M_D^{B,*} Z_{j8}^{E,*} Z_{k8}^E Z_{i3}^H + 2\sqrt{2} \lambda_{SR} \mu_R^* Z_{j8}^{E,*} Z_{k8}^E Z_{i3}^H + 2\lambda_{SR} v_d \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k8}^E Z_{i3}^H \\
& + 2v_d \lambda^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i3}^H + 2v_u \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{k8}^E Z_{i3}^H \\
& + 2g_1 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E \left( 2(M_D^B + M_D^{B,*}) Z_{i3}^H - g_1 v_d Z_{i1}^H + g_1 v_u Z_{i2}^H \right) \\
& + \sqrt{2} v_u \Lambda_T^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^E Z_{i4}^H + \sqrt{2} v_d \lambda_{TR}^* Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^E Z_{i4}^H \\
& - \sqrt{2} \lambda_{TR} v_u Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i4}^H - \sqrt{2} \Lambda_T v_d Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i4}^H \\
& - 2g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i4}^H - 2g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{i4}^H \\
& + 2\lambda_T v_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{i4}^H + \sqrt{2} \Lambda_T v_u \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E Z_{i4}^H
\end{aligned}$$

$$\begin{aligned}
& + 2v_T \lambda_T^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{i4}^H + \sqrt{2} v_u \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E Z_{i4}^H \\
& - \sqrt{2} v_u \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i4}^H - \sqrt{2} \Lambda_T v_u \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{kb}^E Z_{i4}^H \\
& - 2g_2 M_D^W Z_{j7}^{E,*} Z_{k7}^E Z_{i4}^H + 2v_T |\lambda_{TR}|^2 Z_{j7}^{E,*} Z_{k7}^E Z_{i4}^H + 2\mu_R \lambda_{TR}^* Z_{j7}^{E,*} Z_{k7}^E Z_{i4}^H \\
& + \sqrt{2} \lambda_{SR} v_s \lambda_{TR}^* Z_{j7}^{E,*} Z_{k7}^E Z_{i4}^H - 2g_2 M_D^{W,*} Z_{j7}^{E,*} Z_{k7}^E Z_{i4}^H + 2\lambda_{TR} \mu_R^* Z_{j7}^{E,*} Z_{k7}^E Z_{i4}^H \\
& - \sqrt{2} \lambda_T v_s \lambda_{TR}^* Z_{j8}^{E,*} Z_{k7}^E Z_{i4}^H + \sqrt{2} \Lambda_T v_u \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k7}^E Z_{i4}^H \\
& - \sqrt{2} v_u \lambda_{TR}^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{k7}^E Z_{i4}^H - \sqrt{2} \lambda_{TR} v_s \lambda_T^* Z_{j7}^{E,*} Z_{k8}^E Z_{i4}^H \\
& - 2\lambda_{SR} v_T \lambda_T^* Z_{j7}^{E,*} Z_{k8}^E Z_{i4}^H + 2g_2 M_D^W Z_{j8}^{E,*} Z_{k8}^E Z_{i4}^H + 2v_T |\lambda_{TR}|^2 Z_{j8}^{E,*} Z_{k8}^E Z_{i4}^H \\
& + 2\mu_R \lambda_{TR}^* Z_{j8}^{E,*} Z_{k8}^E Z_{i4}^H + \sqrt{2} \lambda_{SR} v_s \lambda_{TR}^* Z_{j8}^{E,*} Z_{k8}^E Z_{i4}^H + 2g_2 M_D^{W,*} Z_{j8}^{E,*} Z_{k8}^E Z_{i4}^H \\
& + 2\lambda_{TR} \mu_R^* Z_{j8}^{E,*} Z_{k8}^E Z_{i4}^H + \sqrt{2} \lambda_{TR} v_d \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{k8}^E Z_{i4}^H \\
& - \sqrt{2} v_d \Lambda_T^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{k8}^E Z_{i4}^H \\
& + \lambda_{SR}^* \left( Z_{k7}^E \left( -2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{B\hat{a}rE,a} \left( v_s Z_{i2}^H + v_u Z_{i3}^H \right) + Z_{j7}^{E,*} \left( \left( 2\sqrt{2} \mu_R + 4\lambda_{SR} v_s + \sqrt{2} \lambda_{TR} v_T \right) Z_{i3}^H + \sqrt{2} \lambda_{TR} v_s Z_{i4}^H \right) \right) \right) \\
& + Z_{j8}^{E,*} \left( 2 \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^E \left( v_d Z_{i3}^H + v_s Z_{i1}^H \right) + Z_{k8}^E \left( \left( 2\sqrt{2} \mu_R + 4\lambda_{SR} v_s + \sqrt{2} \lambda_{TR} v_T \right) Z_{i3}^H + \sqrt{2} \lambda_{TR} v_s Z_{i4}^H \right) \right) \\
& - 2Z_{k7}^E \left( \lambda_T v_T Z_{i4}^H + \sqrt{2} M_S Z_{i3}^H + v_d \lambda Z_{i2}^H + v_u \lambda Z_{i1}^H \right) \Big) \Big) \Big) \Big) \tag{313}
\end{aligned}$$



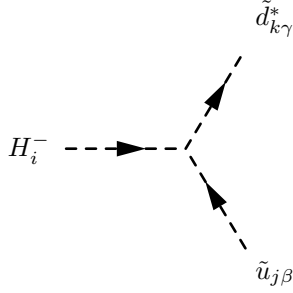
$$\frac{i}{12} \delta_{\beta\gamma} \left( 4g_1 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \left( 2 \left( M_D^B + M_D^{B,*} \right) Z_{i3}^H - g_1 v_d Z_{i1}^H + g_1 v_u Z_{i2}^H \right) \right)$$

$$\begin{aligned}
& + 3 \left( 2\sqrt{2}\mu^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{i1}^H + \sqrt{2}\Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^H \right. \\
& - 2v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^H + 2\sqrt{2}\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i1}^H \\
& - 4v_u \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{k3+b}^U Z_{i2}^H - 4v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{kc}^U Z_{i2}^H \\
& - 2v_d \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i3}^H - 2\lambda^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \left( v_d Z_{i3}^H + v_s Z_{i1}^H \right) \\
& + \sqrt{2}\Lambda_T v_d \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{kb}^U Z_{i4}^H \\
& + \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \left( v_d Z_{i4}^H + v_T Z_{i1}^H \right) \Big) \\
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \left( -2 \left( 3g_2 \left( M_D^W + M_D^{W,*} \right) Z_{i4}^H + g_1 \left( M_D^B + M_D^{B,*} \right) Z_{i3}^H \right) + \left( -3g_2^2 + g_1^2 \right) v_d Z_{i1}^H - \left( -3g_2^2 + g_1^2 \right) v_u Z_{i2}^H \right)
\end{aligned} \tag{314}$$



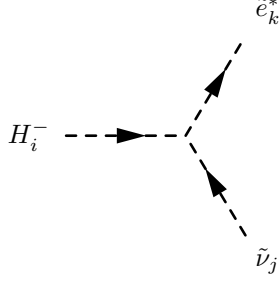
$$\begin{aligned}
& - \frac{i}{4} \left( \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V \left( \left( g_1^2 + g_2^2 \right) v_d Z_{i1}^H - \left( g_1^2 + g_2^2 \right) v_u Z_{i2}^H - 2g_1 M_D^B Z_{i3}^H - 2g_1 M_D^{B,*} Z_{i3}^H + 2g_2 M_D^W Z_{i4}^H \right. \right. \\
& \left. \left. + 2g_2 M_D^{W,*} Z_{i4}^H \right) \right. \\
& + Z_{j4}^{V,*} \left( -2g_1 M_D^B Z_{i3}^H Z_{k4}^V + 4v_s |\lambda_{SR}|^2 Z_{i3}^H Z_{k4}^V + 2\sqrt{2}\mu_R \lambda_{SR}^* Z_{i3}^H Z_{k4}^V - \sqrt{2}\lambda_{TR} v_T \lambda_{SR}^* Z_{i3}^H Z_{k4}^V \right. \\
& - \sqrt{2}\lambda_{SR} v_T \lambda_{TR}^* Z_{i3}^H Z_{k4}^V - 2g_1 M_D^{B,*} Z_{i3}^H Z_{k4}^V + 2\sqrt{2}\lambda_{SR} \mu_R^* Z_{i3}^H Z_{k4}^V + 2g_2 M_D^W Z_{i4}^H Z_{k4}^V \\
& + 2v_T |\lambda_{TR}|^2 Z_{i4}^H Z_{k4}^V - \sqrt{2}\lambda_{TR} v_s \lambda_{SR}^* Z_{i4}^H Z_{k4}^V - 2\mu_R \lambda_{TR}^* Z_{i4}^H Z_{k4}^V \\
& - \sqrt{2}\lambda_{SR} v_s \lambda_{TR}^* Z_{i4}^H Z_{k4}^V + 2g_2 M_D^{W,*} Z_{i4}^H Z_{k4}^V - 2\lambda_{TR} \mu_R^* Z_{i4}^H Z_{k4}^V \\
& \left. \left. - \sqrt{2}\lambda_{TR} v_T \lambda_T^* Z_{i3}^H Z_{k5}^V + 2\sqrt{2}\lambda_{SR} M_S^* Z_{i3}^H Z_{k5}^V - \sqrt{2}\lambda_{TR} v_s \lambda_T^* Z_{i4}^H Z_{k5}^V \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + 2\lambda_{SR}v_T\lambda_T^*Z_{i4}^HZ_{k5}^V + Z_{i2}^H\left(-\left(g_1^2+g_2^2\right)v_uZ_{k4}^V+v_d\left(2\lambda_{SR}\lambda^*+\lambda_{TR}\Lambda_T^*\right)Z_{k5}^V\right) \\
& + Z_{i1}^H\left(\left(g_1^2+g_2^2\right)v_dZ_{k4}^V+v_u\left(2\lambda_{SR}\lambda^*+\lambda_{TR}\Lambda_T^*\right)Z_{k5}^V\right) \\
& + Z_{j5}^{V,*}\left(\left(-\left(g_1^2+g_2^2\right)v_dZ_{i1}^H+\left(g_1^2+g_2^2\right)v_uZ_{i2}^H\right.\right. \\
& \left.\left.+2\left(\left(g_1M_D^{B,*}+g_1M_D^B+\sqrt{2}\lambda_{SR}\mu_R^*\right)Z_{i3}^H-\left(g_2M_D^{W,*}+g_2M_D^W+\lambda_{TR}\mu_R^*\right)Z_{i4}^H\right)\right)Z_{k5}^V \\
& + \lambda_{SR}^*\left(2v_u\lambda Z_{i1}^HZ_{k4}^V+2v_d\lambda Z_{i2}^HZ_{k4}^V+2\sqrt{2}M_SZ_{i3}^HZ_{k4}^V+2\lambda_Tv_TZ_{i4}^HZ_{k4}^V+2\sqrt{2}\mu_RZ_{i3}^HZ_{k5}^V\right. \\
& \left.+4\lambda_{SR}v_sZ_{i3}^HZ_{k5}^V-\sqrt{2}\lambda_{TR}v_TZ_{i3}^HZ_{k5}^V-\sqrt{2}\lambda_{TR}v_sZ_{i4}^HZ_{k5}^V\right) \\
& + \lambda_{TR}^*\left(\Lambda_Tv_uZ_{i1}^HZ_{k4}^V+\Lambda_Tv_dZ_{i2}^HZ_{k4}^V-\sqrt{2}\lambda_Tv_TZ_{i3}^HZ_{k4}^V-\sqrt{2}\lambda_Tv_sZ_{i4}^HZ_{k4}^V\right. \\
& \left.-\sqrt{2}\lambda_{SR}v_TZ_{i3}^HZ_{k5}^V-2\mu_RZ_{i4}^HZ_{k5}^V-\sqrt{2}\lambda_{SR}v_sZ_{i4}^HZ_{k5}^V+2\lambda_{TR}v_TZ_{i4}^HZ_{k5}^V\right)\Big)
\end{aligned} \tag{315}$$



$$\begin{aligned}
& -\frac{i}{4}\delta_{\beta\gamma}\left(g_2\sum_{a=1}^3Z_{ja}^{U,*}Z_{ka}^D\left(2g_2v_TZ_{i3}^+-2g_2v_TZ_{i4}^++4M_D^WZ_{i3}^++4M_D^{W,*}Z_{i4}^++\sqrt{2}g_2v_dZ_{i1}^++\sqrt{2}g_2v_uZ_{i2}^+\right)\right. \\
& +2\left(-\sqrt{2}v_d\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ac}^*Y_{d,ab}Z_{kc}^DZ_{i1}^++v_T\Lambda_T^*\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^DZ_{i2}^+\right. \\
& +\sqrt{2}v_s\lambda^*\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^DZ_{i2}^+-2\mu^*\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^DZ_{i2}^+ \\
& -\sqrt{2}v_u\sum_{c=1}^3\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{u,ac}^*Y_{u,ab}Z_{kc}^DZ_{i2}^+ \\
& -\sqrt{2}\sum_{c=1}^3Z_{j3+c}^{U,*}\sum_{b=1}^3\sum_{a=1}^3Y_{u,ca}^*Y_{d,ba}Z_{k3+b}^D\left(v_dZ_{i2}^++v_uZ_{i1}^+\right) \\
& +\sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*Z_{j3+a}^{U,*}Z_{kb}^D\left(\left(-2\mu+\Lambda_Tv_T+\sqrt{2}v_s\lambda\right)Z_{i1}^+-\sqrt{2}\Lambda_Tv_dZ_{i3}^+\right) \\
& \left.+\sqrt{2}v_u\Lambda_T^*\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{d,ab}Z_{k3+a}^DZ_{i4}^+\right)
\end{aligned} \tag{316}$$



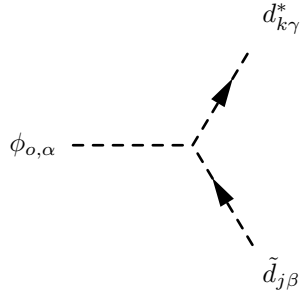


$$\begin{aligned}
& -\frac{i}{4} \left( 4\mu_R^* Z_{j5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i1}^+ + 2\Lambda_T v_T Z_{j5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i1}^+ \right. \\
& + 2\sqrt{2}v_s \lambda Z_{j5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i1}^+ - 4\mu Z_{j5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i1}^+ \\
& + \sqrt{2}g_2^2 v_d \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{i1}^+ + 2\sqrt{2}v_s Z_{j4}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i1}^+ \\
& + 4Z_{j4}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 \mu_{E,ab}^* Y_{\hat{E},a} Z_{k10+b}^E Z_{i1}^+ - 2\sqrt{2}v_d Z_{j4}^{V,*} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{kb}^E Z_{i1}^+ \\
& + 2\sqrt{2}v_s \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i1}^+ + 4 \sum_{c=1}^2 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^2 \mu_{E,ac}^* Y_{L,ba} Z_{k10+c}^E Z_{i1}^+ \\
& - 2\sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{kc}^E Z_{i1}^+ \\
& - 2\sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^E Z_{i1}^+ + \sqrt{2}g_2^2 v_d Z_{j4}^{V,*} Z_{k7}^E Z_{i1}^+ \\
& - 2\sqrt{2}v_d Z_{j4}^{V,*} \sum_{a=1}^2 |Y_{\hat{E},a}|^2 Z_{k7}^E Z_{i1}^+ - 2\sqrt{2}v_d \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{k7}^E Z_{i1}^+ \\
& + \sqrt{2}g_2^2 v_d Z_{j5}^{V,*} Z_{k8}^E Z_{i1}^+ - 2v_T \Lambda_T^* Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^+ \\
& - 2\sqrt{2}v_s \lambda^* Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^+ + 4\mu^* Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E Z_{i2}^+ \\
& - 4\mu_R Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i2}^+ - 2\sqrt{2}\lambda_{SR} v_s Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{k10+a}^E Z_{i2}^+
\end{aligned}$$

$$\begin{aligned}
& + 2\lambda_{TR}v_T Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{k10+a}^E Z_{i2}^+ + \sqrt{2}g_2^2 v_u \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{i2}^+ \\
& - 2\sqrt{2}v_s Z_{j5}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* \lambda_{SE,ba} Z_{k8+b}^E Z_{i2}^+ - 4Z_{j5}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* \mu_{E,ba} Z_{k8+b}^E Z_{i2}^+ \\
& - 2v_T \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^+ - 2\sqrt{2}v_s \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^+ \\
& + 4\mu^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E Z_{i2}^+ + 2v_T \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^+ \\
& + 2\sqrt{2}v_s \lambda^* \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^+ - 4\mu^* \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i2}^+ \\
& + \sqrt{2}g_2^2 v_u Z_{j4}^{V,*} Z_{k7}^E Z_{i2}^+ + 2\sqrt{2}\lambda_{TR}v_d \Lambda_T^* Z_{j4}^{V,*} Z_{k8}^E Z_{i2}^+ + \sqrt{2}g_2^2 v_u Z_{j5}^{V,*} Z_{k8}^E Z_{i2}^+ \\
& - 2\sqrt{2}v_u Z_{j5}^{V,*} \sum_{a=1}^2 |Y_{\widehat{Bar}E,a}|^2 Z_{k8}^E Z_{i2}^+ + 2\sqrt{2}\lambda_{TR}v_u Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{k10+a}^E Z_{i3}^+ \\
& - 2\sqrt{2}\Lambda_T v_d Z_{j5}^{V,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{k10+a}^E Z_{i3}^+ + 4g_2 M_D^W \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{i3}^+ \\
& + 2g_2^2 v_T \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{i3}^+ + 4g_2 M_D^W Z_{j4}^{V,*} Z_{k7}^E Z_{i3}^+ + 2g_2^2 v_T Z_{j4}^{V,*} Z_{k7}^E Z_{i3}^+ \\
& - 4\lambda_{TR} \mu_R^* Z_{j4}^{V,*} Z_{k7}^E Z_{i3}^+ + 4g_2 M_D^W Z_{j5}^{V,*} Z_{k8}^E Z_{i3}^+ + 2g_2^2 v_T Z_{j5}^{V,*} Z_{k8}^E Z_{i3}^+ \\
& + 4\lambda_{TR} \mu_R^* Z_{j5}^{V,*} Z_{k8}^E Z_{i3}^+ \\
& + 2\sqrt{2}v_s \lambda_{SR}^* \left( -\lambda_{TR} Z_{j4}^{V,*} Z_{k7}^E Z_{i3}^+ + Z_{j5}^{V,*} \left( \lambda_{TR} Z_{k8}^E Z_{i3}^+ + \sum_{a=1}^2 Y_{\widehat{E},a} Z_{k8+a}^E Z_{i1}^+ \right) \right) \\
& - 2\sqrt{2}v_u \Lambda_T^* Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\widehat{E},a} Z_{k8+a}^E Z_{i4}^+ - 2g_2^2 v_T \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{i4}^+ \\
& + 4g_2 M_D^{W,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{i4}^+ - 2\sqrt{2}v_u \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E Z_{i4}^+ \\
& + 2\sqrt{2}v_u \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E Z_{i4}^+ - 2g_2^2 v_T Z_{j4}^{V,*} Z_{k7}^E Z_{i4}^+ \\
& + 4g_2 M_D^{W,*} Z_{j4}^{V,*} Z_{k7}^E Z_{i4}^+ + 2\sqrt{2}\lambda_{TR}v_s \lambda_T^* Z_{j4}^{V,*} Z_{k8}^E Z_{i4}^+ - 2g_2^2 v_T Z_{j5}^{V,*} Z_{k8}^E Z_{i4}^+ \\
& + 4g_2 M_D^{W,*} Z_{j5}^{V,*} Z_{k8}^E Z_{i4}^+ \\
& - 2\lambda_{TR}^* \left( Z_{j4}^{V,*} Z_{k7}^E \left( (2\mu_R - \lambda_{TR}v_T + \sqrt{2}\lambda_{SR}v_s) Z_{i4}^+ + \lambda_{TR}v_T Z_{i3}^+ \right) \right)
\end{aligned}$$

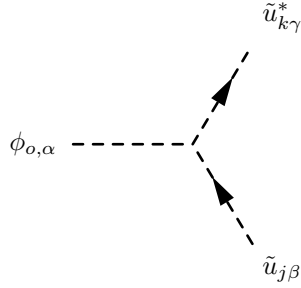
$$\begin{aligned}
& + Z_{j5}^{V,*} \left( \sqrt{2} Z_{k7}^E \left( \lambda_T v_s Z_{i3}^+ - \Lambda_T v_u Z_{i1}^+ \right) + \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \left( -\sqrt{2} v_d Z_{i4}^+ + v_T Z_{i1}^+ \right) \right. \\
& \left. + Z_{k8}^E \left( - \left( 2\mu_R + \lambda_{TR} v_T + \sqrt{2} \lambda_{SR} v_s \right) Z_{i4}^+ + \lambda_{TR} v_T Z_{i3}^+ \right) \right) \Big) \Big) \quad (317)
\end{aligned}$$


---



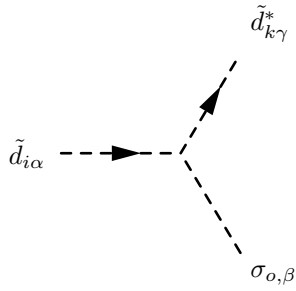
$$- \frac{i}{2} g_3 \left( M_D^O + M_D^{O,*} \right) \lambda_{\gamma,\beta}^\alpha \left( - \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \right) \quad (318)$$


---

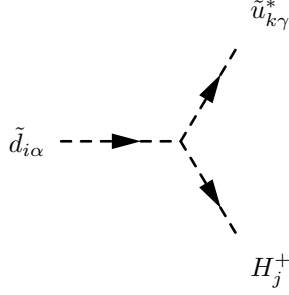


$$- \frac{i}{2} g_3 \left( M_D^O + M_D^{O,*} \right) \lambda_{\gamma,\beta}^\alpha \left( - \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \right) \quad (319)$$

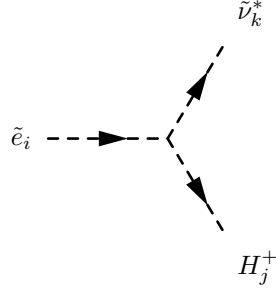

---



$$\frac{1}{2}g_3 \left( -M_D^{O,*} + M_D^O \right) \lambda_{\gamma,\alpha}^\beta \left( -\sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D + \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \right) \quad (320)$$

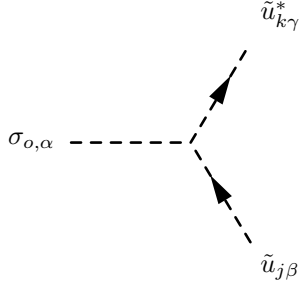


$$\begin{aligned} & -\frac{i}{4}\delta_{\alpha\gamma} \left( g_2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^U \left( 2g_2 v_T Z_{j3}^+ - 2g_2 v_T Z_{j4}^+ + 4M_D^{W,*} Z_{j3}^+ + 4M_D^W Z_{j4}^+ + \sqrt{2}g_2 v_d Z_{j1}^+ + \sqrt{2}g_2 v_u Z_{j2}^+ \right) \right. \\ & + 2 \left( \sqrt{2}v_s \lambda^* \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{j1}^+ - 2\mu^* \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U Z_{j1}^+ \right. \\ & - \sqrt{2}v_u \sum_{c=1}^3 Z_{i3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{u,ba} Z_{k3+b}^U Z_{j1}^+ \\ & - \sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{kc}^U Z_{j1}^+ + \Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{i3+a}^{D,*} Z_{kb}^U Z_{j2}^+ \\ & + \sqrt{2}v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{i3+a}^{D,*} Z_{kb}^U Z_{j2}^+ - 2\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{i3+a}^{D,*} Z_{kb}^U Z_{j2}^+ \\ & - \sqrt{2}v_d \sum_{c=1}^3 Z_{i3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{u,ba} Z_{k3+b}^U Z_{j2}^+ \\ & - \sqrt{2}v_u \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{kc}^U Z_{j2}^+ \\ & + \Lambda_T^* \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \left( -\sqrt{2}v_d Z_{j3}^+ + v_T Z_{j1}^+ \right) \\ & \left. + \sqrt{2}\Lambda_T v_u \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{i3+a}^{D,*} Z_{kb}^U Z_{j4}^+ \right) \quad (321) \end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( 2\sqrt{2}v_s \sum_{c=1}^3 \sum_{b=1}^2 Z_{i10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{kc}^V Z_{j1}^+ + 4 \sum_{c=1}^3 \sum_{b=1}^2 Z_{i10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \mu_{E,ab} Z_{kc}^V Z_{j1}^+ \right. \\
& - 2\sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{kc}^V Z_{j1}^+ \\
& - 2\sqrt{2}v_d \sum_{c=1}^3 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{kc}^V Z_{j1}^+ - 2\Lambda_T v_T \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^V Z_{j2}^+ \\
& - 2\sqrt{2}v_s \lambda \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^V Z_{j2}^+ + 4\mu \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^V Z_{j2}^+ \\
& + 2\Lambda_T v_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{kb}^V Z_{j2}^+ + 2\sqrt{2}v_s \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{kb}^V Z_{j2}^+ \\
& - 4\mu \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{kb}^V Z_{j2}^+ - 2\sqrt{2}\Lambda_T v_u \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^V Z_{j4}^+ \\
& + 2\sqrt{2}\Lambda_T v_u \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{i3+a}^{E,*} Z_{kb}^V Z_{j4}^+ \\
& + g_2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^V \left( 2g_2 v_T Z_{j3}^+ - 2g_2 v_T Z_{j4}^+ + 4M_D^{W,*} Z_{j3}^+ + 4M_D^W Z_{j4}^+ + \sqrt{2}g_2 v_d Z_{j1}^+ + \sqrt{2}g_2 v_u Z_{j2}^+ \right) \\
& + 2\sqrt{2}v_s \sum_{b=1}^2 Z_{i10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{j1}^+ Z_{k4}^V + 4 \sum_{b=1}^2 Z_{i10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \mu_{E,ab} Z_{j1}^+ Z_{k4}^V \\
& - 2\sqrt{2}v_d \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{j1}^+ Z_{k4}^V + 2\sqrt{2}\Lambda_T v_d \lambda_{TR}^* Z_{i8}^{E,*} Z_{j2}^+ Z_{k4}^V \\
& - 2\Lambda_T v_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j2}^+ Z_{k4}^V - 2\sqrt{2}v_s \lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j2}^+ Z_{k4}^V \\
& + 4\mu \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j2}^+ Z_{k4}^V - 2\sqrt{2}v_s \lambda_{SR}^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j2}^+ Z_{k4}^V
\end{aligned}$$

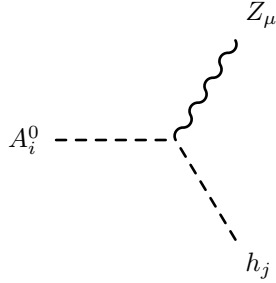
$$\begin{aligned}
& + 2v_T \lambda_{TR}^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j2}^+ Z_{k4}^V - 4\mu_R^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j2}^+ Z_{k4}^V \\
& + 2\sqrt{2}v_u \lambda_{TR}^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j3}^+ Z_{k4}^V + 2\sqrt{2}\lambda_T v_s \lambda_{TR}^* Z_{i8}^{E,*} Z_{j4}^+ Z_{k4}^V \\
& - 2\sqrt{2}\Lambda_T v_u \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j4}^+ Z_{k4}^V + \sqrt{2}g_2^2 v_d Z_{i8}^{E,*} Z_{j1}^+ Z_{k5}^V \\
& + 4\mu_R \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j1}^+ Z_{k5}^V + 2\sqrt{2}\lambda_{SR} v_s \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j1}^+ Z_{k5}^V \\
& - 2\lambda_{TR} v_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j1}^+ Z_{k5}^V + 2v_T \Lambda_T^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j1}^+ Z_{k5}^V \\
& + 2\sqrt{2}v_s \lambda^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j1}^+ Z_{k5}^V - 4\mu^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j1}^+ Z_{k5}^V \\
& + \sqrt{2}g_2^2 v_u Z_{i8}^{E,*} Z_{j2}^+ Z_{k5}^V - 2\sqrt{2}v_u Z_{i8}^{E,*} \sum_{a=1}^2 |Y_{B\hat{a}rE,a}|^2 Z_{j2}^+ Z_{k5}^V \\
& - 2\sqrt{2}v_s \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{B\hat{a}rE,a} Z_{j2}^+ Z_{k5}^V - 4 \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^2 \mu_{E,ba}^* Y_{B\hat{a}rE,a} Z_{j2}^+ Z_{k5}^V \\
& + 2g_2^2 v_T Z_{i8}^{E,*} Z_{j3}^+ Z_{k5}^V - 2v_T |\lambda_{TR}|^2 Z_{i8}^{E,*} Z_{j3}^+ Z_{k5}^V + 4\mu_R \lambda_{TR}^* Z_{i8}^{E,*} Z_{j3}^+ Z_{k5}^V \\
& + 2\sqrt{2}\lambda_{SR} v_s \lambda_{TR}^* Z_{i8}^{E,*} Z_{j3}^+ Z_{k5}^V + 4g_2 M_D^{W,*} Z_{i8}^{E,*} Z_{j3}^+ Z_{k5}^V \\
& - 2\sqrt{2}v_d \Lambda_T^* \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{j3}^+ Z_{k5}^V + 4g_2 M_D^W Z_{i8}^{E,*} Z_{j4}^+ Z_{k5}^V - 2g_2^2 v_T Z_{i8}^{E,*} Z_{j4}^+ Z_{k5}^V \\
& + 2v_T |\lambda_{TR}|^2 Z_{i8}^{E,*} Z_{j4}^+ Z_{k5}^V + 2\sqrt{2}\lambda_{TR} v_s \lambda_{SR}^* Z_{i8}^{E,*} Z_{j4}^+ Z_{k5}^V + 4\lambda_{TR} \mu_R^* Z_{i8}^{E,*} Z_{j4}^+ Z_{k5}^V \\
& + 2\sqrt{2}\lambda_{TR} v_d \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{i8+a}^{E,*} Z_{j4}^+ Z_{k5}^V \\
& + Z_{i7}^{E,*} \left( -2\sqrt{2}v_d \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{kb}^V Z_{j1}^+ + \sqrt{2}g_2^2 v_u Z_{j2}^+ Z_{k4}^V + 2g_2^2 v_T Z_{j3}^+ Z_{k4}^V \right. \\
& \left. - 2v_T |\lambda_{TR}|^2 Z_{j3}^+ Z_{k4}^V - 4\mu_R \lambda_{TR}^* Z_{j3}^+ Z_{k4}^V - 2\sqrt{2}\lambda_{SR} v_s \lambda_{TR}^* Z_{j3}^+ Z_{k4}^V + 4g_2 M_D^{W,*} Z_{j3}^+ Z_{k4}^V \right. \\
& \left. + 4g_2 M_D^W Z_{j4}^+ Z_{k4}^V - 2g_2^2 v_T Z_{j4}^+ Z_{k4}^V + 2v_T |\lambda_{TR}|^2 Z_{j4}^+ Z_{k4}^V - 2\sqrt{2}\lambda_{TR} v_s \lambda_{SR}^* Z_{j4}^+ Z_{k4}^V \right. \\
& \left. - 4\lambda_{TR} \mu_R^* Z_{j4}^+ Z_{k4}^V - 2\sqrt{2}\lambda_{TR} v_s \lambda_T^* Z_{j3}^+ Z_{k5}^V \right. \\
& \left. + \sqrt{2}Z_{j1}^+ \left( 2\lambda_{TR} v_u \Lambda_T^* Z_{k5}^V + v_d \left( -2 \sum_{a=1}^2 |Y_{\hat{E},a}|^2 + g_2^2 \right) Z_{k4}^V \right) \right) \tag{322}
\end{aligned}$$



$$\frac{1}{2}g_3 \left( -M_D^{O,*} + M_D^O \right) \lambda_{\gamma,\beta}^\alpha \left( -\sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \right) \quad (323)$$

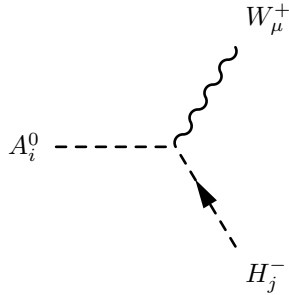

---

## 9.2 Two Scalar-One Vector Boson-Interaction



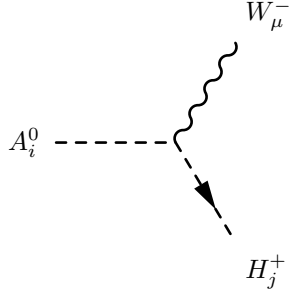
$$\frac{1}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( Z_{i1}^A Z_{j1}^H - Z_{i2}^A Z_{j2}^H \right) \left( -p_\mu^{h_j} + p_\mu^{A_i^0} \right) \quad (324)$$


---



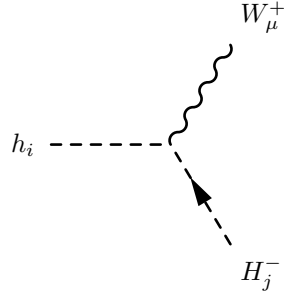
$$\frac{1}{2}g_2 \left( \sqrt{2}Z_{i4}^A \left( -Z_{j4}^+ + Z_{j3}^+ \right) + Z_{i1}^A Z_{j1}^+ + Z_{i2}^A Z_{j2}^+ \right) \left( -p_\mu^{H_j^-} + p_\mu^{A_i^0} \right) \quad (325)$$


---



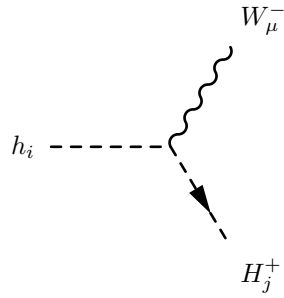
$$\frac{1}{2}g_2\left(\sqrt{2}Z_{i4}^A(-Z_{j4}^+ + Z_{j3}^+) + Z_{i1}^AZ_{j1}^+ + Z_{i2}^AZ_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{A_i^0}\right) \quad (326)$$


---



$$\frac{i}{2}g_2\left(\sqrt{2}Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+) + Z_{i1}^HZ_{j1}^+ - Z_{i2}^HZ_{j2}^+\right)\left(-p_\mu^{H_j^-} + p_\mu^{h_i}\right) \quad (327)$$

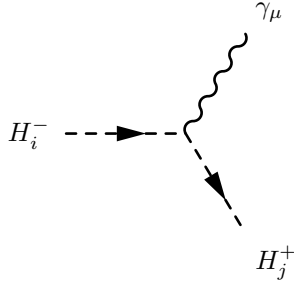

---



$$-\frac{i}{2}g_2\left(\sqrt{2}Z_{i4}^H(Z_{j3}^+ + Z_{j4}^+) + Z_{i1}^HZ_{j1}^+ - Z_{i2}^HZ_{j2}^+\right)\left(-p_\mu^{H_j^+} + p_\mu^{h_i}\right) \quad (328)$$

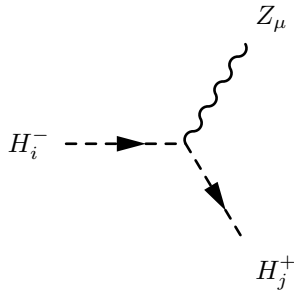

---





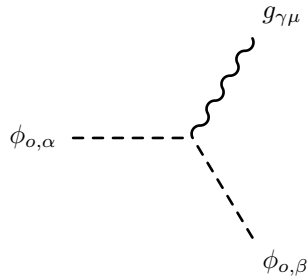
$$\frac{i}{2} \left( (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{i1}^+ Z_{j1}^+ + (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{i2}^+ Z_{j2}^+ \right. \\ \left. + 2g_2 \sin \Theta_W (Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+) \right) (-p_\mu^{H_j^+} + p_\mu^{H_i^-}) \quad (329)$$


---



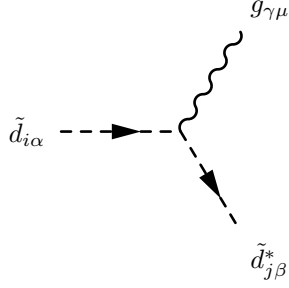
$$\frac{i}{2} \left( (-g_1 \sin \Theta_W + g_2 \cos \Theta_W) Z_{i1}^+ Z_{j1}^+ + (-g_1 \sin \Theta_W + g_2 \cos \Theta_W) Z_{i2}^+ Z_{j2}^+ \right. \\ \left. + 2g_2 \cos \Theta_W (Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+) \right) (-p_\mu^{H_j^+} + p_\mu^{H_i^-}) \quad (330)$$


---



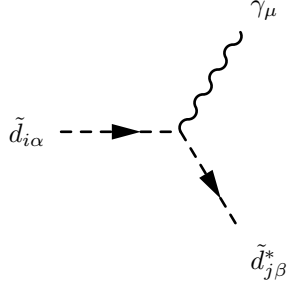
$$g_3 f_{\alpha,\beta,\gamma} (-p_\mu^{\phi_{o,\beta}} + p_\mu^{\phi_{o,\alpha}}) \quad (331)$$


---



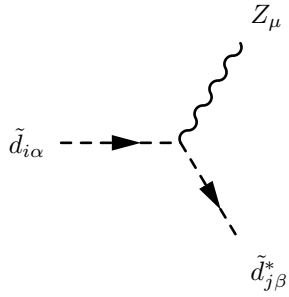
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (332)$$


---



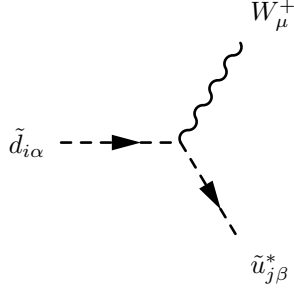
$$-\frac{i}{6}\delta_{\alpha,\beta}\left(-2g_1\cos\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (333)$$


---



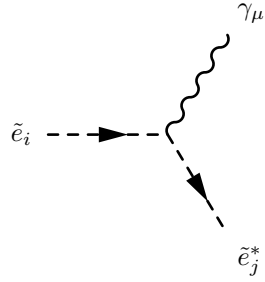
$$\frac{i}{6}\delta_{\alpha,\beta}\left(-2g_1\sin\Theta_W\sum_{a=1}^3Z_{i3+a}^{D,*}Z_{j3+a}^D+\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^D\right)\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{d}_{i\alpha}}\right) \quad (334)$$


---



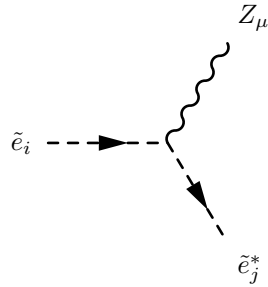
$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U \left( -p_\mu^{\tilde{u}_{j\beta}^*} + p_\mu^{\tilde{d}_{i\alpha}} \right) \quad (335)$$


---



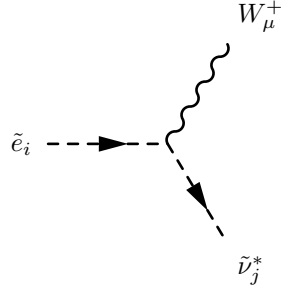
$$\begin{aligned} & \frac{i}{2} \left( 2g_1 \cos \Theta_W \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{j8+a}^E + 2g_1 \cos \Theta_W \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{j10+a}^E + g_1 \cos \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right. \\ & + g_2 \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + 2g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E + g_1 Z_{i7}^{E,*} \cos \Theta_W Z_{j7}^E \\ & \left. + g_2 Z_{i7}^{E,*} \sin \Theta_W Z_{j7}^E + g_1 Z_{i8}^{E,*} \cos \Theta_W Z_{j8}^E + g_2 Z_{i8}^{E,*} \sin \Theta_W Z_{j8}^E \right) \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \quad (336) \end{aligned}$$


---



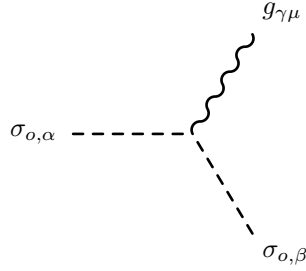
$$\begin{aligned}
& -\frac{i}{2} \left( 2g_1 \sin \Theta_W \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{j8+a}^E + 2g_1 \sin \Theta_W \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{j10+a}^E \right. \\
& - g_2 \cos \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + g_1 \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + 2g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E \\
& - g_2 Z_{i7}^{E,*} \cos \Theta_W Z_{j7}^E + g_1 Z_{i7}^{E,*} \sin \Theta_W Z_{j7}^E - g_2 Z_{i8}^{E,*} \cos \Theta_W Z_{j8}^E \\
& \left. + g_1 Z_{i8}^{E,*} \sin \Theta_W Z_{j8}^E \right) \left( -p_\mu^{\tilde{e}_j^*} + p_\mu^{\tilde{e}_i} \right) \tag{337}
\end{aligned}$$


---



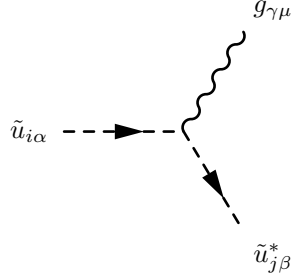
$$-i \frac{1}{\sqrt{2}} g_2 \left( Z_{i7}^{E,*} Z_{j4}^V - Z_{i8}^{E,*} Z_{j5}^V + \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^V \right) \left( -p_\mu^{\tilde{\nu}_j^*} + p_\mu^{\tilde{e}_i} \right) \tag{338}$$


---



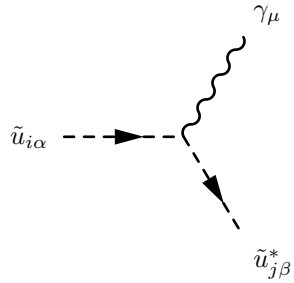
$$g_3 f_{\alpha,\beta,\gamma} \left( -p_\mu^{\sigma_{o,\beta}} + p_\mu^{\sigma_{o,\alpha}} \right) \tag{339}$$


---



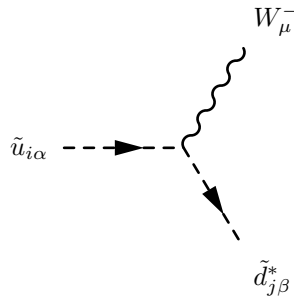
$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\beta,\alpha}^\gamma\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (340)$$


---



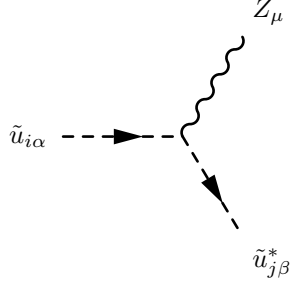
$$-\frac{i}{6}\delta_{\alpha,\beta}\left(\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^U+4g_1\cos\Theta_W\sum_{a=1}^3Z_{i3+a}^{U,*}Z_{j3+a}^U\right)\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (341)$$


---



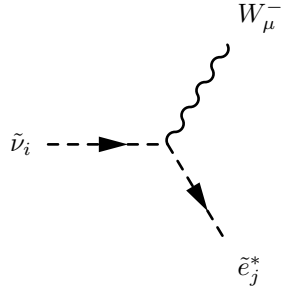
$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha,\beta}\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^D\left(-p_\mu^{\tilde{d}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (342)$$


---



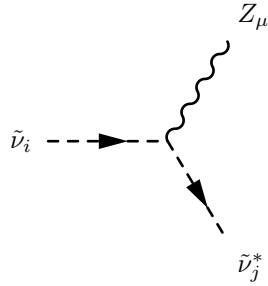
$$-\frac{i}{6}\delta_{\alpha\beta}\left(\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^U-4g_1\sin\Theta_W\sum_{a=1}^3Z_{i3+a}^{U,*}Z_{j3+a}^U\right)\left(-p_\mu^{\tilde{u}_{j\beta}^*}+p_\mu^{\tilde{u}_{i\alpha}}\right) \quad (343)$$


---



$$-i\frac{1}{\sqrt{2}}g_2\left(Z_{i4}^{V,*}Z_{j7}^E-Z_{i5}^{V,*}Z_{j8}^E+\sum_{a=1}^3Z_{ia}^{V,*}Z_{ja}^E\right)\left(-p_\mu^{\tilde{e}_j^*}+p_\mu^{\tilde{\nu}_i}\right) \quad (344)$$

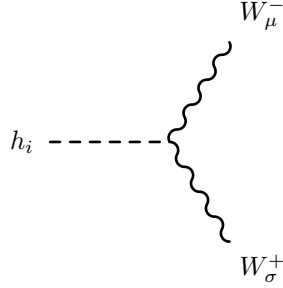

---



$$-\frac{i}{2}\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)\left(Z_{i4}^{V,*}Z_{j4}^V+Z_{i5}^{V,*}Z_{j5}^V+\sum_{a=1}^3Z_{ia}^{V,*}Z_{ja}^V\right)\left(-p_\mu^{\tilde{\nu}_j^*}+p_\mu^{\tilde{\nu}_i}\right) \quad (345)$$

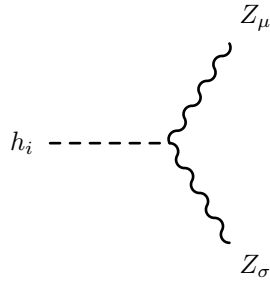

---

### 9.3 One Scalar-Two Vector Boson-Interaction



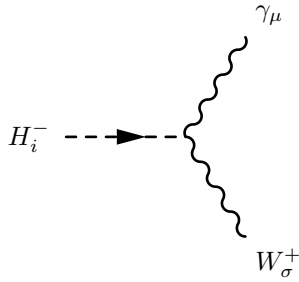
$$\frac{i}{2}g_2^2\left(4v_T Z_{i4}^H + v_d Z_{i1}^H + v_u Z_{i2}^H\right)\left(g_{\sigma\mu}\right) \quad (346)$$


---



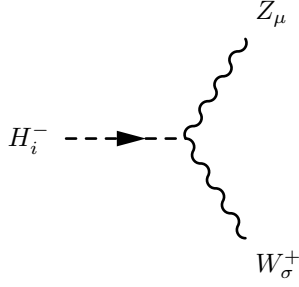
$$\frac{i}{2}\left(g_1 \sin \Theta_W + g_2 \cos \Theta_W\right)^2\left(v_d Z_{i1}^H + v_u Z_{i2}^H\right)\left(g_{\sigma\mu}\right) \quad (347)$$


---



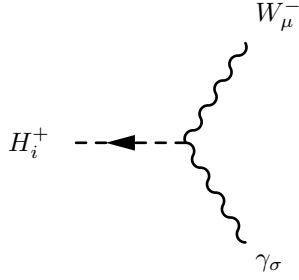
$$-\frac{i}{2}g_2\left(g_1 v_d \cos \Theta_W Z_{i1}^+ - g_1 v_u \cos \Theta_W Z_{i2}^+ + \sqrt{2}g_2 v_T \sin \Theta_W\left(Z_{i3}^+ + Z_{i4}^+\right)\right)\left(g_{\sigma\mu}\right) \quad (348)$$


---



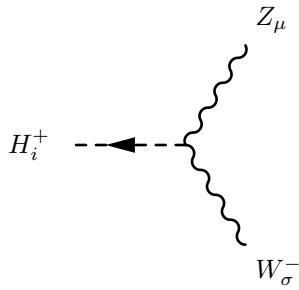
$$-\frac{i}{2}g_2\left(-g_1v_d\sin\Theta_W Z_{i1}^+ + g_1v_u\sin\Theta_W Z_{i2}^+ + \sqrt{2}g_2v_T\cos\Theta_W(Z_{i3}^+ + Z_{i4}^+)\right)(g_{\sigma\mu}) \quad (349)$$


---



$$-\frac{i}{2}g_2\left(g_1v_d\cos\Theta_W Z_{i1}^+ - g_1v_u\cos\Theta_W Z_{i2}^+ + \sqrt{2}g_2v_T\sin\Theta_W(Z_{i3}^+ + Z_{i4}^+)\right)(g_{\sigma\mu}) \quad (350)$$


---

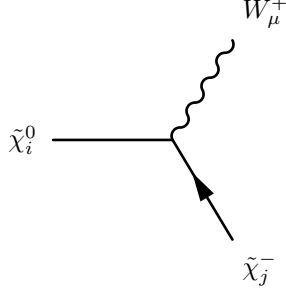


$$-\frac{i}{2}g_2\left(-g_1v_d\sin\Theta_W Z_{i1}^+ + g_1v_u\sin\Theta_W Z_{i2}^+ + \sqrt{2}g_2v_T\cos\Theta_W(Z_{i3}^+ + Z_{i4}^+)\right)(g_{\sigma\mu}) \quad (351)$$


---



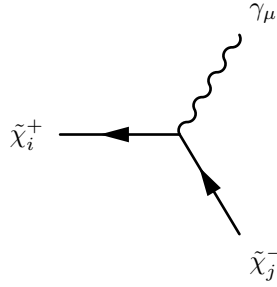
## 9.4 Two Fermion-One Vector Boson-Interaction



$$-\frac{i}{2}g_2\left(2U_{j1}^*N_{i2} + 2U_{j3}^*N_{i6} + \sqrt{2}U_{j2}^*N_{i3}\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (352)$$

$$+ \frac{i}{2}g_2\left(2N_{i2}^*V_{j1} + 2N_{i6}^*V_{j3} - \sqrt{2}N_{i4}^*V_{j2}\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (353)$$

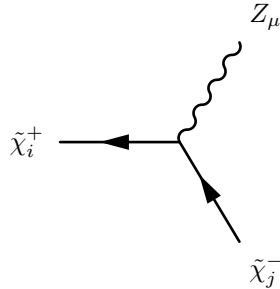

---



$$\frac{i}{2}\left(2g_2U_{j1}^*\sin\Theta_W U_{i1} + 2g_2U_{j3}^*\sin\Theta_W U_{i3} + U_{j2}^*\left(g_1\cos\Theta_W + g_2\sin\Theta_W\right)U_{i2}\right)\left(\gamma_\mu \cdot \frac{1-\gamma_5}{2}\right) \quad (354)$$

$$+ \frac{i}{2}\left(2g_2V_{i1}^*\sin\Theta_W V_{j1} + 2g_2V_{i3}^*\sin\Theta_W V_{j3} + V_{i2}^*\left(g_1\cos\Theta_W + g_2\sin\Theta_W\right)V_{j2}\right)\left(\gamma_\mu \cdot \frac{1+\gamma_5}{2}\right) \quad (355)$$

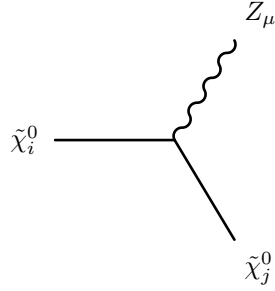

---



$$\frac{i}{2} \left( 2g_2 U_{j1}^* \cos \Theta_W U_{i1} + 2g_2 U_{j3}^* \cos \Theta_W U_{i3} + U_{j2}^* \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) U_{i2} \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (356)$$

$$+ \frac{i}{2} \left( 2g_2 V_{i1}^* \cos \Theta_W V_{j1} + 2g_2 V_{i3}^* \cos \Theta_W V_{j3} + V_{i2}^* \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) V_{j2} \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (357)$$

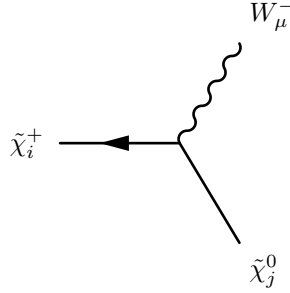

---



$$- \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( N_{j3}^* N_{i3} - N_{j4}^* N_{i4} \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (358)$$

$$+ \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( N_{i3}^* N_{j3} - N_{i4}^* N_{j4} \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (359)$$

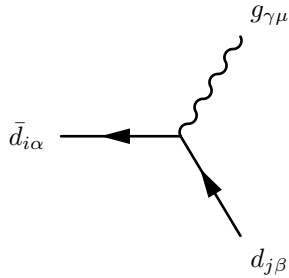

---



$$- \frac{i}{2} g_2 \left( 2N_{j2}^* U_{i1} + 2N_{j6}^* U_{i3} + \sqrt{2} N_{j3}^* U_{i2} \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (360)$$

$$+ - \frac{i}{2} g_2 \left( 2V_{i1}^* N_{j2} + 2V_{i3}^* N_{j6} - \sqrt{2} V_{i2}^* N_{j4} \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (361)$$

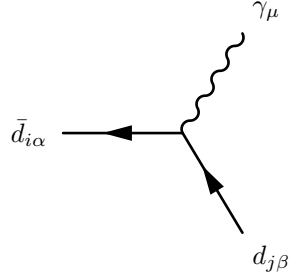

---



$$-\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (362)$$

$$+\frac{i}{2}g_3\delta_{ij}\lambda_{\alpha,\beta}^\gamma\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (363)$$

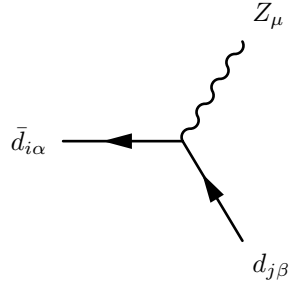

---



$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(-3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (364)$$

$$+\frac{i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (365)$$

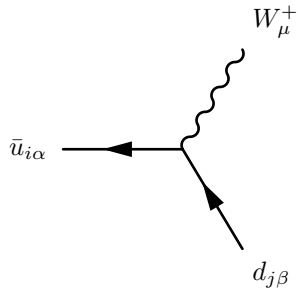

---



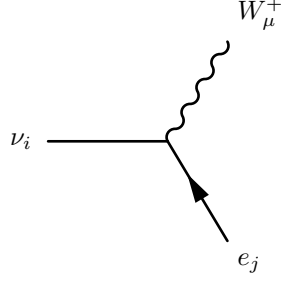
$$\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(3g_2\cos\Theta_W+g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (366)$$

$$+\frac{i}{3}g_1\delta_{\alpha\beta}\delta_{ij}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (367)$$


---

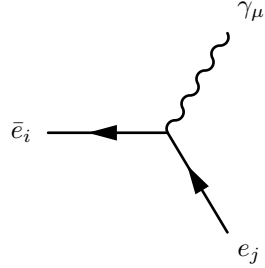


$$-i \frac{1}{\sqrt{2}} g_2 \delta_{\alpha\beta} \sum_{a=1}^3 U_{L,ja}^{d,*} U_{L,ia}^u \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (368)$$



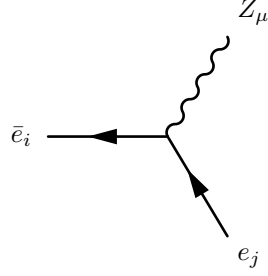
$$-i \frac{1}{\sqrt{2}} g_2 \left( U_{L,j4}^{e,*} U_{i4}^V + \sum_{a=1}^3 U_{L,ja}^{e,*} U_{ia}^V \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (369)$$

$$+ i \frac{1}{\sqrt{2}} g_2 U_{i5}^{V,*} U_{R,j4}^e \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (370)$$



$$\frac{i}{2} \left( 2g_1 \cos \Theta_W \sum_{a=1}^2 U_{L,j4+a}^{e,*} U_{L,i4+a}^e + \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) \left( U_{L,j4}^{e,*} U_{L,i4}^e + \sum_{a=1}^3 U_{L,ja}^{e,*} U_{L,ia}^e \right) \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (371)$$

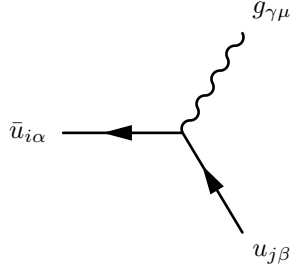
$$+ \frac{i}{2} \left( 2g_1 \cos \Theta_W \sum_{a=1}^2 U_{R,i4+a}^{e,*} U_{R,j4+a}^e + 2g_1 \cos \Theta_W \sum_{a=1}^3 U_{R,ia}^{e,*} U_{R,ja}^e \right. \\ \left. + U_{R,i4}^{e,*} \left( g_1 \cos \Theta_W + g_2 \sin \Theta_W \right) U_{R,j4}^e \right) \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (372)$$



$$\begin{aligned}
& -\frac{i}{2} \left( 2g_1 \sin \Theta_W \sum_{a=1}^2 U_{L,j4+a}^{e,*} U_{L,i4+a}^e \right. \\
& \left. - \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( U_{L,j4}^{e,*} U_{L,i4}^e + \sum_{a=1}^3 U_{L,ja}^{e,*} U_{L,ia}^e \right) \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (373)
\end{aligned}$$

$$\begin{aligned}
& + -\frac{i}{2} \left( 2g_1 \sin \Theta_W \sum_{a=1}^2 U_{R,i4+a}^{e,*} U_{R,j4+a}^e + 2g_1 \sin \Theta_W \sum_{a=1}^3 U_{R,ia}^{e,*} U_{R,ja}^e \right. \\
& \left. + U_{R,i4}^{e,*} \left( g_1 \sin \Theta_W - g_2 \cos \Theta_W \right) U_{R,j4}^e \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (374)
\end{aligned}$$

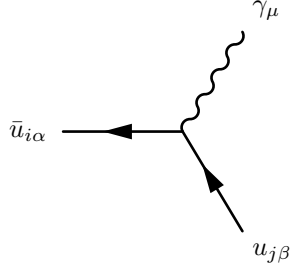

---



$$-\frac{i}{2} g_3 \delta_{ij} \lambda_{\alpha,\beta}^\gamma \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (375)$$

$$+\frac{i}{2} g_3 \delta_{ij} \lambda_{\alpha,\beta}^\gamma \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (376)$$

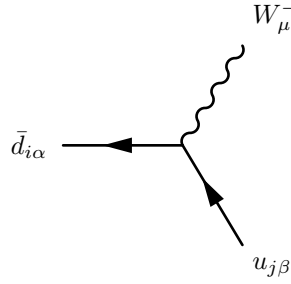

---



$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(3g_2\sin\Theta_W+g_1\cos\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (377)$$

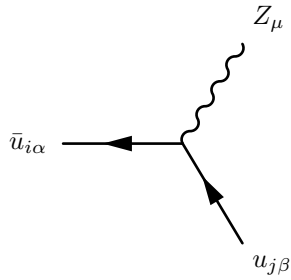
$$+\frac{2i}{3}g_1\cos\Theta_W\delta_{\alpha\beta}\delta_{ij}\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (378)$$


---



$$-i\frac{1}{\sqrt{2}}g_2\delta_{\alpha\beta}\sum_{a=1}^3U_{L,ja}^{u,*}U_{L,ia}^d\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (379)$$

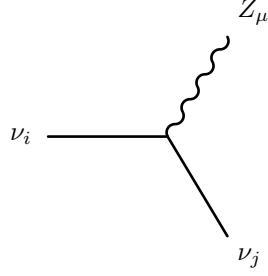

---



$$-\frac{i}{6}\delta_{\alpha\beta}\delta_{ij}\left(3g_2\cos\Theta_W-g_1\sin\Theta_W\right)\left(\gamma_\mu\cdot\frac{1-\gamma_5}{2}\right) \quad (380)$$

$$+\frac{2i}{3}g_1\delta_{\alpha\beta}\delta_{ij}\sin\Theta_W\left(\gamma_\mu\cdot\frac{1+\gamma_5}{2}\right) \quad (381)$$

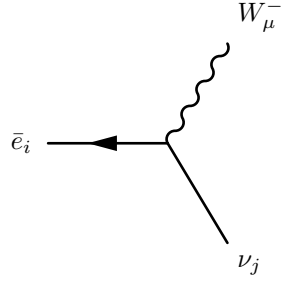

---



$$- \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( U_{j4}^{V,*} U_{i4}^V - U_{j5}^{V,*} U_{i5}^V + \sum_{a=1}^3 U_{ja}^{V,*} U_{ia}^V \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (382)$$

$$+ \frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) \left( U_{i4}^{V,*} U_{j4}^V - U_{i5}^{V,*} U_{j5}^V + \sum_{a=1}^3 U_{ia}^{V,*} U_{ja}^V \right) \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (383)$$

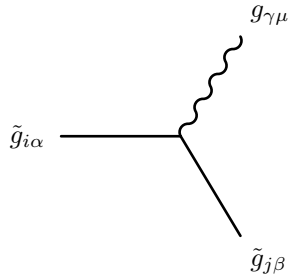

---



$$- i \frac{1}{\sqrt{2}} g_2 \left( U_{j4}^{V,*} U_{L,i4}^e + \sum_{a=1}^3 U_{ja}^{V,*} U_{L,ia}^e \right) \left( \gamma_\mu \cdot \frac{1 - \gamma_5}{2} \right) \quad (384)$$

$$+ i \frac{1}{\sqrt{2}} g_2 U_{R,i4}^{e,*} U_{j5}^V \left( \gamma_\mu \cdot \frac{1 + \gamma_5}{2} \right) \quad (385)$$

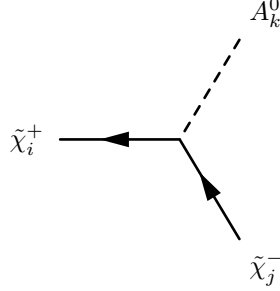

---



$$-g_3 f_{\alpha,\beta,\gamma} \left( Z_{j1}^{G,*} Z_{i1}^G + Z_{j2}^{G,*} Z_{i2}^G \right) \left( \gamma_\mu \cdot \frac{1-\gamma_5}{2} \right) \quad (386)$$

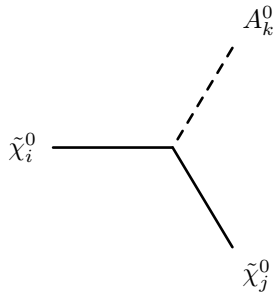
$$+ -g_3 f_{\alpha,\beta,\gamma} \left( Z_{i1}^{G,*} Z_{j1}^G + Z_{i2}^{G,*} Z_{j2}^G \right) \left( \gamma_\mu \cdot \frac{1+\gamma_5}{2} \right) \quad (387)$$

## 9.5 Two Fermion-One Scalar Boson-Interaction



$$\begin{aligned} & \frac{1}{2} \left( U_{j3}^* \left( -2g_2 V_{i1}^* Z_{k4}^A + \sqrt{2} \Lambda_T V_{i2}^* Z_{k1}^A + \sqrt{2} \lambda_T V_{i3}^* Z_{k3}^A \right) \right. \\ & + g_2 U_{j1}^* \left( 2V_{i3}^* Z_{k4}^A - \sqrt{2} V_{i2}^* Z_{k2}^A \right) \\ & \left. - U_{j2}^* \left( \sqrt{2} g_2 V_{i1}^* Z_{k1}^A + \sqrt{2} \Lambda_T V_{i3}^* Z_{k2}^A + V_{i2}^* \left( \Lambda_T Z_{k4}^A + \sqrt{2} \lambda Z_{k3}^A \right) \right) \right) \left( \frac{1-\gamma_5}{2} \right) \end{aligned} \quad (388)$$

$$\begin{aligned} & + \frac{1}{2} \left( -\sqrt{2} \Lambda_T^* U_{i3} V_{j2} Z_{k1}^A + \sqrt{2} g_2 U_{i1} V_{j2} Z_{k2}^A - \sqrt{2} \lambda_T^* U_{i3} V_{j3} Z_{k3}^A + 2g_2 U_{i3} V_{j1} Z_{k4}^A \right. \\ & \left. - 2g_2 U_{i1} V_{j3} Z_{k4}^A + U_{i2} \left( \Lambda_T^* V_{j2} Z_{k4}^A + \sqrt{2} g_2 V_{j1} Z_{k1}^A + \sqrt{2} \Lambda_T^* V_{j3} Z_{k2}^A + \sqrt{2} \lambda^* V_{j2} Z_{k3}^A \right) \right) \left( \frac{1+\gamma_5}{2} \right) \end{aligned} \quad (389)$$

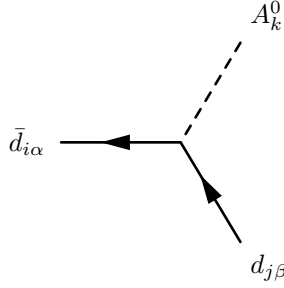


$$\begin{aligned} & \frac{1}{2} \left( -g_2 N_{i2}^* N_{j3}^* Z_{k1}^A + \sqrt{2} \lambda N_{i5}^* N_{j4}^* Z_{k1}^A - \Lambda_T N_{i6}^* N_{j4}^* Z_{k1}^A + \sqrt{2} \lambda N_{i4}^* N_{j5}^* Z_{k1}^A \right. \\ & - \Lambda_T N_{i4}^* N_{j6}^* Z_{k1}^A - g_1 N_{i4}^* N_{j1}^* Z_{k2}^A + g_2 N_{i4}^* N_{j2}^* Z_{k2}^A + \sqrt{2} \lambda N_{i5}^* N_{j3}^* Z_{k2}^A \\ & \left. - \Lambda_T N_{i6}^* N_{j3}^* Z_{k2}^A + g_2 N_{i2}^* N_{j4}^* Z_{k2}^A + g_1 N_{i1}^* \left( N_{j3}^* Z_{k1}^A - N_{j4}^* Z_{k2}^A \right) \right) \end{aligned}$$



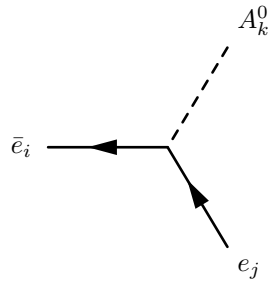
$$\begin{aligned}
& + \sqrt{2}\lambda N_{i4}^* N_{j3}^* Z_{k3}^A + \sqrt{2}\lambda_T N_{i6}^* N_{j6}^* Z_{k3}^A - \Lambda_T N_{i4}^* N_{j3}^* Z_{k4}^A + \sqrt{2}\lambda_T N_{i6}^* N_{j5}^* Z_{k4}^A \\
& + \sqrt{2}\lambda_T N_{i5}^* N_{j6}^* Z_{k4}^A \\
& + N_{i3}^* \left( g_1 N_{j1}^* Z_{k1}^A - g_2 N_{j2}^* Z_{k1}^A + \sqrt{2}\lambda N_{j5}^* Z_{k2}^A - \Lambda_T N_{j6}^* Z_{k2}^A + \sqrt{2}\lambda N_{j4}^* Z_{k3}^A \right. \\
& \left. - \Lambda_T N_{j4}^* Z_{k4}^A \right) \left( \frac{1 - \gamma_5}{2} \right) \tag{390}
\end{aligned}$$

$$\begin{aligned}
& + \frac{1}{2} \left( -\sqrt{2}\lambda^* Z_{k3}^A N_{i4} N_{j3} + \Lambda_T^* Z_{k4}^A N_{i4} N_{j3} - \sqrt{2}\lambda^* Z_{k3}^A N_{i3} N_{j4} + \Lambda_T^* Z_{k4}^A N_{i3} N_{j4} \right. \\
& - \sqrt{2}\lambda_T^* Z_{k4}^A N_{i6} N_{j5} - \sqrt{2}\lambda_T^* Z_{k4}^A N_{i5} N_{j6} - \sqrt{2}\lambda_T^* Z_{k3}^A N_{i6} N_{j6} \\
& + Z_{k2}^A \left( N_{i4} \left( g_1 N_{j1} - g_2 N_{j2} \right) + \Lambda_T^* N_{i6} N_{j3} + g_1 N_{i1} N_{j4} - g_2 N_{i2} N_{j4} - \sqrt{2}\lambda^* \left( N_{i3} N_{j5} + N_{i5} N_{j3} \right) \right. \\
& \left. + \Lambda_T^* N_{i3} N_{j6} \right) \\
& + Z_{k1}^A \left( N_{i3} \left( -g_1 N_{j1} + g_2 N_{j2} \right) - g_1 N_{i1} N_{j3} + g_2 N_{i2} N_{j3} - \sqrt{2}\lambda^* N_{i5} N_{j4} + \Lambda_T^* N_{i6} N_{j4} \right. \\
& \left. - \sqrt{2}\lambda^* N_{i4} N_{j5} + \Lambda_T^* N_{i4} N_{j6} \right) \left( \frac{1 + \gamma_5}{2} \right) \tag{391}
\end{aligned}$$



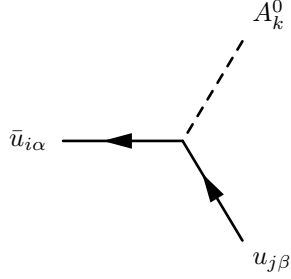
$$\frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{d,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} Z_{k1}^A \left( \frac{1 - \gamma_5}{2} \right) \tag{392}$$

$$+ -\frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* U_{R,ja}^d U_{L,ib}^d Z_{k1}^A \left( \frac{1 + \gamma_5}{2} \right) \tag{393}$$



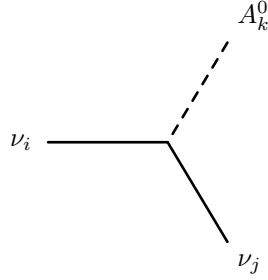
$$\begin{aligned}
& \frac{1}{2} \left( \sqrt{2} \left( - \sum_{b=1}^2 U_{R,i4+b}^{e,*} \sum_{a=1}^3 U_{L,ja}^{e,*} Y_{L,ab} Z_{k1}^A + \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} Z_{k1}^A \right. \right. \\
& + U_{R,i4}^{e,*} \sum_{a=1}^2 U_{L,j4+a}^{e,*} Y_{B\hat{a}rE,a} Z_{k2}^A + \sum_{b=1}^2 U_{L,j4+b}^{e,*} \sum_{a=1}^2 U_{R,i4+a}^{e,*} \lambda_{SE,ab} Z_{k3}^A \left. \right) \\
& - U_{L,j4}^{e,*} \left( \sqrt{2} \sum_{a=1}^2 U_{R,i4+a}^{e,*} Y_{\hat{E},a} Z_{k1}^A + U_{R,i4}^{e,*} \left( \lambda_{TR} Z_{k4}^A + \sqrt{2} \lambda_{SR} Z_{k3}^A \right) \right) \left( \frac{1-\gamma_5}{2} \right) \tag{394}
\end{aligned}$$

$$\begin{aligned}
& + \frac{1}{2} \left( \sqrt{2} \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ab}^* U_{L,ia}^e U_{R,j4+b}^e Z_{k1}^A - \sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{L,ib}^e Z_{k1}^A \right. \\
& - \sqrt{2} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* U_{R,j4+a}^e U_{L,i4+b}^e Z_{k3}^A + \sqrt{2} \sum_{a=1}^2 Y_{\hat{E},a}^* U_{R,j4+a}^e Z_{k1}^A U_{L,i4}^e \\
& \left. - \sqrt{2} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* U_{L,i4+a}^e Z_{k2}^A U_{R,j4}^e + \sqrt{2} \lambda_{SR}^* Z_{k3}^A U_{L,i4}^e U_{R,j4}^e + \lambda_{TR}^* Z_{k4}^A U_{L,i4}^e U_{R,j4}^e \right) \left( \frac{1+\gamma_5}{2} \right) \tag{395}
\end{aligned}$$



$$\frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} Z_{k2}^A \left( \frac{1-\gamma_5}{2} \right) \tag{396}$$

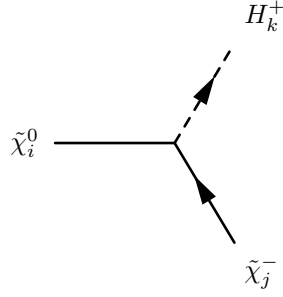
$$+ - \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^u Z_{k2}^A \left( \frac{1+\gamma_5}{2} \right) \tag{397}$$



$$\frac{1}{2} \left( U_{i4}^{V,*} U_{j5}^{V,*} + U_{i5}^{V,*} U_{j4}^{V,*} \right) \left( -\lambda_{TR} Z_{k4}^A + \sqrt{2} \lambda_{SR} Z_{k3}^A \right) \left( \frac{1-\gamma_5}{2} \right) \quad (398)$$

$$+ \frac{1}{2} \left( U_{i4}^V U_{j5}^V + U_{i5}^V U_{j4}^V \right) \left( -\lambda_{TR}^* Z_{k4}^A + \sqrt{2} \lambda_{SR}^* Z_{k3}^A \right) \left( \frac{1+\gamma_5}{2} \right) \quad (399)$$

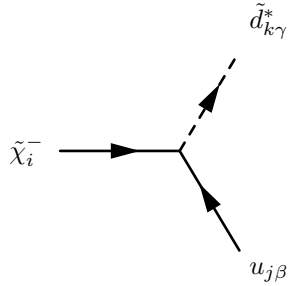

---



$$\frac{i}{2} \left( U_{j2}^* \left( 2\lambda N_{i5}^* Z_{k2}^+ + 2\Lambda_T N_{i4}^* Z_{k4}^+ + \sqrt{2} g_1 N_{i1}^* Z_{k1}^+ + \sqrt{2} g_2 N_{i2}^* Z_{k1}^+ + \sqrt{2} \Lambda_T N_{i6}^* Z_{k2}^+ \right) \right. \\ \left. - 2 \left( g_2 U_{j1}^* \left( N_{i3}^* Z_{k1}^+ + \sqrt{2} N_{i6}^* Z_{k3}^+ \right) + U_{j3}^* \left( \Lambda_T N_{i3}^* Z_{k2}^+ + \lambda_T N_{i5}^* Z_{k4}^+ - \sqrt{2} g_2 N_{i2}^* Z_{k3}^+ \right) \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (400)$$

$$+ \frac{i}{2} \left( 2\lambda^* V_{j2} N_{i5} Z_{k1}^+ - \sqrt{2} g_1 V_{j2} N_{i1} Z_{k2}^+ - \sqrt{2} g_2 V_{j2} N_{i2} Z_{k2}^+ - 2g_2 V_{j1} N_{i4} Z_{k2}^+ \right. \\ \left. - 2\lambda_T^* V_{j3} N_{i5} Z_{k3}^+ + \Lambda_T^* \left( 2V_{j3} N_{i4} Z_{k1}^+ + V_{j2} \left( -2N_{i3} Z_{k3}^+ + \sqrt{2} N_{i6} Z_{k1}^+ \right) \right) - 2\sqrt{2} g_2 V_{j3} N_{i2} Z_{k4}^+ \right. \\ \left. + 2\sqrt{2} g_2 V_{j1} N_{i6} Z_{k4}^+ \right) \left( \frac{1+\gamma_5}{2} \right) \quad (401)$$

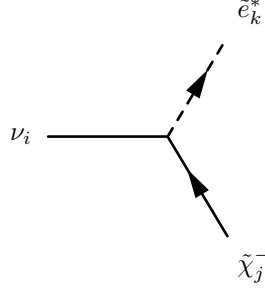

---



$$- i\delta_{\beta\gamma} \left( g_2 U_{i1}^* \sum_{a=1}^3 U_{L,ja}^{u,*} Z_{ka}^D - U_{i2}^* \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \right) \left( \frac{1-\gamma_5}{2} \right) \quad (402)$$

$$+ i\delta_{\beta\gamma} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u Z_{kb}^D V_{i2} \left( \frac{1+\gamma_5}{2} \right) \quad (403)$$

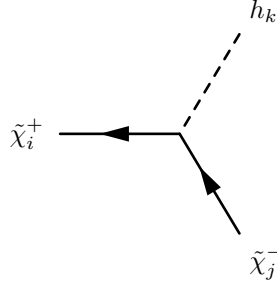

---



$$\begin{aligned}
& -i \left( U_{j2}^* \left( - \sum_{b=1}^3 U_{ib}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E + U_{i4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E + \sum_{b=1}^2 \sum_{a=1}^3 U_{ia}^{V,*} Y_{L,ab} Z_{k8+b}^E \right) \right. \\
& + g_2 U_{j1}^* \left( U_{i4}^{V,*} Z_{k7}^E + \sum_{a=1}^3 U_{ia}^{V,*} Z_{ka}^E \right) + \lambda_{TR} U_{j3}^* U_{i4}^{V,*} Z_{k8}^E \left. \right) \left( \frac{1-\gamma_5}{2} \right) \tag{404}
\end{aligned}$$

$$+ i U_{i5}^V \left( -g_2 V_{j1} Z_{k8}^E + \lambda_{TR}^* V_{j3} Z_{k7}^E + \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{k10+a}^E V_{j2} \right) \left( \frac{1+\gamma_5}{2} \right) \tag{405}$$

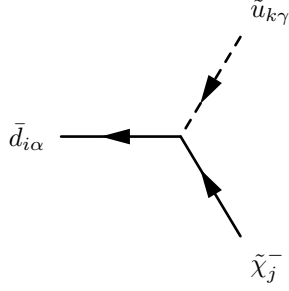

---



$$\begin{aligned}
& -\frac{i}{2} \left( U_{j3}^* \left( 2g_2 V_{i1}^* Z_{k4}^H + \sqrt{2} \Lambda_T V_{i2}^* Z_{k1}^H + \sqrt{2} \lambda_T V_{i3}^* Z_{k3}^H \right) + g_2 U_{j1}^* \left( -2V_{i3}^* Z_{k4}^H + \sqrt{2} V_{i2}^* Z_{k2}^H \right) \right. \\
& + U_{j2}^* \left( \sqrt{2} g_2 V_{i1}^* Z_{k1}^H - \sqrt{2} \Lambda_T V_{i3}^* Z_{k2}^H - V_{i2}^* \left( \Lambda_T Z_{k4}^H + \sqrt{2} \lambda Z_{k3}^H \right) \right) \left. \right) \left( \frac{1-\gamma_5}{2} \right) \tag{406}
\end{aligned}$$

$$\begin{aligned}
& + -\frac{i}{2} \left( \sqrt{2} \Lambda_T^* U_{i3} V_{j2} Z_{k1}^H + \sqrt{2} g_2 U_{i1} V_{j2} Z_{k2}^H + \sqrt{2} \lambda_T^* U_{i3} V_{j3} Z_{k3}^H + 2g_2 U_{i3} V_{j1} Z_{k4}^H \right. \\
& \left. - 2g_2 U_{i1} V_{j3} Z_{k4}^H + U_{i2} \left( -\Lambda_T^* \left( \sqrt{2} V_{j3} Z_{k2}^H + V_{j2} Z_{k4}^H \right) + \sqrt{2} g_2 V_{j1} Z_{k1}^H - \sqrt{2} \lambda^* V_{j2} Z_{k3}^H \right) \right) \left( \frac{1+\gamma_5}{2} \right) \tag{407}
\end{aligned}$$

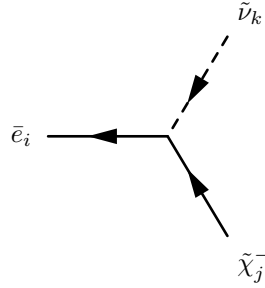

---



$$iU_{j2}^* \delta_{\alpha\gamma} \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (408)$$

$$+ -i\delta_{\alpha\gamma} \left( g_2 \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^d V_{j1} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} U_{L,ib}^d V_{j2} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (409)$$

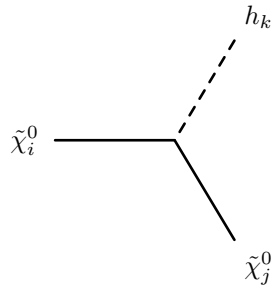

---



$$-i \left( \lambda_{TR} U_{j3}^* U_{R,i4}^{e,*} Z_{k4}^{V,*} + g_2 U_{j1}^* U_{R,i4}^{e,*} Z_{k5}^{V,*} \right. \\ \left. + U_{j2}^* \left( - \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} + Z_{k4}^{V,*} \sum_{a=1}^2 U_{R,i4+a}^{e,*} Y_{\hat{E},a} + \sum_{b=1}^2 U_{R,i4+b}^{e,*} \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (410)$$

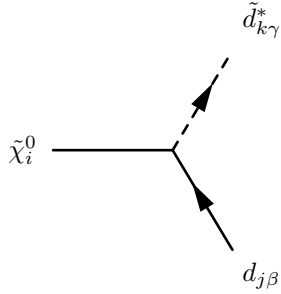
$$+ -i \left( g_2 \sum_{a=1}^3 Z_{ka}^{V,*} U_{L,ia}^e V_{j1} + g_2 Z_{k4}^{V,*} V_{j1} U_{L,i4}^e - Z_{k5}^{V,*} \left( \lambda_{TR} V_{j3} U_{L,i4}^e + \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* U_{L,i4+a}^e V_{j2} \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (411)$$


---



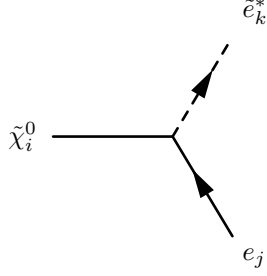
$$\begin{aligned}
& -\frac{i}{2} \left( g_2 N_{i2}^* N_{j3}^* Z_{k1}^H + \sqrt{2} \lambda N_{i5}^* N_{j4}^* Z_{k1}^H - \Lambda_T N_{i6}^* N_{j4}^* Z_{k1}^H + \sqrt{2} \lambda N_{i4}^* N_{j5}^* Z_{k1}^H \right. \\
& - \Lambda_T N_{i4}^* N_{j6}^* Z_{k1}^H + g_1 N_{i4}^* N_{j1}^* Z_{k2}^H - g_2 N_{i4}^* N_{j2}^* Z_{k2}^H + \sqrt{2} \lambda N_{i5}^* N_{j3}^* Z_{k2}^H \\
& - \Lambda_T N_{i6}^* N_{j3}^* Z_{k2}^H - g_2 N_{i2}^* N_{j4}^* Z_{k2}^H + N_{i1}^* \left( -g_1 N_{j3}^* Z_{k1}^H + g_1 N_{j4}^* Z_{k2}^H \right) \\
& + \sqrt{2} \lambda N_{i4}^* N_{j3}^* Z_{k3}^H + \sqrt{2} \lambda_T N_{i6}^* N_{j6}^* Z_{k3}^H - \Lambda_T N_{i4}^* N_{j3}^* Z_{k4}^H + \sqrt{2} \lambda_T N_{i6}^* N_{j5}^* Z_{k4}^H \\
& + \sqrt{2} \lambda_T N_{i5}^* N_{j6}^* Z_{k4}^H \\
& + N_{i3}^* \left( -g_1 N_{j1}^* Z_{k1}^H + g_2 N_{j2}^* Z_{k1}^H + \sqrt{2} \lambda N_{j5}^* Z_{k2}^H - \Lambda_T N_{j6}^* Z_{k2}^H + \sqrt{2} \lambda N_{j4}^* Z_{k3}^H \right. \\
& \left. - \Lambda_T N_{j4}^* Z_{k4}^H \right) \left( \frac{1 - \gamma_5}{2} \right) \tag{412}
\end{aligned}$$

$$\begin{aligned}
& + \frac{i}{2} \left( \sqrt{2} \lambda^* Z_{k3}^H N_{i4} N_{j3} - \Lambda_T^* Z_{k4}^H N_{i4} N_{j3} + \sqrt{2} \lambda^* Z_{k3}^H N_{i3} N_{j4} - \Lambda_T^* Z_{k4}^H N_{i3} N_{j4} \right. \\
& + \sqrt{2} \lambda_T^* Z_{k4}^H N_{i6} N_{j5} + \sqrt{2} \lambda_T^* Z_{k4}^H N_{i5} N_{j6} + \sqrt{2} \lambda_T^* Z_{k3}^H N_{i6} N_{j6} \\
& + Z_{k2}^H \left( N_{i4} \left( g_1 N_{j1} - g_2 N_{j2} \right) - \Lambda_T^* N_{i6} N_{j3} + g_1 N_{i1} N_{j4} - g_2 N_{i2} N_{j4} + \sqrt{2} \lambda^* \left( N_{i3} N_{j5} + N_{i5} N_{j3} \right) \right. \\
& \left. - \Lambda_T^* N_{i3} N_{j6} \right) \\
& + Z_{k1}^H \left( N_{i3} \left( -g_1 N_{j1} + g_2 N_{j2} \right) - g_1 N_{i1} N_{j3} + g_2 N_{i2} N_{j3} + \sqrt{2} \lambda^* N_{i5} N_{j4} - \Lambda_T^* N_{i6} N_{j4} \right. \\
& \left. + \sqrt{2} \lambda^* N_{i4} N_{j5} - \Lambda_T^* N_{i4} N_{j6} \right) \left( \frac{1 + \gamma_5}{2} \right) \tag{413}
\end{aligned}$$

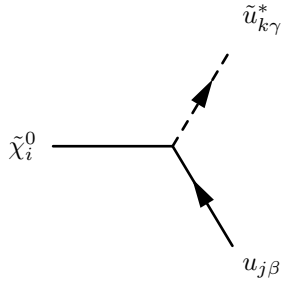


$$-\frac{i}{6} \delta_{\beta\gamma} \left( -3\sqrt{2} g_2 N_{i2}^* \sum_{a=1}^3 U_{L,ja}^{d,*} Z_{ka}^D + 6N_{i3}^* \sum_{b=1}^3 U_{L,jb}^{d,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D + \sqrt{2} g_1 N_{i1}^* \sum_{a=1}^3 U_{L,ja}^{d,*} Z_{ka}^D \right) \left( \frac{1 - \gamma_5}{2} \right) \tag{414}$$

$$+\frac{i}{3} \delta_{\beta\gamma} \left( 3 \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab} U_{R,ja}^d Z_{kb}^D N_{i3} + \sqrt{2} g_1 \sum_{a=1}^3 Z_{k3+a}^D U_{R,ja}^d N_{i1} \right) \left( \frac{1 + \gamma_5}{2} \right) \tag{415}$$

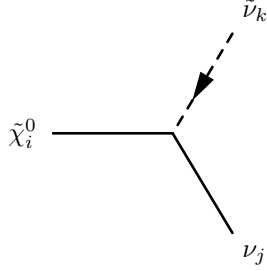


$$\begin{aligned}
& \frac{i}{2} \left( \sqrt{2}g_2 N_{i2}^* \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{ka}^E + \sqrt{2}g_1 N_{i1}^* \left( 2 \sum_{a=1}^2 U_{L,j4+a}^{e,*} Z_{k10+a}^E + \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{ka}^E \right) \right. \\
& - 2N_{i5}^* \sum_{b=1}^2 U_{L,j4+b}^{e,*} \sum_{a=1}^2 \lambda_{SE,ab} Z_{k8+a}^E + 2N_{i3}^* \sum_{b=1}^2 \sum_{a=1}^3 U_{L,ja}^{e,*} Y_{L,ab} Z_{k8+b}^E \\
& - 2N_{i3}^* \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E - 2N_{i4}^* \sum_{a=1}^2 U_{L,j4+a}^{e,*} Y_{B\hat{a}rE,a} Z_{k8}^E \\
& \left. + U_{L,j4}^{e,*} \left( 2\lambda_{SR} N_{i5}^* Z_{k8}^E + 2N_{i3}^* \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E + \sqrt{2}g_1 N_{i1}^* Z_{k7}^E + \sqrt{2}g_2 N_{i2}^* Z_{k7}^E + \sqrt{2}\lambda_{TR} N_{i6}^* Z_{k8}^E \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (416) \\
& + \frac{i}{2} \left( 2\sqrt{2}g_1 \sum_{a=1}^2 Z_{k8+a}^E U_{R,j4+a}^e N_{i1} + 2\sqrt{2}g_1 \sum_{a=1}^3 Z_{k3+a}^E U_{R,ja}^e N_{i1} + \sqrt{2}g_1 Z_{k8}^E U_{R,j4}^e N_{i1} \right. \\
& + \sqrt{2}g_2 Z_{k8}^E U_{R,j4}^e N_{i2} - 2 \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^E U_{R,j4+b}^e N_{i3} + 2 \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e Z_{kb}^E N_{i3} \\
& - 2 \sum_{a=1}^2 Y_{\hat{E},a}^* U_{R,j4+a}^e Z_{k7}^E N_{i3} + 2 \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{k10+a}^E U_{R,j4}^e N_{i4} + 2 \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* U_{R,j4+a}^e Z_{k10+b}^E N_{i5} \\
& \left. - 2\lambda_{SR}^* Z_{k7}^E U_{R,j4}^e N_{i5} - \sqrt{2}\lambda_{TR}^* Z_{k7}^E U_{R,j4}^e N_{i6} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (417)
\end{aligned}$$



$$- \frac{i}{6} \delta_{\beta\gamma} \left( 3\sqrt{2}g_2 N_{i2}^* \sum_{a=1}^3 U_{L,ja}^{u,*} Z_{ka}^U + 6N_{i4}^* \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U + \sqrt{2}g_1 N_{i1}^* \sum_{a=1}^3 U_{L,ja}^{u,*} Z_{ka}^U \right) \left( \frac{1-\gamma_5}{2} \right) \quad (418)$$

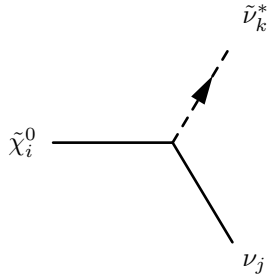
$$+ \frac{i}{3} \delta_{\beta\gamma} \left( 2\sqrt{2}g_1 \sum_{a=1}^3 Z_{k3+a}^U U_{R,ja}^u N_{i1} - 3 \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u Z_{kb}^U N_{i4} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (419)$$



$$- \frac{i}{2} U_{j5}^{V,*} \left( 2\lambda_{SR} N_{i5}^* Z_{k4}^{V,*} - \sqrt{2} \left( (-g_1 N_{i1}^* + g_2 N_{i2}^*) Z_{k5}^{V,*} + \lambda_{TR} N_{i6}^* Z_{k4}^{V,*} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (420)$$

$$+ \frac{i}{2} \left( \sqrt{2} \sum_{a=1}^3 Z_{ka}^{V,*} U_{ja}^V (g_1 N_{i1} - g_2 N_{i2}) \right)$$

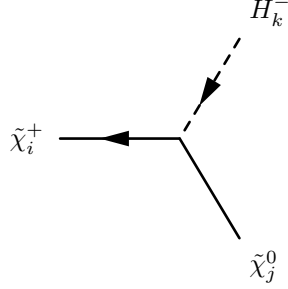
$$+ U_{j4}^V \left( \sqrt{2} Z_{k4}^{V,*} (g_1 N_{i1} - g_2 N_{i2}) + Z_{k5}^{V,*} (-2\lambda_{SR}^* N_{i5} + \sqrt{2}\lambda_{TR}^* N_{i6}) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (421)$$



$$\frac{i}{2} \left( \sqrt{2}g_1 N_{i1}^* \left( U_{j4}^{V,*} Z_{k4}^V + \sum_{a=1}^3 U_{ja}^{V,*} Z_{ka}^V \right) - \sqrt{2}g_2 N_{i2}^* \left( U_{j4}^{V,*} Z_{k4}^V + \sum_{a=1}^3 U_{ja}^{V,*} Z_{ka}^V \right) \right. \\ \left. + U_{j4}^{V,*} \left( -2\lambda_{SR} N_{i5}^* + \sqrt{2}\lambda_{TR} N_{i6}^* \right) Z_{k5}^V \right) \left( \frac{1-\gamma_5}{2} \right) \quad (422)$$

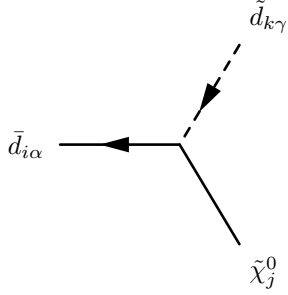
$$+ - \frac{i}{2} U_{j5}^V \left( 2\lambda_{SR}^* N_{i5} Z_{k4}^V - \sqrt{2} \left( (-g_1 N_{i1} + g_2 N_{i2}) Z_{k5}^V + \lambda_{TR}^* N_{i6} Z_{k4}^V \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (423)$$





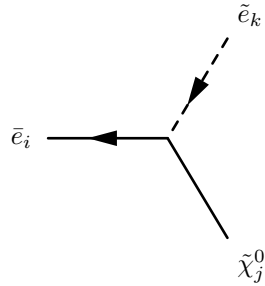
$$\begin{aligned} & \frac{i}{2} \left( V_{i2}^* \left( 2\lambda N_{j5}^* Z_{k1}^+ - 2\Lambda_T N_{j3}^* Z_{k3}^+ - \sqrt{2}g_1 N_{j1}^* Z_{k2}^+ - \sqrt{2}g_2 N_{j2}^* Z_{k2}^+ + \sqrt{2}\Lambda_T N_{j6}^* Z_{k1}^+ \right) \right. \\ & \left. + 2V_{i3}^* \left( \Lambda_T N_{j4}^* Z_{k1}^+ - \lambda_T N_{j5}^* Z_{k3}^+ - \sqrt{2}g_2 N_{j2}^* Z_{k4}^+ \right) + 2g_2 V_{i1}^* \left( -N_{j4}^* Z_{k2}^+ + \sqrt{2}N_{j6}^* Z_{k4}^+ \right) \right) \left( \frac{1-\gamma_5}{2} \right) \end{aligned} \quad (424)$$

$$\begin{aligned} & + \frac{i}{2} \left( U_{i2} \left( 2\lambda^* N_{j5} Z_{k2}^+ + 2\Lambda_T^* N_{j4} Z_{k4}^+ + \sqrt{2}g_1 N_{j1} Z_{k1}^+ + \sqrt{2}g_2 N_{j2} Z_{k1}^+ + \sqrt{2}\Lambda_T^* N_{j6} Z_{k2}^+ \right) \right. \\ & \left. - 2 \left( g_2 U_{i1} \left( N_{j3} Z_{k1}^+ + \sqrt{2}N_{j6} Z_{k3}^+ \right) + U_{i3} \left( \Lambda_T^* N_{j3} Z_{k2}^+ + \lambda_T^* N_{j5} Z_{k4}^+ - \sqrt{2}g_2 N_{j2} Z_{k3}^+ \right) \right) \right) \left( \frac{1+\gamma_5}{2} \right) \end{aligned} \quad (425)$$



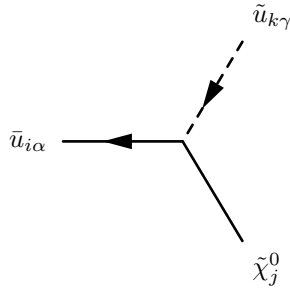
$$- \frac{i}{3} \delta_{\alpha\gamma} \left( 3N_{j3}^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} + \sqrt{2}g_1 N_{j1}^* \sum_{a=1}^3 Z_{k3+a}^{D,*} U_{R,ia}^{d,*} \right) \left( \frac{1-\gamma_5}{2} \right) \quad (426)$$

$$+ - \frac{i}{6} \delta_{\alpha\gamma} \left( 6 \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} U_{L,ib}^d N_{j3} + \sqrt{2} \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ia}^d \left( -3g_2 N_{j2} + g_1 N_{j1} \right) \right) \left( \frac{1+\gamma_5}{2} \right) \quad (427)$$



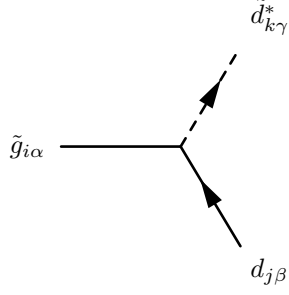
$$\begin{aligned}
& -\frac{i}{2} \left( \sqrt{2} Z_{k8}^{E,*} U_{R,i4}^{e,*} (g_1 N_{j1}^* + g_2 N_{j2}^*) \right. \\
& - Z_{k7}^{E,*} \left( 2N_{j3}^* \sum_{a=1}^2 U_{R,i4+a}^{e,*} Y_{\hat{E},a} + U_{R,i4}^{e,*} (2\lambda_{SR} N_{j5}^* + \sqrt{2}\lambda_{TR} N_{j6}^*) \right) \\
& + 2 \left( U_{R,i4}^{e,*} N_{j4}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} + \sqrt{2}g_1 N_{j1}^* \left( \sum_{a=1}^2 Z_{k8+a}^{E,*} U_{R,i4+a}^{e,*} + \sum_{a=1}^3 Z_{k3+a}^{E,*} U_{R,ia}^{e,*} \right) \right. \\
& + N_{j5}^* \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 U_{R,i4+a}^{e,*} \lambda_{SE,ab} - N_{j3}^* \sum_{b=1}^2 U_{R,i4+b}^{e,*} \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} \\
& \left. \left. + N_{j3}^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} \right) \right) \left( \frac{1-\gamma_5}{2} \right) \tag{428}
\end{aligned}$$

$$\begin{aligned}
& + \frac{i}{2} \left( 2\sqrt{2}g_1 \sum_{a=1}^2 Z_{k10+a}^{E,*} U_{L,i4+a}^e N_{j1} + \sqrt{2}g_1 Z_{k7}^{E,*} U_{L,i4}^e N_{j1} + \sqrt{2}g_2 Z_{k7}^{E,*} U_{L,i4}^e N_{j2} \right. \\
& + \sqrt{2} \sum_{a=1}^3 Z_{ka}^{E,*} U_{L,ia}^e (g_1 N_{j1} + g_2 N_{j2}) + 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* U_{L,ia}^e N_{j3} \\
& - 2 \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} U_{L,ib}^e N_{j3} + 2 \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} U_{L,i4}^e N_{j3} - 2 Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* U_{L,i4+a}^e N_{j4} \\
& \left. - 2 \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Z_{k8+a}^{E,*} U_{L,i4+b}^e N_{j5} + 2\lambda_{SR}^* Z_{k8}^{E,*} U_{L,i4}^e N_{j5} + \sqrt{2}\lambda_{TR}^* Z_{k8}^{E,*} U_{L,i4}^e N_{j6} \right) \left( \frac{1+\gamma_5}{2} \right) \tag{429}
\end{aligned}$$



$$\frac{i}{3} \delta_{\alpha\gamma} \left( 2\sqrt{2}g_1 N_{j1}^* \sum_{a=1}^3 Z_{k3+a}^{U,*} U_{R,ia}^{u,*} - 3N_{j4}^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} \right) \left( \frac{1-\gamma_5}{2} \right) \tag{430}$$

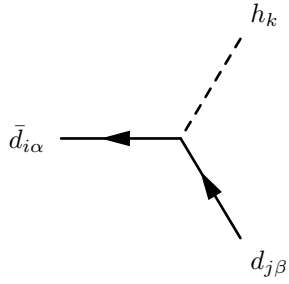
$$+ \frac{i}{6} \delta_{\alpha\gamma} \left( 6 \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} U_{L,ib}^u N_{j4} + \sqrt{2} \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^u (3g_2 N_{j2} + g_1 N_{j1}) \right) \left( \frac{1+\gamma_5}{2} \right) \tag{431}$$



$$-i \frac{1}{\sqrt{2}} g_3 Z_{i1}^{G,*} \lambda_{\gamma,\beta}^\alpha \sum_{a=1}^3 U_{L,ja}^{d,*} Z_{ka}^D \left( \frac{1-\gamma_5}{2} \right) \quad (432)$$

$$+ i \frac{1}{\sqrt{2}} g_3 \lambda_{\gamma,\beta}^\alpha \sum_{a=1}^3 Z_{k3+a}^D U_{R,ja}^d Z_{i1}^G \left( \frac{1+\gamma_5}{2} \right) \quad (433)$$

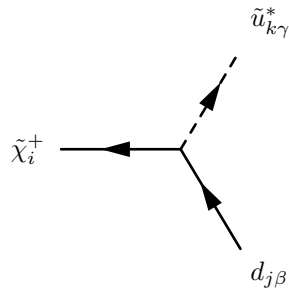

---



$$-i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{d,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} Z_{k1}^H \left( \frac{1-\gamma_5}{2} \right) \quad (434)$$

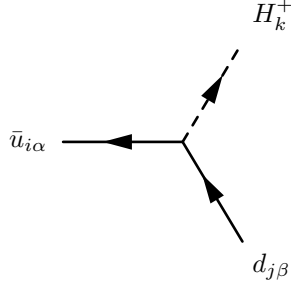
$$+ -i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* U_{R,ja}^d U_{L,ib}^d Z_{k1}^H \left( \frac{1+\gamma_5}{2} \right) \quad (435)$$


---



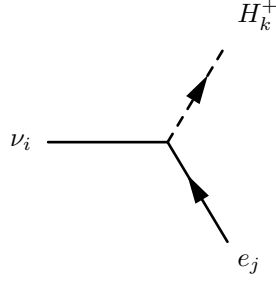
$$-i\delta_{\beta\gamma}\left(g_2V_{i1}^*\sum_{a=1}^3U_{L,ja}^{d,*}Z_{ka}^U - V_{i2}^*\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3Y_{u,ab}Z_{k3+a}^U\right)\left(\frac{1-\gamma_5}{2}\right) \quad (436)$$

$$+i\delta_{\beta\gamma}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*U_{R,ja}^dZ_{kb}^U U_{i2}\left(\frac{1+\gamma_5}{2}\right) \quad (437)$$



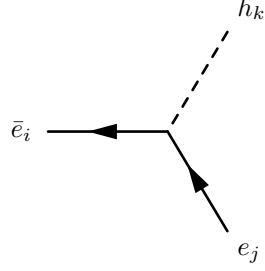
$$i\delta_{\alpha\beta}\sum_{b=1}^3U_{L,jb}^{d,*}\sum_{a=1}^3U_{R,ia}^{u,*}Y_{u,ab}Z_{k2}^+\left(\frac{1-\gamma_5}{2}\right) \quad (438)$$

$$+i\delta_{\alpha\beta}\sum_{b=1}^3\sum_{a=1}^3Y_{d,ab}^*U_{R,ja}^dU_{L,ib}^uZ_{k1}^+\left(\frac{1+\gamma_5}{2}\right) \quad (439)$$



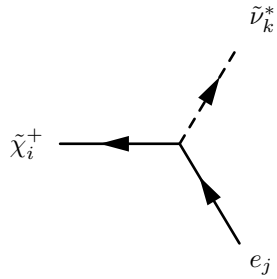
$$iU_{i5}^{V,*}\left(\lambda_{TR}U_{L,j4}^{e,*}Z_{k4}^+ + \sum_{a=1}^2U_{L,j4+a}^{e,*}Y_{B\hat{a}rE,a}Z_{k2}^+\right)\left(\frac{1-\gamma_5}{2}\right) \quad (440)$$

$$+ -i\left(\sum_{b=1}^2\sum_{a=1}^3Y_{L,ab}^*U_{ia}^VU_{R,j4+b}^eZ_{k1}^+ - \sum_{b=1}^3\sum_{a=1}^3Y_{e,ab}^*U_{R,ja}^eU_{ib}^VZ_{k1}^+\right) \\ + U_{i4}^V\left(\lambda_{TR}^*U_{R,j4}^eZ_{k3}^+ + \sum_{a=1}^2Y_{\hat{E},a}^*U_{R,j4+a}^eZ_{k1}^+\right)\left(\frac{1+\gamma_5}{2}\right) \quad (441)$$



$$\begin{aligned}
& \frac{i}{2} \left( \sqrt{2} \left( \sum_{b=1}^2 U_{R,i4+b}^{e,*} \sum_{a=1}^3 U_{L,ja}^{e,*} Y_{L,ab} Z_{k1}^H - \sum_{b=1}^3 U_{L,jb}^{e,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} Z_{k1}^H \right. \right. \\
& - U_{R,i4}^{e,*} \sum_{a=1}^2 U_{L,j4+a}^{e,*} Y_{\hat{B}\hat{a}rE,a} Z_{k2}^H - \sum_{b=1}^2 U_{L,j4+b}^{e,*} \sum_{a=1}^2 U_{R,i4+a}^{e,*} \lambda_{SE,ab} Z_{k3}^H \Big) \\
& + U_{L,j4}^{e,*} \left( \sqrt{2} \sum_{a=1}^2 U_{R,i4+a}^{e,*} Y_{\hat{E},a} Z_{k1}^H + U_{R,i4}^{e,*} \left( \lambda_{TR} Z_{k4}^H + \sqrt{2} \lambda_{SR} Z_{k3}^H \right) \right) \Big) \left( \frac{1-\gamma_5}{2} \right) \tag{442}
\end{aligned}$$

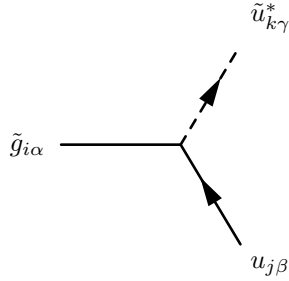
$$\begin{aligned}
& + \frac{i}{2} \left( \sqrt{2} \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ab}^* U_{L,ia}^e U_{R,j4+b}^e Z_{k1}^H - \sqrt{2} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e U_{L,ib}^e Z_{k1}^H \right. \\
& + \sqrt{2} \sum_{a=1}^2 Y_{\hat{E},a}^* U_{R,j4+a}^e U_{L,i4}^e Z_{k1}^H - \sqrt{2} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* U_{L,i4+a}^e U_{R,j4}^e Z_{k2}^H \\
& \left. - \sqrt{2} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* U_{R,j4+a}^e U_{L,i4+b}^e Z_{k3}^H + \sqrt{2} \lambda_{SR}^* U_{L,i4}^e U_{R,j4}^e Z_{k3}^H + \lambda_{TR}^* U_{L,i4}^e U_{R,j4}^e Z_{k4}^H \right) \left( \frac{1+\gamma_5}{2} \right) \tag{443}
\end{aligned}$$



$$\begin{aligned}
& - i \left( g_2 V_{i1}^* \left( U_{L,j4}^{e,*} Z_{k4}^V + \sum_{a=1}^3 U_{L,ja}^{e,*} Z_{ka}^V \right) - \left( \lambda_{TR} V_{i3}^* U_{L,j4}^{e,*} + V_{i2}^* \sum_{a=1}^2 U_{L,j4+a}^{e,*} Y_{\hat{B}\hat{a}rE,a} \right) Z_{k5}^V \right) \left( \frac{1-\gamma_5}{2} \right) \tag{444} \\
& + -i \left( \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ab}^* Z_{ka}^V U_{R,j4+b}^e U_{i2} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* U_{R,ja}^e Z_{kb}^V U_{i2} + \sum_{a=1}^2 Y_{\hat{E},a}^* U_{R,j4+a}^e U_{i2} Z_{k4}^V \right)
\end{aligned}$$

$$+ \lambda_{TR}^* U_{i3} U_{R,j4}^e Z_{k4}^V + g_2 U_{i1} U_{R,j4}^e Z_{k5}^V \left( \frac{1 + \gamma_5}{2} \right) \quad (445)$$

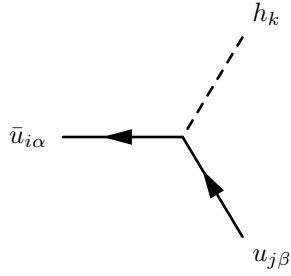

---



$$- i \frac{1}{\sqrt{2}} g_3 Z_{i1}^{G,*} \lambda_{\gamma,\beta}^\alpha \sum_{a=1}^3 U_{L,ja}^{u,*} Z_{ka}^U \left( \frac{1 - \gamma_5}{2} \right) \quad (446)$$

$$+ i \frac{1}{\sqrt{2}} g_3 \lambda_{\gamma,\beta}^\alpha \sum_{a=1}^3 Z_{k3+a}^U U_{R,ja}^u Z_{i1}^G \left( \frac{1 + \gamma_5}{2} \right) \quad (447)$$

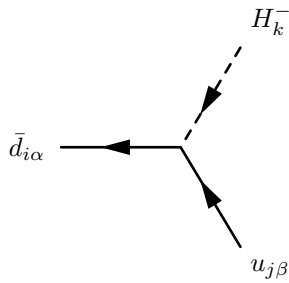

---



$$- i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{u,*} Y_{u,ab} Z_{k2}^H \left( \frac{1 - \gamma_5}{2} \right) \quad (448)$$

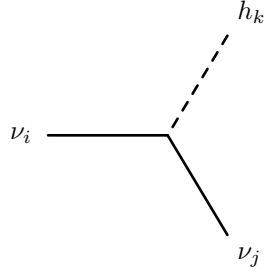
$$+ -i \frac{1}{\sqrt{2}} \delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^u Z_{k2}^H \left( \frac{1 + \gamma_5}{2} \right) \quad (449)$$


---



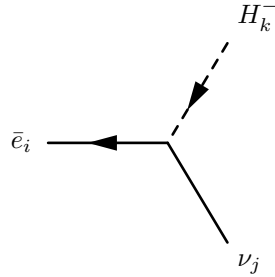
$$i\delta_{\alpha\beta} \sum_{b=1}^3 U_{L,jb}^{u,*} \sum_{a=1}^3 U_{R,ia}^{d,*} Y_{d,ab} Z_{k1}^+ \left( \frac{1-\gamma_5}{2} \right) \quad (450)$$

$$+ i\delta_{\alpha\beta} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* U_{R,ja}^u U_{L,ib}^d Z_{k2}^+ \left( \frac{1+\gamma_5}{2} \right) \quad (451)$$



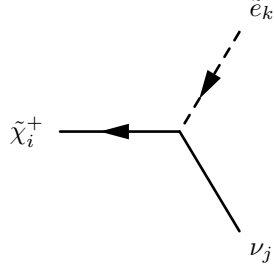
$$- \frac{i}{2} \left( U_{i4}^{V,*} U_{j5}^{V,*} + U_{i5}^{V,*} U_{j4}^{V,*} \right) \left( -\lambda_{TR} Z_{k4}^H + \sqrt{2} \lambda_{SR} Z_{k3}^H \right) \left( \frac{1-\gamma_5}{2} \right) \quad (452)$$

$$+ - \frac{i}{2} \left( U_{i4}^V U_{j5}^V + U_{i5}^V U_{j4}^V \right) \left( -\lambda_{TR}^* Z_{k4}^H + \sqrt{2} \lambda_{SR}^* Z_{k3}^H \right) \left( \frac{1+\gamma_5}{2} \right) \quad (453)$$



$$- i \left( \left( - \sum_{b=1}^3 U_{jb}^{V,*} \sum_{a=1}^3 U_{R,ia}^{e,*} Y_{e,ab} + \sum_{b=1}^2 U_{R,i4+b}^{e,*} \sum_{a=1}^3 U_{ja}^{V,*} Y_{L,ab} \right) Z_{k1}^+ \right. \\ \left. + U_{j4}^{V,*} \left( \lambda_{TR} U_{R,i4}^{e,*} Z_{k3}^+ + \sum_{a=1}^2 U_{R,i4+a}^{e,*} Y_{\hat{E},a} Z_{k1}^+ \right) \right) \left( \frac{1-\gamma_5}{2} \right) \quad (454)$$

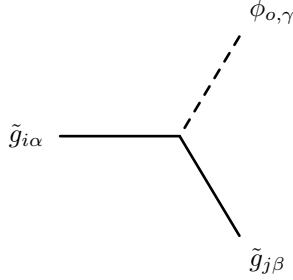
$$+ i U_{j5}^V \left( \lambda_{TR}^* U_{L,i4}^e Z_{k4}^+ + \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* U_{L,i4+a}^e Z_{k2}^+ \right) \left( \frac{1+\gamma_5}{2} \right) \quad (455)$$



$$iU_{j5}^{V,*} \left( -g_2 V_{i1}^* Z_{k8}^{E,*} + \lambda_{TR} V_{i3}^* Z_{k7}^{E,*} + V_{i2}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} \right) \left( \frac{1-\gamma_5}{2} \right) \quad (456)$$

$$+ -i \left( g_2 \sum_{a=1}^3 Z_{ka}^{E,*} U_{ja}^V U_{i1} + \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* U_{ja}^V U_{i2} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} U_{jb}^V U_{i2} \right. \\ \left. + g_2 Z_{k7}^{E,*} U_{i1} U_{j4}^V + \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} U_{i2} U_{j4}^V + \lambda_{TR}^* Z_{k8}^{E,*} U_{i3} U_{j4}^V \right) \left( \frac{1+\gamma_5}{2} \right) \quad (457)$$

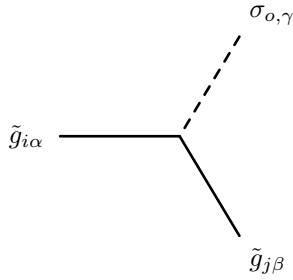

---



$$g_3 \left( Z_{i1}^{G,*} Z_{j2}^{G,*} - Z_{i2}^{G,*} Z_{j1}^{G,*} \right) f_{\alpha,\beta,\gamma} \left( \frac{1-\gamma_5}{2} \right) \quad (458)$$

$$+ g_3 f_{\alpha,\beta,\gamma} \left( -Z_{i1}^G Z_{j2}^G + Z_{i2}^G Z_{j1}^G \right) \left( \frac{1+\gamma_5}{2} \right) \quad (459)$$


---

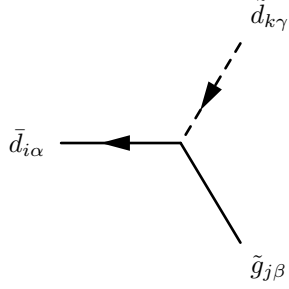




$$ig_3 \left( -Z_{i1}^{G,*} Z_{j2}^{G,*} + Z_{i2}^{G,*} Z_{j1}^{G,*} \right) f_{\alpha,\beta,\gamma} \left( \frac{1-\gamma_5}{2} \right) \quad (460)$$

$$+ ig_3 f_{\alpha,\beta,\gamma} \left( -Z_{i1}^G Z_{j2}^G + Z_{i2}^G Z_{j1}^G \right) \left( \frac{1+\gamma_5}{2} \right) \quad (461)$$

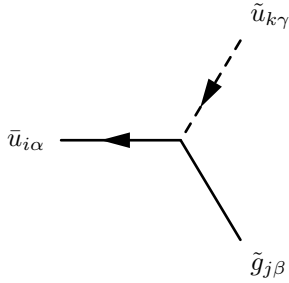

---



$$i \frac{1}{\sqrt{2}} g_3 Z_{j1}^{G,*} \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{k3+a}^{D,*} U_{R,ia}^{d,*} \left( \frac{1-\gamma_5}{2} \right) \quad (462)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ia}^d Z_{j1}^G \left( \frac{1+\gamma_5}{2} \right) \quad (463)$$

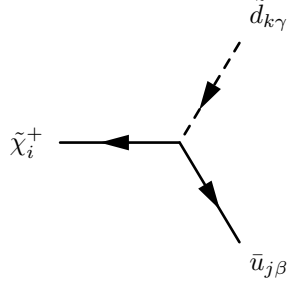

---



$$i \frac{1}{\sqrt{2}} g_3 Z_{j1}^{G,*} \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{k3+a}^{U,*} U_{R,ia}^{u,*} \left( \frac{1-\gamma_5}{2} \right) \quad (464)$$

$$+ -i \frac{1}{\sqrt{2}} g_3 \lambda_{\alpha,\gamma}^\beta \sum_{a=1}^3 Z_{ka}^{U,*} U_{L,ia}^u Z_{j1}^G \left( \frac{1+\gamma_5}{2} \right) \quad (465)$$

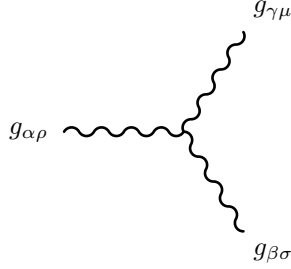

---



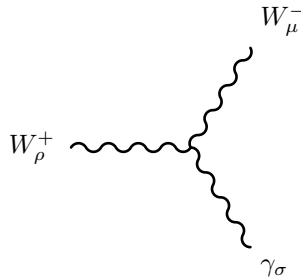
$$iV_{i2}^* \delta_{\beta\gamma} \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 U_{R,ja}^{u,*} Y_{u,ab} \left( \frac{1-\gamma_5}{2} \right) \quad (466)$$

$$+ -i\delta_{\beta\gamma} \left( g_2 \sum_{a=1}^3 Z_{ka}^{D,*} U_{L,ja}^u U_{i1} - \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} U_{L,jb}^u U_{i2} \right) \left( \frac{1+\gamma_5}{2} \right) \quad (467)$$

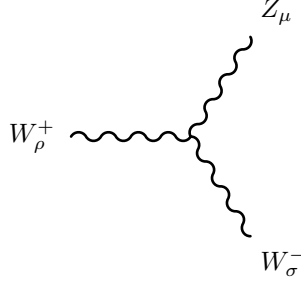
## 9.6 Three Vector Boson-Interaction



$$g_3 f_{\alpha,\beta,\gamma} \left( g_{\rho\mu} \left( -p_\sigma^{g_{\gamma\mu}} + p_\sigma^{g_{\alpha\rho}} \right) + g_{\rho\sigma} \left( -p_\mu^{g_{\alpha\rho}} + p_\mu^{g_{\beta\sigma}} \right) + g_{\sigma\mu} \left( -p_\rho^{g_{\beta\sigma}} + p_\rho^{g_{\gamma\mu}} \right) \right) \quad (468)$$

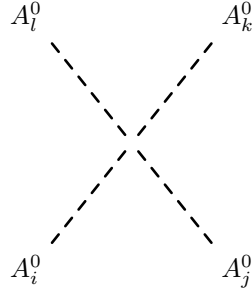


$$ig_2 \sin \Theta_W \left( g_{\rho\mu} \left( -p_\sigma^{W_\mu^-} + p_\sigma^{W_\rho^+} \right) + g_{\rho\sigma} \left( -p_\mu^{W_\rho^+} + p_\mu^{\gamma_\sigma} \right) + g_{\sigma\mu} \left( -p_\rho^{\gamma_\sigma} + p_\rho^{W_\mu^-} \right) \right) \quad (469)$$



$$-ig_2 \cos \Theta_W \left( g_{\rho\mu} \left( -p_\sigma^{Z_\mu} + p_\sigma^{W_\rho^+} \right) + g_{\rho\sigma} \left( -p_\mu^{W_\rho^+} + p_\mu^{W_\sigma^-} \right) + g_{\sigma\mu} \left( -p_\rho^{W_\sigma^-} + p_\rho^{Z_\mu} \right) \right) \quad (470)$$

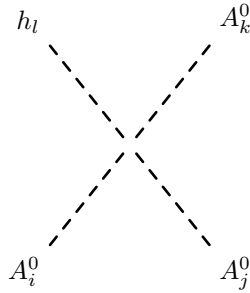
## 9.7 Four Scalar-Interaction



$$\begin{aligned}
& -\frac{i}{8} \left( 8|\lambda|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^A Z_{l1}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^A Z_{l1}^A \right. \\
& - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^A Z_{j3}^A Z_{k1}^A Z_{l1}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^A Z_{l1}^A \\
& - 2\sqrt{2}\Lambda_T\lambda^* Z_{i3}^A Z_{j4}^A Z_{k1}^A Z_{l1}^A + 4|\Lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^A Z_{l1}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^A Z_{l1}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^A Z_{l1}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^A Z_{l1}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^A Z_{l1}^A \\
& + 2\lambda\lambda_T^* Z_{i4}^A Z_{j4}^A Z_{k2}^A Z_{l1}^A + 2\lambda_T\lambda^* Z_{i4}^A Z_{j4}^A Z_{k2}^A Z_{l1}^A + 8|\lambda|^2 Z_{i3}^A Z_{j1}^A Z_{k3}^A Z_{l1}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^A Z_{l1}^A - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^A Z_{j1}^A Z_{k3}^A Z_{l1}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^A Z_{l1}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^A Z_{l1}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^A Z_{l1}^A - 2\sqrt{2}\Lambda_T\lambda^* Z_{i3}^A Z_{j1}^A Z_{k4}^A Z_{l1}^A \\
& + 4|\Lambda_T|^2 Z_{i4}^A Z_{j1}^A Z_{k4}^A Z_{l1}^A - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^A Z_{l1}^A \\
& - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^A Z_{l1}^A + 2\lambda\lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k4}^A Z_{l1}^A + 2\lambda_T\lambda^* Z_{i4}^A Z_{j2}^A Z_{k4}^A Z_{l1}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^A Z_{l2}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^A Z_{l2}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^A Z_{l2}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^A Z_{l2}^A \left. \right)
\end{aligned}$$

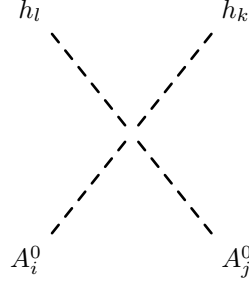
$$\begin{aligned}
& + 2\lambda\lambda_T^* Z_{i4}^A Z_{j4}^A Z_{k1}^A Z_{l2}^A + 2\lambda_T \lambda^* Z_{i4}^A Z_{j4}^A Z_{k1}^A Z_{l2}^A + 8|\lambda|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^A Z_{l2}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^A Z_{l2}^A - 2\sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j3}^A Z_{k2}^A Z_{l2}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^A Z_{l2}^A - 2\sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j4}^A Z_{k2}^A Z_{l2}^A \\
& + 4|\Lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^A Z_{l2}^A - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^A Z_{l2}^A \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^A Z_{l2}^A + 8|\lambda|^2 Z_{i3}^A Z_{j2}^A Z_{k3}^A Z_{l2}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^A Z_{l2}^A - 2\sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j2}^A Z_{k3}^A Z_{l2}^A \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^A Z_{l2}^A - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^A Z_{l2}^A \\
& + 2\lambda\lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k4}^A Z_{l2}^A + 2\lambda_T \lambda^* Z_{i4}^A Z_{j1}^A Z_{k4}^A Z_{l2}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^A Z_{l2}^A \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j2}^A Z_{k4}^A Z_{l2}^A + 4|\Lambda_T|^2 Z_{i4}^A Z_{j2}^A Z_{k4}^A Z_{l2}^A + 8|\lambda|^2 Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l3}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l3}^A - 2\sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l3}^A \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k1}^A Z_{l3}^A - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k1}^A Z_{l3}^A \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k2}^A Z_{l3}^A - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k2}^A Z_{l3}^A \\
& + 8|\lambda|^2 Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l3}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l3}^A \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l3}^A + 8|\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k3}^A Z_{l3}^A + 8|\lambda_T|^2 Z_{i4}^A Z_{j3}^A Z_{k4}^A Z_{l3}^A \\
& + 8|\lambda_T|^2 Z_{i3}^A Z_{j4}^A Z_{k4}^A Z_{l3}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^A \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^A + 4|\Lambda_T|^2 Z_{i4}^A Z_{j1}^A Z_{k1}^A Z_{l4}^A \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k1}^A Z_{l4}^A - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k1}^A Z_{l4}^A \\
& + 2\lambda\lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k1}^A Z_{l4}^A + 2\lambda_T \lambda^* Z_{i4}^A Z_{j2}^A Z_{k1}^A Z_{l4}^A - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k2}^A Z_{l4}^A \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k2}^A Z_{l4}^A + 2\lambda\lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k2}^A Z_{l4}^A + 2\lambda_T \lambda^* Z_{i4}^A Z_{j1}^A Z_{k2}^A Z_{l4}^A \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l4}^A - 2\sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l4}^A \\
& + 4|\Lambda_T|^2 Z_{i4}^A Z_{j2}^A Z_{k2}^A Z_{l4}^A + 8|\lambda_T|^2 Z_{i4}^A Z_{j3}^A Z_{k3}^A Z_{l4}^A + 8|\lambda_T|^2 Z_{i3}^A Z_{j4}^A Z_{k3}^A Z_{l4}^A \\
& + 8|\lambda_T|^2 Z_{i3}^A Z_{j3}^A Z_{k4}^A Z_{l4}^A + 12|\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k4}^A Z_{l4}^A \\
& - Z_{i2}^A \left( \sqrt{2}\Lambda_T \lambda_T^* Z_{j4}^A Z_{k3}^A Z_{l1}^A + \sqrt{2}\lambda_T \Lambda_T^* Z_{j4}^A Z_{k3}^A Z_{l1}^A + \sqrt{2}\Lambda_T \lambda_T^* Z_{j3}^A Z_{k4}^A Z_{l1}^A \right. \\
& + \sqrt{2}\lambda_T \Lambda_T^* Z_{j3}^A Z_{k4}^A Z_{l1}^A - 2\lambda\lambda_T^* Z_{j4}^A Z_{k4}^A Z_{l1}^A - 2\lambda_T \lambda^* Z_{j4}^A Z_{k4}^A Z_{l1}^A \\
& - 8|\lambda|^2 Z_{j3}^A Z_{k3}^A Z_{l2}^A + 2\sqrt{2}\lambda\Lambda_T^* Z_{j4}^A Z_{k3}^A Z_{l2}^A + 2\sqrt{2}\Lambda_T \lambda^* Z_{j4}^A Z_{k3}^A Z_{l2}^A \\
& + 2\sqrt{2}\lambda\Lambda_T^* Z_{j3}^A Z_{k4}^A Z_{l2}^A + 2\sqrt{2}\Lambda_T \lambda^* Z_{j3}^A Z_{k4}^A Z_{l2}^A - 4|\Lambda_T|^2 Z_{j4}^A Z_{k4}^A Z_{l2}^A \\
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{j4}^A Z_{k1}^A Z_{l3}^A + \sqrt{2}\lambda_T \Lambda_T^* Z_{j4}^A Z_{k1}^A Z_{l3}^A - 8|\lambda|^2 Z_{j3}^A Z_{k2}^A Z_{l3}^A \\
& + 2\sqrt{2}\lambda\Lambda_T^* Z_{j4}^A Z_{k2}^A Z_{l3}^A + 2\sqrt{2}\Lambda_T \lambda^* Z_{j4}^A Z_{k2}^A Z_{l3}^A + \sqrt{2}\Lambda_T \lambda_T^* Z_{j3}^A Z_{k1}^A Z_{l4}^A \\
& + \sqrt{2}\lambda_T \Lambda_T^* Z_{j3}^A Z_{k1}^A Z_{l4}^A - 2\lambda\lambda_T^* Z_{j4}^A Z_{k1}^A Z_{l4}^A - 2\lambda_T \lambda^* Z_{j4}^A Z_{k1}^A Z_{l4}^A \\
& + 2\sqrt{2}\lambda\Lambda_T^* Z_{j3}^A Z_{k2}^A Z_{l4}^A + 2\sqrt{2}\Lambda_T \lambda^* Z_{j3}^A Z_{k2}^A Z_{l4}^A - 4|\Lambda_T|^2 Z_{j4}^A Z_{k2}^A Z_{l4}^A \\
& \left. + 2Z_{j2}^A \left( (-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2) Z_{k1}^A Z_{l1}^A - 3(g_1^2 + g_2^2) Z_{k2}^A Z_{l2}^A - 4|\lambda|^2 Z_{k3}^A Z_{l3}^A \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2}\lambda\Lambda_T^* Z_{k_4}^A Z_{l_3}^A + \sqrt{2}\Lambda_T\lambda^* Z_{k_4}^A Z_{l_3}^A + \sqrt{2}\lambda\Lambda_T^* Z_{k_3}^A Z_{l_4}^A + \sqrt{2}\Lambda_T\lambda^* Z_{k_3}^A Z_{l_4}^A \\
& - 2|\Lambda_T|^2 Z_{k_4}^A Z_{l_4}^A) \\
& + Z_{j_1}^A \left( 2 \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^A Z_{l_1}^A + 2 \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^A Z_{l_2}^A \right. \\
& + \sqrt{2}\Lambda_T\lambda_T^* Z_{k_4}^A Z_{l_3}^A + \sqrt{2}\lambda_T\Lambda_T^* Z_{k_4}^A Z_{l_3}^A + \sqrt{2}\Lambda_T\lambda_T^* Z_{k_3}^A Z_{l_4}^A + \sqrt{2}\lambda_T\Lambda_T^* Z_{k_3}^A Z_{l_4}^A \\
& \left. - 2\lambda\lambda_T^* Z_{k_4}^A Z_{l_4}^A - 2\lambda_T\lambda^* Z_{k_4}^A Z_{l_4}^A \right) \\
& + Z_{i_1}^A \left( 8|\lambda|^2 Z_{j_3}^A Z_{k_3}^A Z_{l_1}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{j_4}^A Z_{k_3}^A Z_{l_1}^A - 2\sqrt{2}\Lambda_T\lambda^* Z_{j_4}^A Z_{k_3}^A Z_{l_1}^A \right. \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{j_3}^A Z_{k_4}^A Z_{l_1}^A - 2\sqrt{2}\Lambda_T\lambda^* Z_{j_3}^A Z_{k_4}^A Z_{l_1}^A + 4|\Lambda_T|^2 Z_{j_4}^A Z_{k_4}^A Z_{l_1}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{j_4}^A Z_{k_3}^A Z_{l_2}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{j_4}^A Z_{k_3}^A Z_{l_2}^A - \sqrt{2}\Lambda_T\lambda_T^* Z_{j_3}^A Z_{k_4}^A Z_{l_2}^A \\
& - \sqrt{2}\lambda_T\Lambda_T^* Z_{j_3}^A Z_{k_4}^A Z_{l_2}^A + 2\lambda\lambda_T^* Z_{j_4}^A Z_{k_4}^A Z_{l_2}^A + 2\lambda_T\lambda^* Z_{j_4}^A Z_{k_4}^A Z_{l_2}^A \\
& + 8|\lambda|^2 Z_{j_3}^A Z_{k_1}^A Z_{l_3}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{j_4}^A Z_{k_1}^A Z_{l_3}^A - 2\sqrt{2}\Lambda_T\lambda^* Z_{j_4}^A Z_{k_1}^A Z_{l_3}^A \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{j_4}^A Z_{k_2}^A Z_{l_3}^A - \sqrt{2}\lambda_T\Lambda_T^* Z_{j_4}^A Z_{k_2}^A Z_{l_3}^A - 2\sqrt{2}\lambda\Lambda_T^* Z_{j_3}^A Z_{k_1}^A Z_{l_4}^A \\
& - 2\sqrt{2}\Lambda_T\lambda^* Z_{j_3}^A Z_{k_1}^A Z_{l_4}^A + 4|\Lambda_T|^2 Z_{j_4}^A Z_{k_1}^A Z_{l_4}^A - \sqrt{2}\Lambda_T\lambda_T^* Z_{j_3}^A Z_{k_2}^A Z_{l_4}^A \\
& - \sqrt{2}\lambda_T\Lambda_T^* Z_{j_3}^A Z_{k_2}^A Z_{l_4}^A + 2\lambda\lambda_T^* Z_{j_4}^A Z_{k_2}^A Z_{l_4}^A + 2\lambda_T\lambda^* Z_{j_4}^A Z_{k_2}^A Z_{l_4}^A \\
& \left. - Z_{j_2}^A \left( 2 \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^A Z_{l_1}^A + 2 \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_1}^A Z_{l_2}^A \right. \right. \\
& + \sqrt{2}\Lambda_T\lambda_T^* Z_{k_4}^A Z_{l_3}^A + \sqrt{2}\lambda_T\Lambda_T^* Z_{k_4}^A Z_{l_3}^A + \sqrt{2}\Lambda_T\lambda_T^* Z_{k_3}^A Z_{l_4}^A + \sqrt{2}\lambda_T\Lambda_T^* Z_{k_3}^A Z_{l_4}^A \\
& \left. - 2\lambda\lambda_T^* Z_{k_4}^A Z_{l_4}^A - 2\lambda_T\lambda^* Z_{k_4}^A Z_{l_4}^A \right) \\
& + Z_{j_1}^A \left( 6 \left( g_1^2 + g_2^2 \right) Z_{k_1}^A Z_{l_1}^A \right. \\
& - 2 \left( \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k_2}^A Z_{l_2}^A + \Lambda_T^* \left( \sqrt{2}\lambda Z_{k_3}^A Z_{l_4}^A + Z_{k_4}^A \left( -2\Lambda_T Z_{l_4}^A + \sqrt{2}\lambda Z_{l_3}^A \right) \right) \right. \\
& \left. \left. + \lambda^* \left( \sqrt{2}\Lambda_T Z_{k_4}^A Z_{l_3}^A + Z_{k_3}^A \left( -4\lambda Z_{l_3}^A + \sqrt{2}\Lambda_T Z_{l_4}^A \right) \right) \right) \right) \tag{471}
\end{aligned}$$



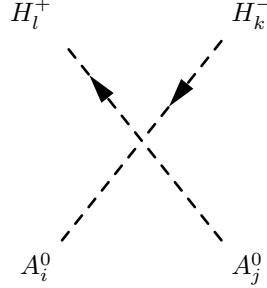
$$\begin{aligned}
& \frac{1}{8} \left( \lambda_T^* \left( \sqrt{2}\Lambda_T Z_{i_2}^A Z_{j_4}^A Z_{k_3}^A Z_{l_1}^H + \sqrt{2}\Lambda_T Z_{i_2}^A Z_{j_3}^A Z_{k_4}^A Z_{l_1}^H - 2\lambda Z_{i_2}^A Z_{j_4}^A Z_{k_4}^A Z_{l_1}^H \right. \right. \\
& \left. + \sqrt{2}\Lambda_T Z_{i_1}^A Z_{j_4}^A Z_{k_3}^A Z_{l_2}^H + \sqrt{2}\Lambda_T Z_{i_1}^A Z_{j_3}^A Z_{k_4}^A Z_{l_2}^H - 2\lambda Z_{i_1}^A Z_{j_4}^A Z_{k_4}^A Z_{l_2}^H \right.
\end{aligned}$$

$$\begin{aligned}
& -\sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^A Z_{k1}^A Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^A Z_{k2}^A Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j1}^A Z_{k4}^A Z_{l3}^H \\
& -\sqrt{2}\Lambda_T Z_{i1}^A Z_{j2}^A Z_{k4}^A Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j3}^A Z_{k1}^A Z_{l4}^H + 2\lambda Z_{i2}^A Z_{j4}^A Z_{k1}^A Z_{l4}^H \\
& -\sqrt{2}\Lambda_T Z_{i1}^A Z_{j3}^A Z_{k2}^A Z_{l4}^H + 2\lambda Z_{i1}^A Z_{j4}^A Z_{k2}^A Z_{l4}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j1}^A Z_{k3}^A Z_{l4}^H \\
& -\sqrt{2}\Lambda_T Z_{i1}^A Z_{j2}^A Z_{k3}^A Z_{l4}^H + 2\lambda Z_{i2}^A Z_{j1}^A Z_{k4}^A Z_{l4}^H + 2\lambda Z_{i1}^A Z_{j2}^A Z_{k4}^A Z_{l4}^H \\
& + Z_{i4}^A \left( \sqrt{2}\Lambda_T Z_{j2}^A Z_{k3}^A Z_{l1}^H - 2\lambda Z_{j2}^A Z_{k4}^A Z_{l1}^H + \sqrt{2}\Lambda_T Z_{j1}^A Z_{k3}^A Z_{l2}^H - 2\lambda Z_{j1}^A Z_{k4}^A Z_{l2}^H \right. \\
& + \sqrt{2}\Lambda_T Z_{j3}^A \left( Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) - 2\lambda Z_{j4}^A \left( Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) - \sqrt{2}\Lambda_T Z_{j2}^A Z_{k1}^A Z_{l3}^H \\
& - \sqrt{2}\Lambda_T Z_{j1}^A Z_{k2}^A Z_{l3}^H + 2\lambda Z_{j2}^A Z_{k1}^A Z_{l4}^H + 2\lambda Z_{j1}^A Z_{k2}^A Z_{l4}^H \left. \right) \\
& + \sqrt{2}\Lambda_T Z_{i3}^A \left( Z_{j1}^A \left( -Z_{k2}^A Z_{l4}^H + Z_{k4}^A Z_{l2}^H \right) + Z_{j2}^A \left( -Z_{k1}^A Z_{l4}^H + Z_{k4}^A Z_{l1}^H \right) + Z_{j4}^A \left( Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) \right) \\
& + \sqrt{2}\Lambda_T^* \left( -\lambda_T Z_{i2}^A Z_{j4}^A Z_{k3}^A Z_{l1}^H - \lambda_T Z_{i2}^A Z_{j3}^A Z_{k4}^A Z_{l1}^H - \lambda_T Z_{i1}^A Z_{j4}^A Z_{k3}^A Z_{l2}^H \right. \\
& - \lambda_T Z_{i1}^A Z_{j3}^A Z_{k4}^A Z_{l2}^H + 2\lambda Z_{i1}^A Z_{j4}^A Z_{k1}^A Z_{l3}^H + \lambda_T Z_{i2}^A Z_{j4}^A Z_{k1}^A Z_{l3}^H \\
& + \lambda_T Z_{i1}^A Z_{j4}^A Z_{k2}^A Z_{l3}^H + 2\lambda Z_{i2}^A Z_{j4}^A Z_{k2}^A Z_{l3}^H + 2\lambda Z_{i1}^A Z_{j1}^A Z_{k4}^A Z_{l3}^H \\
& + \lambda_T Z_{i2}^A Z_{j1}^A Z_{k4}^A Z_{l3}^H + \lambda_T Z_{i1}^A Z_{j2}^A Z_{k4}^A Z_{l3}^H + 2\lambda Z_{i2}^A Z_{j2}^A Z_{k4}^A Z_{l3}^H \\
& - Z_{i4}^A \left( \lambda_T Z_{j3}^A \left( Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) + Z_{j1}^A \left( - \left( 2\lambda Z_{k1}^A + \lambda_T Z_{k2}^A \right) Z_{l3}^H + \lambda_T Z_{k3}^A Z_{l2}^H \right) \right. \\
& + Z_{j2}^A \left( - \left( 2\lambda Z_{k2}^A + \lambda_T Z_{k1}^A \right) Z_{l3}^H + \lambda_T Z_{k3}^A Z_{l1}^H \right) \left. \right) \\
& - 2\lambda Z_{i1}^A Z_{j3}^A Z_{k1}^A Z_{l4}^H + \lambda_T Z_{i2}^A Z_{j3}^A Z_{k1}^A Z_{l4}^H + \lambda_T Z_{i1}^A Z_{j3}^A Z_{k2}^A Z_{l4}^H \\
& - 2\lambda Z_{i2}^A Z_{j3}^A Z_{k2}^A Z_{l4}^H - 2\lambda Z_{i1}^A Z_{j1}^A Z_{k3}^A Z_{l4}^H + \lambda_T Z_{i2}^A Z_{j1}^A Z_{k3}^A Z_{l4}^H \\
& + \lambda_T Z_{i1}^A Z_{j2}^A Z_{k3}^A Z_{l4}^H - 2\lambda Z_{i2}^A Z_{j2}^A Z_{k3}^A Z_{l4}^H \\
& - Z_{i3}^A \left( \lambda_T Z_{j4}^A \left( Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) + Z_{j1}^A \left( \left( 2\lambda Z_{k1}^A - \lambda_T Z_{k2}^A \right) Z_{l4}^H + \lambda_T Z_{k4}^A Z_{l2}^H \right) \right. \\
& + Z_{j2}^A \left( \left( 2\lambda Z_{k2}^A - \lambda_T Z_{k1}^A \right) Z_{l4}^H + \lambda_T Z_{k4}^A Z_{l1}^H \right) \left. \right) \\
& + 2\lambda^* \left( \lambda_T Z_{i1}^A Z_{j4}^A Z_{k4}^A Z_{l2}^H - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^A Z_{k1}^A Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j1}^A Z_{k4}^A Z_{l3}^H \right. \\
& + \sqrt{2}\Lambda_T Z_{i3}^A Z_{j1}^A Z_{k1}^A Z_{l4}^H + \sqrt{2}\Lambda_T Z_{i1}^A Z_{j3}^A Z_{k1}^A Z_{l4}^H + \sqrt{2}\Lambda_T Z_{i3}^A Z_{j2}^A Z_{k2}^A Z_{l4}^H \\
& - \lambda_T Z_{i1}^A Z_{j4}^A Z_{k2}^A Z_{l4}^H + \sqrt{2}\Lambda_T Z_{i1}^A Z_{j1}^A Z_{k3}^A Z_{l4}^H - \lambda_T Z_{i1}^A Z_{j2}^A Z_{k4}^A Z_{l4}^H \\
& + Z_{i4}^A \left( \lambda_T Z_{j4}^A \left( Z_{k1}^A Z_{l2}^H + Z_{k2}^A Z_{l1}^H \right) + Z_{j2}^A \left( -\lambda_T Z_{k1}^A Z_{l4}^H + \lambda_T Z_{k4}^A Z_{l1}^H - \sqrt{2}\Lambda_T Z_{k2}^A Z_{l3}^H \right) \right. \\
& + Z_{j1}^A \left( -\lambda_T Z_{k2}^A Z_{l4}^H + \lambda_T Z_{k4}^A Z_{l2}^H - \sqrt{2}\Lambda_T Z_{k1}^A Z_{l3}^H \right) \left. \right) \\
& + Z_{i2}^A \left( \left( -\lambda_T Z_{j1}^A Z_{k4}^A + \sqrt{2}\Lambda_T Z_{j3}^A Z_{k2}^A \right) Z_{l4}^H \right. \\
& \left. + Z_{j4}^A \left( -\lambda_T Z_{k1}^A Z_{l4}^H + \lambda_T Z_{k4}^A Z_{l1}^H - \sqrt{2}\Lambda_T Z_{k2}^A Z_{l3}^H \right) + \sqrt{2}\Lambda_T Z_{j2}^A \left( Z_{k3}^A Z_{l4}^H - Z_{k4}^A Z_{l3}^H \right) \right) \left. \right) \left. \right) \left. \right) \quad (472)
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{8} \left( 8|\lambda|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^H Z_{l1}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^H Z_{l1}^H \right. \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j3}^A Z_{k1}^H Z_{l1}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^H Z_{l1}^H \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j4}^A Z_{k1}^H Z_{l1}^H + 4|\Lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^H Z_{l1}^H \\
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^H Z_{l1}^H + \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^H Z_{l1}^H \\
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^H Z_{l1}^H + \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^H Z_{l1}^H - 2\lambda\lambda_T^* Z_{i4}^A Z_{j4}^A Z_{k2}^H Z_{l1}^H \\
& - 2\lambda_T \lambda^* Z_{i4}^A Z_{j4}^A Z_{k2}^H Z_{l1}^H - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^H Z_{l1}^H \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k3}^H Z_{l1}^H - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^H Z_{l1}^H \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^H Z_{l1}^H + 2\lambda\lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k4}^H Z_{l1}^H + 2\lambda_T \lambda^* Z_{i4}^A Z_{j2}^A Z_{k4}^H Z_{l1}^H \\
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^H Z_{l2}^H + \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^H Z_{l2}^H \\
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^H Z_{l2}^H + \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^H Z_{l2}^H - 2\lambda\lambda_T^* Z_{i4}^A Z_{j4}^A Z_{k1}^H Z_{l2}^H \\
& - 2\lambda_T \lambda^* Z_{i4}^A Z_{j4}^A Z_{k1}^H Z_{l2}^H + 8|\lambda|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^H Z_{l2}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^H Z_{l2}^H \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j3}^A Z_{k2}^H Z_{l2}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^H Z_{l2}^H \\
& - 2\sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j4}^A Z_{k2}^H Z_{l2}^H + 4|\Lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^H Z_{l2}^H - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k3}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^H Z_{l2}^H - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^H Z_{l2}^H \\
& + 2\lambda\lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k4}^H Z_{l2}^H + 2\lambda_T \lambda^* Z_{i4}^A Z_{j1}^A Z_{k4}^H Z_{l2}^H - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k1}^H Z_{l3}^H \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k1}^H Z_{l3}^H - \sqrt{2}\Lambda_T \lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k2}^H Z_{l3}^H \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k2}^H Z_{l3}^H + 8|\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k3}^H Z_{l3}^H \\
& - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k1}^H Z_{l4}^H - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k1}^H Z_{l4}^H \\
& + 2\lambda\lambda_T^* Z_{i4}^A Z_{j2}^A Z_{k1}^H Z_{l4}^H + 2\lambda_T \lambda^* Z_{i4}^A Z_{j2}^A Z_{k1}^H Z_{l4}^H - \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k2}^H Z_{l4}^H \\
& - \sqrt{2}\lambda_T \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k2}^H Z_{l4}^H + 2\lambda\lambda_T^* Z_{i4}^A Z_{j1}^A Z_{k2}^H Z_{l4}^H + 2\lambda_T \lambda^* Z_{i4}^A Z_{j1}^A Z_{k2}^H Z_{l4}^H \\
& + 8|\lambda_T|^2 Z_{i3}^A Z_{j3}^A Z_{k4}^H Z_{l4}^H + 4|\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k4}^H Z_{l4}^H \\
& - Z_{i2}^A \left( 2Z_{j2}^A \left( (-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2) Z_{k1}^H Z_{l1}^H - (g_1^2 + g_2^2) Z_{k2}^H Z_{l2}^H - 4|\lambda|^2 Z_{k3}^H Z_{l3}^H \right) \right. \\
& \left. + \sqrt{2}\lambda\Lambda_T^* Z_{k4}^H Z_{l3}^H + \sqrt{2}\Lambda_T \lambda^* Z_{k4}^H Z_{l3}^H + \sqrt{2}\lambda\Lambda_T^* Z_{k3}^H Z_{l4}^H + \sqrt{2}\Lambda_T \lambda^* Z_{k3}^H Z_{l4}^H \right)
\end{aligned}$$

$$\begin{aligned}
& - 2|\Lambda_T|^2 Z_{k4}^H Z_{l4}^H) \\
& + \lambda_T^* \left( \sqrt{2}\Lambda_T Z_{j3}^A \left( Z_{k1}^H Z_{l4}^H + Z_{k4}^H Z_{l1}^H \right) \right. \\
& + Z_{j4}^A \left( - 2\lambda Z_{k4}^H Z_{l1}^H + \sqrt{2}\Lambda_T Z_{k3}^H Z_{l1}^H + Z_{k1}^H \left( - 2\lambda Z_{l4}^H + \sqrt{2}\Lambda_T Z_{l3}^H \right) \right) \\
& \left. - Z_{j1}^A \left( \sqrt{2}\Lambda_T Z_{k3}^H Z_{l4}^H + Z_{k4}^H \left( - 2\lambda Z_{l4}^H + \sqrt{2}\Lambda_T Z_{l3}^H \right) \right) \right) \\
& + \lambda_T \left( - 2\lambda^* \left( - Z_{j1}^A Z_{k4}^H Z_{l4}^H + Z_{j4}^A \left( Z_{k1}^H Z_{l4}^H + Z_{k4}^H Z_{l1}^H \right) \right) \right. \\
& + \sqrt{2}\Lambda_T^* \left( - Z_{j1}^A \left( Z_{k3}^H Z_{l4}^H + Z_{k4}^H Z_{l3}^H \right) + Z_{j3}^A \left( Z_{k1}^H Z_{l4}^H + Z_{k4}^H Z_{l1}^H \right) + Z_{j4}^A \left( Z_{k1}^H Z_{l3}^H + Z_{k3}^H Z_{l1}^H \right) \right) \\
& \left. + Z_{i1}^A \left( 2Z_{j1}^A \left( (g_1^2 + g_2^2) Z_{k1}^H Z_{l1}^H - \left( - 2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{k2}^H Z_{l2}^H + 4|\lambda|^2 Z_{k3}^H Z_{l3}^H \right. \right. \right. \\
& \left. \left. - \sqrt{2}\lambda\Lambda_T^* Z_{k4}^H Z_{l3}^H - \sqrt{2}\Lambda_T\lambda^* Z_{k4}^H Z_{l3}^H - \sqrt{2}\lambda\Lambda_T^* Z_{k3}^H Z_{l4}^H - \sqrt{2}\Lambda_T\lambda^* Z_{k3}^H Z_{l4}^H \right. \right. \\
& \left. \left. + 2|\Lambda_T|^2 Z_{k4}^H Z_{l4}^H \right) \right. \\
& \left. - \lambda_T^* \left( \sqrt{2}\Lambda_T Z_{j3}^A \left( Z_{k2}^H Z_{l4}^H + Z_{k4}^H Z_{l2}^H \right) \right. \right. \\
& + Z_{j4}^A \left( - 2\lambda Z_{k4}^H Z_{l2}^H + \sqrt{2}\Lambda_T Z_{k3}^H Z_{l2}^H + Z_{k2}^H \left( - 2\lambda Z_{l4}^H + \sqrt{2}\Lambda_T Z_{l3}^H \right) \right) \\
& \left. - Z_{j2}^A \left( \sqrt{2}\Lambda_T Z_{k3}^H Z_{l4}^H + Z_{k4}^H \left( - 2\lambda Z_{l4}^H + \sqrt{2}\Lambda_T Z_{l3}^H \right) \right) \right) \\
& \left. - \lambda_T \left( - 2\lambda^* \left( - Z_{j2}^A Z_{k4}^H Z_{l4}^H + Z_{j4}^A \left( Z_{k2}^H Z_{l4}^H + Z_{k4}^H Z_{l2}^H \right) \right) \right. \right. \\
& \left. \left. + \sqrt{2}\Lambda_T^* \left( - Z_{j2}^A \left( Z_{k3}^H Z_{l4}^H + Z_{k4}^H Z_{l3}^H \right) + Z_{j3}^A \left( Z_{k2}^H Z_{l4}^H + Z_{k4}^H Z_{l2}^H \right) + Z_{j4}^A \left( Z_{k2}^H Z_{l3}^H + Z_{k3}^H Z_{l2}^H \right) \right) \right) \right) \quad (473)
\end{aligned}$$



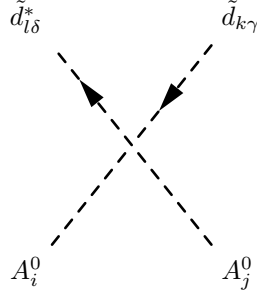
$$\begin{aligned}
& - \frac{i}{4} \left( 4|\lambda|^2 Z_{i3}^A Z_{j3}^A Z_{k1}^+ Z_{l1}^+ + \sqrt{2}\lambda\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^+ Z_{l1}^+ + \sqrt{2}\Lambda_T\lambda^* Z_{i4}^A Z_{j3}^A Z_{k1}^+ Z_{l1}^+ \right. \\
& + \sqrt{2}\lambda\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^+ Z_{l1}^+ + \sqrt{2}\Lambda_T\lambda^* Z_{i3}^A Z_{j4}^A Z_{k1}^+ Z_{l1}^+ + 2|\Lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k1}^+ Z_{l1}^+ \\
& + \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^+ Z_{l1}^+ + \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^+ Z_{l1}^+ + 2\lambda_T\lambda^* Z_{i4}^A Z_{j4}^A Z_{k2}^+ Z_{l1}^+ \\
& - 2\Lambda_T\lambda^* Z_{i3}^A Z_{j1}^A Z_{k3}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^A Z_{k3}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j1}^A Z_{k3}^+ Z_{l1}^+ \\
& - 2\lambda_T\Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k3}^+ Z_{l1}^+ + 2\lambda\Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^A Z_{k4}^+ Z_{l1}^+ \\
& \left. - \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j1}^A Z_{k4}^+ Z_{l1}^+ + \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k1}^+ Z_{l2}^+ \right)
\end{aligned}$$



$$\begin{aligned}
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k1}^+ Z_{l2}^+ + 2\lambda \lambda_T^* Z_{i4}^A Z_{j4}^A Z_{k1}^+ Z_{l2}^+ + 4|\lambda|^2 Z_{i3}^A Z_{j3}^A Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2}\lambda \Lambda_T^* Z_{i4}^A Z_{j3}^A Z_{k2}^+ Z_{l2}^+ + \sqrt{2}\Lambda_T \lambda^* Z_{i4}^A Z_{j3}^A Z_{k2}^+ Z_{l2}^+ + \sqrt{2}\lambda \Lambda_T^* Z_{i3}^A Z_{j4}^A Z_{k2}^+ Z_{l2}^+ \\
& + \sqrt{2}\Lambda_T \lambda^* Z_{i3}^A Z_{j4}^A Z_{k2}^+ Z_{l2}^+ + 2|\Lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k2}^+ Z_{l2}^+ - 2\Lambda_T \lambda^* Z_{i3}^A Z_{j2}^A Z_{k3}^+ Z_{l2}^+ \\
& - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^A Z_{k3}^+ Z_{l2}^+ + \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j2}^A Z_{k3}^+ Z_{l2}^+ + 2\Lambda_T \lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k4}^+ Z_{l2}^+ \\
& + 2\lambda \Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k4}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^A Z_{k4}^+ Z_{l2}^+ + \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j2}^A Z_{k4}^+ Z_{l2}^+ \\
& - 2\lambda \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k1}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^A Z_{k1}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j1}^A Z_{k1}^+ Z_{l3}^+ \\
& - 2\Lambda_T \lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k1}^+ Z_{l3}^+ - 2\lambda \Lambda_T^* Z_{i3}^A Z_{j2}^A Z_{k2}^+ Z_{l3}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^A Z_{k2}^+ Z_{l3}^+ \\
& + \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j2}^A Z_{k2}^+ Z_{l3}^+ + 4|\lambda_T|^2 Z_{i3}^A Z_{j3}^A Z_{k3}^+ Z_{l3}^+ + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k3}^+ Z_{l3}^+ \\
& + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k4}^+ Z_{l3}^+ - 2|\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k4}^+ Z_{l3}^+ + 2\Lambda_T \lambda^* Z_{i3}^A Z_{j1}^A Z_{k1}^+ Z_{l4}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^A Z_{k1}^+ Z_{l4}^+ - \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j1}^A Z_{k1}^+ Z_{l4}^+ + 2\lambda_T \Lambda_T^* Z_{i3}^A Z_{j1}^A Z_{k2}^+ Z_{l4}^+ \\
& + 2\Lambda_T \lambda^* Z_{i3}^A Z_{j2}^A Z_{k2}^+ Z_{l4}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^A Z_{k2}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_T|^2 Z_{i4}^A Z_{j2}^A Z_{k2}^+ Z_{l4}^+ \\
& + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k3}^+ Z_{l4}^+ - 2|\lambda_T|^2 Z_{i4}^A Z_{j4}^A Z_{k3}^+ Z_{l4}^+ + 4|\lambda_T|^2 Z_{i3}^A Z_{j3}^A Z_{k4}^+ Z_{l4}^+ \\
& + 4g_2^2 Z_{i4}^A Z_{j4}^A Z_{k4}^+ Z_{l4}^+ \\
& - Z_{i2}^A \left( 2\lambda_T \Lambda_T^* Z_{j3}^A Z_{k3}^+ Z_{l1}^+ + 2\Lambda_T \lambda^* Z_{j3}^A Z_{k3}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k3}^+ Z_{l2}^+ \right. \\
& - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k3}^+ Z_{l2}^+ - 2\lambda \Lambda_T^* Z_{j3}^A Z_{k4}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k4}^+ Z_{l2}^+ \\
& - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k4}^+ Z_{l2}^+ + 2\Lambda_T \lambda_T^* Z_{j3}^A Z_{k1}^+ Z_{l3}^+ + 2\lambda \Lambda_T^* Z_{j3}^A Z_{k2}^+ Z_{l3}^+ \\
& + \sqrt{2}g_2^2 Z_{j4}^A Z_{k2}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k2}^+ Z_{l3}^+ - 2\Lambda_T \lambda^* Z_{j3}^A Z_{k2}^+ Z_{l4}^+ \\
& + \sqrt{2}g_2^2 Z_{j4}^A Z_{k2}^+ Z_{l4}^+ - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k2}^+ Z_{l4}^+ \\
& \left. + Z_{j2}^A \left( \left( -4|\Lambda_T|^2 - g_2^2 + g_1^2 \right) Z_{k1}^+ Z_{l1}^+ - \left( g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ - 2g_2^2 Z_{k3}^+ Z_{l3}^+ + 2g_2^2 Z_{k4}^+ Z_{l4}^+ \right. \right. \\
& \left. \left. - 4|\Lambda_T|^2 Z_{k4}^+ Z_{l4}^+ \right) \right) \\
& + Z_{j1}^A \left( \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k2}^+ Z_{l1}^+ + \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k1}^+ Z_{l2}^+ \right. \\
& \left. + 2 \left( \lambda \lambda_T^* Z_{k4}^+ Z_{l3}^+ + \lambda_T \lambda^* Z_{k3}^+ Z_{l4}^+ \right) \right) \\
& + Z_{i1}^A \left( -2\Lambda_T \lambda^* Z_{j3}^A Z_{k3}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k3}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k3}^+ Z_{l1}^+ \right. \\
& + 2\lambda \Lambda_T^* Z_{j3}^A Z_{k4}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k4}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k4}^+ Z_{l1}^+ \\
& + 2\Lambda_T \lambda_T^* Z_{j3}^A Z_{k4}^+ Z_{l2}^+ - 2\lambda \Lambda_T^* Z_{j3}^A Z_{k1}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k1}^+ Z_{l3}^+ \\
& - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k1}^+ Z_{l3}^+ + 2\Lambda_T \lambda^* Z_{j3}^A Z_{k1}^+ Z_{l4}^+ + \sqrt{2}g_2^2 Z_{j4}^A Z_{k1}^+ Z_{l4}^+ \\
& - \sqrt{2}|\Lambda_T|^2 Z_{j4}^A Z_{k1}^+ Z_{l4}^+ + 2\lambda_T \Lambda_T^* Z_{j3}^A Z_{k2}^+ Z_{l4}^+ \\
& \left. + Z_{j1}^A \left( \left( g_1^2 + g_2^2 \right) Z_{k1}^+ Z_{l1}^+ + \left( 4|\Lambda_T|^2 - g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ - 2g_2^2 Z_{k3}^+ Z_{l3}^+ + 4|\Lambda_T|^2 Z_{k3}^+ Z_{l3}^+ \right. \right. \\
& \left. \left. + 2g_2^2 Z_{k4}^+ Z_{l4}^+ \right) \right)
\end{aligned}$$

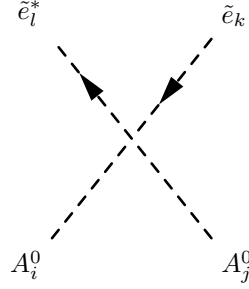
$$\begin{aligned}
& - Z_{j2}^A \left( \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k2}^+ Z_{l1}^+ + \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k1}^+ Z_{l2}^+ \right. \\
& \left. + 2 \left( \lambda \lambda_T^* Z_{k4}^+ Z_{l3}^+ + \lambda_T \lambda^* Z_{k3}^+ Z_{l4}^+ \right) \right) \quad (474)
\end{aligned}$$


---



$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( \left( 3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{D,*} Z_{la}^D \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \right. \\
& + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{D,*} Z_{l3+a}^D \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \\
& - 3 \left( 4 \sum_{c=1}^3 Z_{k3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D Z_{i1}^A Z_{j1}^A \right. \\
& + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D Z_{i1}^A Z_{j1}^A - 2\lambda^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i3}^A Z_{j2}^A \\
& - 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i3}^A Z_{j2}^A + \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i4}^A Z_{j2}^A \\
& + \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i4}^A Z_{j2}^A - 2\lambda^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^A Z_{j3}^A \\
& - 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i2}^A Z_{j3}^A + \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^A Z_{j4}^A \\
& \left. + \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i2}^A Z_{j4}^A \right) \quad (475)
\end{aligned}$$


---

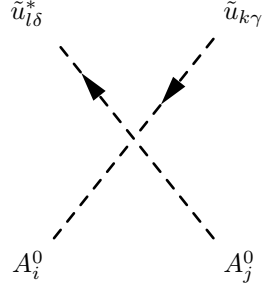


$$\begin{aligned}
& -\frac{i}{4} \left( g_1^2 \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E Z_{i1}^A Z_{j1}^A - g_2^2 \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E Z_{i1}^A Z_{j1}^A \right. \\
& - 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E Z_{i1}^A Z_{j1}^A + 4 \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{k8+b}^{E,*} Z_{i1}^A Z_{j1}^A \\
& + 4Z_{k7}^{E,*} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{lb}^E Z_{i1}^A Z_{j1}^A + 4 \sum_{c=1}^2 Z_{k8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ac}^* Y_{L,ab} Z_{l8+b}^E Z_{i1}^A Z_{j1}^A \\
& - 4 \sum_{c=1}^2 Z_{k8+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{L,ac}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^A Z_{j1}^A \\
& - 4 \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{e,ca}^* Y_{L,ab} Z_{l8+b}^E Z_{i1}^A Z_{j1}^A \\
& + 4 \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^A Z_{j1}^A \\
& + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^E Z_{i1}^A Z_{j1}^A + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E Z_{i1}^A Z_{j1}^A \\
& - 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i2}^A Z_{j1}^A - 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i2}^A Z_{j1}^A \\
& + 2\lambda_{SR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^A Z_{j1}^A - 2\lambda Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}R\hat{E},a}^* Z_{l10+a}^E Z_{i3}^A Z_{j1}^A \\
& - 2Z_{k7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{l10+b}^E Z_{i3}^A Z_{j1}^A - 2 \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i3}^A Z_{j1}^A \\
& - 2 \sum_{c=1}^3 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^E Z_{i3}^A Z_{j1}^A + \sqrt{2} \lambda_{TR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^A Z_{j1}^A \\
& + \sqrt{2} \Lambda_T Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}R\hat{E},a}^* Z_{l10+a}^E Z_{i4}^A Z_{j1}^A - 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i1}^A Z_{j2}^A
\end{aligned}$$

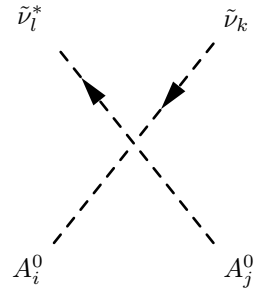
$$\begin{aligned}
& - 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k_{10+a}}^{E,*} \lambda_{SE,ba} Z_{l_{8+b}}^E Z_{i_1}^A Z_{j_2}^A - g_1^2 \sum_{a=1}^3 Z_{k_a}^{E,*} Z_{l_a}^E Z_{i_2}^A Z_{j_2}^A \\
& + g_2^2 \sum_{a=1}^3 Z_{k_a}^{E,*} Z_{l_a}^E Z_{i_2}^A Z_{j_2}^A + 2g_1^2 \sum_{a=1}^3 Z_{k_{3+a}}^{E,*} Z_{l_{3+a}}^E Z_{i_2}^A Z_{j_2}^A \\
& + 4 \sum_{a=1}^2 Z_{k_{10+a}}^{E,*} Y_{\widehat{Bar}E,a} \sum_{b=1}^2 Y_{\widehat{Bar}E,b}^* Z_{l_{10+b}}^E Z_{i_2}^A Z_{j_2}^A + 2\lambda^* Z_{k_7}^{E,*} \sum_{a=1}^2 Y_{\widehat{E},a} Z_{l_{8+a}}^E Z_{i_3}^A Z_{j_2}^A \\
& - 2\lambda_{SR} Z_{k_7}^{E,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{l_{10+a}}^E Z_{i_3}^A Z_{j_2}^A + 2\lambda \sum_{b=1}^2 Z_{k_{8+b}}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{l_a}^E Z_{i_3}^A Z_{j_2}^A \\
& + 2Z_{k_8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* \lambda_{SE,ba} Z_{l_{8+b}}^E Z_{i_3}^A Z_{j_2}^A + 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{k_a}^{E,*} Y_{L,ab} Z_{l_{8+b}}^E Z_{i_3}^A Z_{j_2}^A \\
& - 2\lambda^* \sum_{b=1}^3 Z_{k_b}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l_{3+a}}^E Z_{i_3}^A Z_{j_2}^A - 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k_{3+a}}^{E,*} Z_{l_b}^E Z_{i_3}^A Z_{j_2}^A \\
& - \sqrt{2}\Lambda_T^* Z_{k_7}^{E,*} \sum_{a=1}^2 Y_{\widehat{E},a} Z_{l_{8+a}}^E Z_{i_4}^A Z_{j_2}^A - \sqrt{2}\lambda_{TR} Z_{k_7}^{E,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{l_{10+a}}^E Z_{i_4}^A Z_{j_2}^A \\
& - \sqrt{2}\Lambda_T \sum_{b=1}^2 Z_{k_{8+b}}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{l_a}^E Z_{i_4}^A Z_{j_2}^A - \sqrt{2}\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{k_a}^{E,*} Y_{L,ab} Z_{l_{8+b}}^E Z_{i_4}^A Z_{j_2}^A \\
& + \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{k_b}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l_{3+a}}^E Z_{i_4}^A Z_{j_2}^A + \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k_{3+a}}^{E,*} Z_{l_b}^E Z_{i_4}^A Z_{j_2}^A \\
& + 2g_1^2 \sum_{a=1}^2 Z_{k_{10+a}}^{E,*} Z_{l_{10+a}}^E \left( Z_{i_1}^A Z_{j_1}^A - Z_{i_2}^A Z_{j_2}^A \right) \\
& + 2g_1^2 \sum_{a=1}^2 Z_{k_{8+a}}^{E,*} Z_{l_{8+a}}^E \left( -Z_{i_1}^A Z_{j_1}^A + Z_{i_2}^A Z_{j_2}^A \right) + 2\lambda_{SR}^* Z_{k_8}^{E,*} \sum_{a=1}^2 Y_{\widehat{E},a} Z_{l_{8+a}}^E Z_{i_1}^A Z_{j_3}^A \\
& - 2\lambda Z_{k_8}^{E,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{l_{10+a}}^E Z_{i_1}^A Z_{j_3}^A - 2Z_{k_7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\widehat{E},a} Z_{l_{10+b}}^E Z_{i_1}^A Z_{j_3}^A \\
& - 2 \sum_{c=1}^2 \sum_{b=1}^3 Z_{k_b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l_{10+c}}^E Z_{i_1}^A Z_{j_3}^A \\
& - 2 \sum_{c=1}^3 \sum_{b=1}^2 Z_{k_{10+b}}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{l_c}^E Z_{i_1}^A Z_{j_3}^A + 2\lambda^* Z_{k_7}^{E,*} \sum_{a=1}^2 Y_{\widehat{E},a} Z_{l_{8+a}}^E Z_{i_2}^A Z_{j_3}^A \\
& - 2\lambda_{SR} Z_{k_7}^{E,*} \sum_{a=1}^2 Y_{\widehat{Bar}E,a}^* Z_{l_{10+a}}^E Z_{i_2}^A Z_{j_3}^A + 2\lambda \sum_{b=1}^2 Z_{k_{8+b}}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{l_a}^E Z_{i_2}^A Z_{j_3}^A
\end{aligned}$$

$$\begin{aligned}
& + 2Z_{k8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i2}^A Z_{j3}^A + 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^A Z_{j3}^A \\
& - 2\lambda^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^A Z_{j3}^A - 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i2}^A Z_{j3}^A \\
& + 4 \sum_{c=1}^2 Z_{k8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ca}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i3}^A Z_{j3}^A \\
& + 4 \sum_{c=1}^2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* \lambda_{SE,ab} Z_{l10+c}^E Z_{i3}^A Z_{j3}^A + \sqrt{2} \lambda_{TR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^A Z_{j4}^A \\
& + \sqrt{2} \Lambda_T Z_{k8}^{E,*} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^A Z_{j4}^A - \sqrt{2} \Lambda_T^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i2}^A Z_{j4}^A \\
& - \sqrt{2} \lambda_{TR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{l10+a}^E Z_{i2}^A Z_{j4}^A - \sqrt{2} \Lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab} Z_{la}^E Z_{i2}^A Z_{j4}^A \\
& - \sqrt{2} \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^A Z_{j4}^A + \sqrt{2} \Lambda_T \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^A Z_{j4}^A \\
& + \sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i2}^A Z_{j4}^A - 2\lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i4}^A Z_{j4}^A \\
& - 2\lambda_T^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i4}^A Z_{j4}^A + g_1^2 Z_{k7}^{E,*} Z_{i1}^A Z_{j1}^A Z_{l7}^E \\
& - g_2^2 Z_{k7}^{E,*} Z_{i1}^A Z_{j1}^A Z_{l7}^E + 4Z_{k7}^{E,*} \sum_{a=1}^2 |Y_{\hat{E},a}|^2 Z_{i1}^A Z_{j1}^A Z_{l7}^E \\
& + 4 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{i1}^A Z_{j1}^A Z_{l7}^E + 2\lambda \lambda_{SR}^* Z_{k8}^{E,*} Z_{i2}^A Z_{j1}^A Z_{l7}^E \\
& - \Lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{i2}^A Z_{j1}^A Z_{l7}^E - 2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i3}^A Z_{j1}^A Z_{l7}^E \\
& + 2\lambda \lambda_{SR}^* Z_{k8}^{E,*} Z_{i1}^A Z_{j2}^A Z_{l7}^E - \Lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{i1}^A Z_{j2}^A Z_{l7}^E - g_1^2 Z_{k7}^{E,*} Z_{i2}^A Z_{j2}^A Z_{l7}^E \\
& + g_2^2 Z_{k7}^{E,*} Z_{i2}^A Z_{j2}^A Z_{l7}^E + 2\lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i3}^A Z_{j2}^A Z_{l7}^E \\
& - 2\lambda_{SR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{i3}^A Z_{j2}^A Z_{l7}^E - \sqrt{2} \Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i4}^A Z_{j2}^A Z_{l7}^E \\
& - \sqrt{2} \lambda_{TR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{B\hat{a}rE,a} Z_{i4}^A Z_{j2}^A Z_{l7}^E - 2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i1}^A Z_{j3}^A Z_{l7}^E
\end{aligned}$$

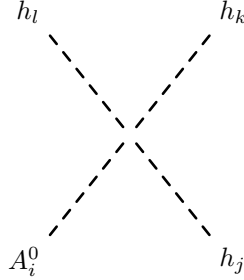
$$\begin{aligned}
& + 2\lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i2}^A Z_{j3}^A Z_{l7}^E - 2\lambda_{SR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{i2}^A Z_{j3}^A Z_{l7}^E \\
& + 4|\lambda_{SR}|^2 Z_{k7}^{E,*} Z_{i3}^A Z_{j3}^A Z_{l7}^E + \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k7}^{E,*} Z_{i4}^A Z_{j3}^A Z_{l7}^E \\
& + \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k7}^{E,*} Z_{i4}^A Z_{j3}^A Z_{l7}^E + \sqrt{2}\lambda_T\lambda_{TR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{j3}^A Z_{l7}^E \\
& - \sqrt{2}\Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i2}^A Z_{j4}^A Z_{l7}^E - \sqrt{2}\lambda_{TR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{i2}^A Z_{j4}^A Z_{l7}^E \\
& + \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k7}^{E,*} Z_{i3}^A Z_{j4}^A Z_{l7}^E + \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k7}^{E,*} Z_{i3}^A Z_{j4}^A Z_{l7}^E \\
& + \sqrt{2}\lambda_T\lambda_{TR}^* Z_{k8}^{E,*} Z_{i3}^A Z_{j4}^A Z_{l7}^E + 2|\lambda_{TR}|^2 Z_{k7}^{E,*} Z_{i4}^A Z_{j4}^A Z_{l7}^E \\
& + 2\lambda_T\lambda_{SR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{j4}^A Z_{l7}^E - g_1^2 Z_{k8}^{E,*} Z_{i1}^A Z_{j1}^A Z_{l8}^E + g_2^2 Z_{k8}^{E,*} Z_{i1}^A Z_{j1}^A Z_{l8}^E \\
& - \lambda_{TR}\Lambda_T^* Z_{k7}^{E,*} Z_{i2}^A Z_{j1}^A Z_{l8}^E + 2\lambda_{SR}\lambda^* Z_{k7}^{E,*} Z_{i2}^A Z_{j1}^A Z_{l8}^E \\
& + 2\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i3}^A Z_{j1}^A Z_{l8}^E - 2\lambda^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{i3}^A Z_{j1}^A Z_{l8}^E \\
& + \sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i4}^A Z_{j1}^A Z_{l8}^E + \sqrt{2}\Lambda_T^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{i4}^A Z_{j1}^A Z_{l8}^E \\
& - \lambda_{TR}\Lambda_T^* Z_{k7}^{E,*} Z_{i1}^A Z_{j2}^A Z_{l8}^E + 2\lambda_{SR}\lambda^* Z_{k7}^{E,*} Z_{i1}^A Z_{j2}^A Z_{l8}^E + g_1^2 Z_{k8}^{E,*} Z_{i2}^A Z_{j2}^A Z_{l8}^E \\
& - g_2^2 Z_{k8}^{E,*} Z_{i2}^A Z_{j2}^A Z_{l8}^E + 4Z_{k8}^{E,*} \sum_{a=1}^2 |Y_{\hat{B}arE,a}|^2 Z_{i2}^A Z_{j2}^A Z_{l8}^E \\
& + 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}arE,a} Z_{i3}^A Z_{j2}^A Z_{l8}^E + 2\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i1}^A Z_{j3}^A Z_{l8}^E \\
& - 2\lambda^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{i1}^A Z_{j3}^A Z_{l8}^E + 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}arE,a} Z_{i2}^A Z_{j3}^A Z_{l8}^E \\
& + 4|\lambda_{SR}|^2 Z_{k8}^{E,*} Z_{i3}^A Z_{j3}^A Z_{l8}^E + \sqrt{2}\lambda_{TR}\lambda_T^* Z_{k7}^{E,*} Z_{i4}^A Z_{j3}^A Z_{l8}^E \\
& + \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{j3}^A Z_{l8}^E + \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{j3}^A Z_{l8}^E \\
& + \sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i1}^A Z_{j4}^A Z_{l8}^E + \sqrt{2}\Lambda_T^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{i1}^A Z_{j4}^A Z_{l8}^E \\
& + \sqrt{2}\lambda_{TR}\lambda_T^* Z_{k7}^{E,*} Z_{i3}^A Z_{j4}^A Z_{l8}^E + \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k8}^{E,*} Z_{i3}^A Z_{j4}^A Z_{l8}^E \\
& + \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k8}^{E,*} Z_{i3}^A Z_{j4}^A Z_{l8}^E + 2\lambda_{SR}\lambda_T^* Z_{k7}^{E,*} Z_{i4}^A Z_{j4}^A Z_{l8}^E \\
& + 2|\lambda_{TR}|^2 Z_{k8}^{E,*} Z_{i4}^A Z_{j4}^A Z_{l8}^E \Big) \tag{476}
\end{aligned}$$



$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( \left( -3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U \left( Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A \right) \right. \\
& + 4g_1^2 \sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U \left( -Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) \\
& + 3 \left( -\sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i4}^A Z_{j1}^A \right. \\
& - 4 \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U Z_{i2}^A Z_{j2}^A \\
& - 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U Z_{i2}^A Z_{j2}^A \\
& + 2\lambda^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \left( Z_{i1}^A Z_{j3}^A + Z_{i3}^A Z_{j1}^A \right) \\
& - \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i1}^A Z_{j4}^A \\
& \left. \left. + \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^U \left( 2\lambda Z_{i3}^A Z_{j1}^A - \sqrt{2}\Lambda_T Z_{i4}^A Z_{j1}^A + Z_{i1}^A \left( 2\lambda Z_{j3}^A - \sqrt{2}\Lambda_T Z_{j4}^A \right) \right) \right) \right) \quad (477)
\end{aligned}$$



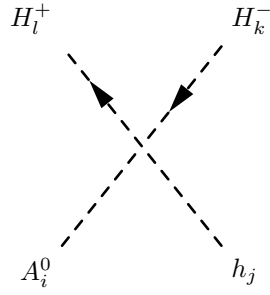
$$\begin{aligned}
& -\frac{i}{4} \left( (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{ka}^{V,*} Z_{la}^V (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) \right. \\
& + Z_{k4}^{V,*} \left( 4|\lambda_{SR}|^2 Z_{i3}^A Z_{j3}^A Z_{l4}^V - \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{i4}^A Z_{j3}^A Z_{l4}^V - \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{i4}^A Z_{j3}^A Z_{l4}^V \right. \\
& - \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{i3}^A Z_{j4}^A Z_{l4}^V - \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{i3}^A Z_{j4}^A Z_{l4}^V + 2|\lambda_{TR}|^2 Z_{i4}^A Z_{j4}^A Z_{l4}^V \\
& + \sqrt{2}\lambda_{TR}\lambda_T^* Z_{i4}^A Z_{j3}^A Z_{l5}^V + \sqrt{2}\lambda_{TR}\lambda_T^* Z_{i3}^A Z_{j4}^A Z_{l5}^V - 2\lambda_{SR}\lambda_T^* Z_{i4}^A Z_{j4}^A Z_{l5}^V \\
& - Z_{i2}^A \left( (2\lambda_{SR}\lambda^* + \lambda_{TR}\Lambda_T^*) Z_{j1}^A Z_{l5}^V + (g_1^2 + g_2^2) Z_{j2}^A Z_{l4}^V \right) \\
& + Z_{i1}^A \left( - (2\lambda_{SR}\lambda^* + \lambda_{TR}\Lambda_T^*) Z_{j2}^A Z_{l5}^V + (g_1^2 + g_2^2) Z_{j1}^A Z_{l4}^V \right) \\
& - Z_{k5}^{V,*} \left( (g_1^2 + g_2^2) (Z_{i1}^A Z_{j1}^A - Z_{i2}^A Z_{j2}^A) Z_{l5}^V \right. \\
& + \lambda_{SR}^* \left( 2\lambda Z_{i2}^A Z_{j1}^A Z_{l4}^V + 2\lambda Z_{i1}^A Z_{j2}^A Z_{l4}^V + 2\lambda_T Z_{i4}^A Z_{j4}^A Z_{l4}^V - 4\lambda_{SR} Z_{i3}^A Z_{j3}^A Z_{l5}^V \right. \\
& + \sqrt{2}\lambda_{TR} Z_{i4}^A Z_{j3}^A Z_{l5}^V + \sqrt{2}\lambda_{TR} Z_{i3}^A Z_{j4}^A Z_{l5}^V \left. \right) \\
& + \lambda_{TR}^* \left( \Lambda_T Z_{i2}^A Z_{j1}^A Z_{l4}^V + \Lambda_T Z_{i1}^A Z_{j2}^A Z_{l4}^V - \sqrt{2}\lambda_T Z_{i4}^A Z_{j3}^A Z_{l4}^V - \sqrt{2}\lambda_T Z_{i3}^A Z_{j4}^A Z_{l4}^V \right. \\
& \left. \left. + \sqrt{2}\lambda_{SR} Z_{i4}^A Z_{j3}^A Z_{l5}^V + \sqrt{2}\lambda_{SR} Z_{i3}^A Z_{j4}^A Z_{l5}^V - 2\lambda_{TR} Z_{i4}^A Z_{j4}^A Z_{l5}^V \right) \right) \quad (478)
\end{aligned}$$



$$\begin{aligned}
& \frac{1}{8} \left( \lambda_T^* \left( -\sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^H Z_{k3}^H Z_{l1}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j3}^H Z_{k4}^H Z_{l1}^H + 2\lambda Z_{i2}^A Z_{j4}^H Z_{k4}^H Z_{l1}^H \right. \right. \\
& - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^H Z_{k3}^H Z_{l2}^H - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j3}^H Z_{k4}^H Z_{l2}^H + 2\lambda Z_{i1}^A Z_{j4}^H Z_{k4}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^H Z_{k1}^H Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^H Z_{k2}^H Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j1}^H Z_{k4}^H Z_{l3}^H \\
& - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j2}^H Z_{k4}^H Z_{l3}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j3}^H Z_{k1}^H Z_{l4}^H + 2\lambda Z_{i2}^A Z_{j4}^H Z_{k1}^H Z_{l4}^H \\
& - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j3}^H Z_{k2}^H Z_{l4}^H + 2\lambda Z_{i1}^A Z_{j4}^H Z_{k2}^H Z_{l4}^H - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j1}^H Z_{k3}^H Z_{l4}^H \\
& - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j2}^H Z_{k3}^H Z_{l4}^H + 2\lambda Z_{i2}^A Z_{j1}^H Z_{k4}^H Z_{l4}^H + 2\lambda Z_{i1}^A Z_{j2}^H Z_{k4}^H Z_{l4}^H \\
& \left. + Z_{i4}^A \left( \sqrt{2}\Lambda_T Z_{j2}^H Z_{k3}^H Z_{l1}^H - 2\lambda Z_{j2}^H Z_{k4}^H Z_{l1}^H + \sqrt{2}\Lambda_T Z_{j1}^H Z_{k3}^H Z_{l2}^H - 2\lambda Z_{j1}^H Z_{k4}^H Z_{l2}^H \right. \right. \\
& \left. \left. + \sqrt{2}\Lambda_T Z_{j3}^H \left( Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H \right) - 2\lambda Z_{j4}^H \left( Z_{k1}^H Z_{l2}^H + Z_{k2}^H Z_{l1}^H \right) + \sqrt{2}\Lambda_T Z_{j2}^H Z_{k1}^H Z_{l3}^H \right) \right)
\end{aligned}$$

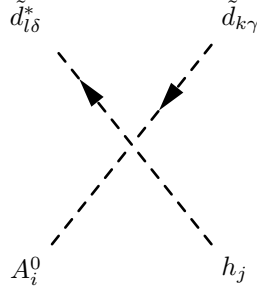


$$\begin{aligned}
& + \sqrt{2}\Lambda_T Z_{j_1}^H Z_{k_2}^H Z_{l_3}^H - 2\lambda Z_{j_2}^H Z_{k_1}^H Z_{l_4}^H - 2\lambda Z_{j_1}^H Z_{k_2}^H Z_{l_4}^H \\
& + \sqrt{2}\Lambda_T Z_{i_3}^A \left( Z_{j_1}^H \left( Z_{k_2}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_2}^H \right) + Z_{j_2}^H \left( Z_{k_1}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_1}^H \right) + Z_{j_4}^H \left( Z_{k_1}^H Z_{l_2}^H + Z_{k_2}^H Z_{l_1}^H \right) \right) \\
& - 2\lambda^* \left( Z_{i_4}^A \left( \sqrt{2}\Lambda_T Z_{j_1}^H Z_{k_3}^H Z_{l_1}^H - \lambda_T Z_{j_2}^H Z_{k_4}^H Z_{l_1}^H + \sqrt{2}\Lambda_T Z_{j_2}^H Z_{k_3}^H Z_{l_2}^H - \lambda_T Z_{j_1}^H Z_{k_4}^H Z_{l_2}^H \right. \right. \\
& - \lambda_T Z_{j_4}^H \left( Z_{k_1}^H Z_{l_2}^H + Z_{k_2}^H Z_{l_1}^H \right) + \sqrt{2}\Lambda_T Z_{j_3}^H \left( Z_{k_1}^H Z_{l_1}^H + Z_{k_2}^H Z_{l_2}^H \right) + \sqrt{2}\Lambda_T Z_{j_1}^H Z_{k_1}^H Z_{l_3}^H \\
& + \sqrt{2}\Lambda_T Z_{j_2}^H Z_{k_2}^H Z_{l_3}^H - \lambda_T Z_{j_2}^H Z_{k_1}^H Z_{l_4}^H - \lambda_T Z_{j_1}^H Z_{k_2}^H Z_{l_4}^H \left. \right) \\
& - \sqrt{2}\Lambda_T Z_{i_3}^A \left( Z_{j_1}^H \left( Z_{k_1}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_1}^H \right) + Z_{j_2}^H \left( Z_{k_2}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_2}^H \right) + Z_{j_4}^H \left( Z_{k_1}^H Z_{l_1}^H + Z_{k_2}^H Z_{l_2}^H \right) \right) \\
& + \lambda_T \left( Z_{i_2}^A \left( Z_{j_1}^H Z_{k_4}^H Z_{l_4}^H + Z_{j_4}^H \left( Z_{k_1}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_1}^H \right) \right) \right) \\
& + Z_{i_1}^A \left( Z_{j_2}^H Z_{k_4}^H Z_{l_4}^H + Z_{j_4}^H \left( Z_{k_2}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_2}^H \right) \right) \\
& + \sqrt{2}\Lambda_T^* \left( Z_{i_4}^A \left( Z_{j_3}^H \left( Z_{k_1}^H \left( 2\lambda Z_{l_1}^H - \lambda_T Z_{l_2}^H \right) + Z_{k_2}^H \left( 2\lambda Z_{l_2}^H - \lambda_T Z_{l_1}^H \right) \right) \right. \right. \\
& + Z_{j_1}^H \left( \left( 2\lambda Z_{k_1}^H - \lambda_T Z_{k_2}^H \right) Z_{l_3}^H + Z_{k_3}^H \left( 2\lambda Z_{l_1}^H - \lambda_T Z_{l_2}^H \right) \right) \\
& - Z_{j_2}^H \left( \left( -2\lambda Z_{k_2}^H + \lambda_T Z_{k_1}^H \right) Z_{l_3}^H + Z_{k_3}^H \left( -2\lambda Z_{l_2}^H + \lambda_T Z_{l_1}^H \right) \right) \left. \right) \\
& - Z_{i_3}^A \left( Z_{j_4}^H \left( Z_{k_1}^H \left( 2\lambda Z_{l_1}^H + \lambda_T Z_{l_2}^H \right) + Z_{k_2}^H \left( 2\lambda Z_{l_2}^H + \lambda_T Z_{l_1}^H \right) \right) \right) \\
& + Z_{j_1}^H \left( \left( 2\lambda Z_{k_1}^H + \lambda_T Z_{k_2}^H \right) Z_{l_4}^H + Z_{k_4}^H \left( 2\lambda Z_{l_1}^H + \lambda_T Z_{l_2}^H \right) \right) \\
& + Z_{j_2}^H \left( \left( 2\lambda Z_{k_2}^H + \lambda_T Z_{k_1}^H \right) Z_{l_4}^H + Z_{k_4}^H \left( 2\lambda Z_{l_2}^H + \lambda_T Z_{l_1}^H \right) \right) \\
& + \lambda_T \left( Z_{i_2}^A \left( Z_{j_1}^H \left( Z_{k_3}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_3}^H \right) + Z_{j_3}^H \left( Z_{k_1}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_1}^H \right) + Z_{j_4}^H \left( Z_{k_1}^H Z_{l_3}^H + Z_{k_3}^H Z_{l_1}^H \right) \right) \right. \\
& \left. + Z_{i_1}^A \left( Z_{j_2}^H \left( Z_{k_3}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_3}^H \right) + Z_{j_3}^H \left( Z_{k_2}^H Z_{l_4}^H + Z_{k_4}^H Z_{l_2}^H \right) + Z_{j_4}^H \left( Z_{k_2}^H Z_{l_3}^H + Z_{k_3}^H Z_{l_2}^H \right) \right) \right) \right) \tag{479}
\end{aligned}$$

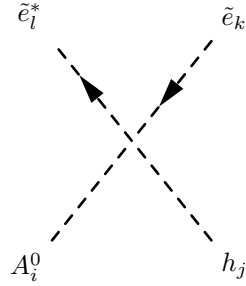


$$\begin{aligned}
& \frac{1}{4} \left( g_2^2 Z_{i_2}^A Z_{j_1}^H Z_{k_2}^+ Z_{l_1}^+ + g_2^2 Z_{i_1}^A Z_{j_2}^H Z_{k_2}^+ Z_{l_1}^+ - \sqrt{2} g_2^2 Z_{i_4}^A Z_{j_1}^H Z_{k_3}^+ Z_{l_1}^+ \right. \\
& + \sqrt{2} g_2^2 Z_{i_1}^A Z_{j_4}^H Z_{k_3}^+ Z_{l_1}^+ - \sqrt{2} g_2^2 Z_{i_4}^A Z_{j_1}^H Z_{k_4}^+ Z_{l_1}^+ - \sqrt{2} g_2^2 Z_{i_1}^A Z_{j_4}^H Z_{k_4}^+ Z_{l_1}^+ \\
& \left. - g_2^2 Z_{i_2}^A Z_{j_1}^H Z_{k_1}^+ Z_{l_2}^+ - g_2^2 Z_{i_1}^A Z_{j_2}^H Z_{k_1}^+ Z_{l_2}^+ + \sqrt{2}\Lambda_T \lambda_T^* Z_{i_4}^A Z_{j_3}^H Z_{k_1}^+ Z_{l_2}^+ \right)
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2}\Lambda_T \lambda_T^* Z_{i3}^A Z_{j4}^H Z_{k1}^+ Z_{l2}^+ + 2\lambda\lambda_T^* Z_{i4}^A Z_{j4}^H Z_{k1}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^H Z_{k3}^+ Z_{l2}^+ \\
& - \sqrt{2}g_2^2 Z_{i2}^A Z_{j4}^H Z_{k3}^+ Z_{l2}^+ - 2\Lambda_T \lambda_T^* Z_{i3}^A Z_{j1}^H Z_{k4}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^H Z_{k4}^+ Z_{l2}^+ \\
& + 2\Lambda_T \lambda_T^* Z_{i1}^A Z_{j3}^H Z_{k4}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{i2}^A Z_{j4}^H Z_{k4}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^H Z_{k1}^+ Z_{l3}^+ \\
& + 2\Lambda_T \lambda_T^* Z_{i3}^A Z_{j2}^H Z_{k1}^+ Z_{l3}^+ - 2\Lambda_T \lambda_T^* Z_{i2}^A Z_{j3}^H Z_{k1}^+ Z_{l3}^+ - \sqrt{2}g_2^2 Z_{i1}^A Z_{j4}^H Z_{k1}^+ Z_{l3}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^H Z_{k2}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l3}^+ + 2\lambda\lambda_T^* Z_{i2}^A Z_{j1}^H Z_{k4}^+ Z_{l3}^+ \\
& + 2\lambda\lambda_T^* Z_{i1}^A Z_{j2}^H Z_{k4}^+ Z_{l3}^+ - 4g_2^2 Z_{i4}^A Z_{j4}^H Z_{k4}^+ Z_{l3}^+ + 2|\lambda_T|^2 Z_{i4}^A Z_{j4}^H Z_{k4}^+ Z_{l3}^+ \\
& + \sqrt{2}g_2^2 Z_{i4}^A Z_{j1}^H Z_{k1}^+ Z_{l4}^+ + \sqrt{2}g_2^2 Z_{i1}^A Z_{j4}^H Z_{k1}^+ Z_{l4}^+ + \sqrt{2}g_2^2 Z_{i4}^A Z_{j2}^H Z_{k2}^+ Z_{l4}^+ \\
& - \sqrt{2}g_2^2 Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l4}^+ + 4g_2^2 Z_{i4}^A Z_{j4}^H Z_{k3}^+ Z_{l4}^+ - 2|\lambda_T|^2 Z_{i4}^A Z_{j4}^H Z_{k3}^+ Z_{l4}^+ \\
& + \lambda^* \left( Z_{i4}^A \left( -2\lambda_T Z_{j4}^H Z_{k2}^+ Z_{l1}^+ + \sqrt{2}\Lambda_T Z_{j3}^H \left( Z_{k1}^+ Z_{l1}^+ + Z_{k2}^+ Z_{l2}^+ \right) \right) \right. \\
& - \Lambda_T Z_{i3}^A \left( -2Z_{j1}^H \left( Z_{k1}^+ Z_{l4}^+ + Z_{k3}^+ Z_{l1}^+ \right) + 2Z_{j2}^H \left( Z_{k2}^+ Z_{l4}^+ + Z_{k3}^+ Z_{l2}^+ \right) + \sqrt{2}Z_{j4}^H \left( Z_{k1}^+ Z_{l1}^+ + Z_{k2}^+ Z_{l2}^+ \right) \right) \\
& - 2 \left( Z_{i2}^A \left( \Lambda_T Z_{j3}^H \left( -Z_{k2}^+ Z_{l4}^+ + Z_{k3}^+ Z_{l2}^+ \right) + Z_{j1}^H \left( \lambda_T Z_{k3}^+ Z_{l4}^+ - \lambda Z_{k1}^+ Z_{l2}^+ + \lambda Z_{k2}^+ Z_{l1}^+ \right) \right) \right. \\
& \left. + Z_{i1}^A \left( \Lambda_T Z_{j3}^H \left( -Z_{k1}^+ Z_{l4}^+ + Z_{k3}^+ Z_{l1}^+ \right) + Z_{j2}^H \left( \lambda_T Z_{k3}^+ Z_{l4}^+ - \lambda Z_{k1}^+ Z_{l2}^+ + \lambda Z_{k2}^+ Z_{l1}^+ \right) \right) \right) \\
& - \Lambda_T^* \left( -\Lambda_T Z_{i2}^A Z_{j1}^H Z_{k2}^+ Z_{l1}^+ - \Lambda_T Z_{i1}^A Z_{j2}^H Z_{k2}^+ Z_{l1}^+ - 2\lambda_T Z_{i2}^A Z_{j3}^H Z_{k3}^+ Z_{l1}^+ \right. \\
& + \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^H Z_{k3}^+ Z_{l1}^+ + 2\lambda Z_{i1}^A Z_{j3}^H Z_{k4}^+ Z_{l1}^+ - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^H Z_{k4}^+ Z_{l1}^+ \\
& + \Lambda_T Z_{i2}^A Z_{j1}^H Z_{k1}^+ Z_{l2}^+ + \Lambda_T Z_{i1}^A Z_{j2}^H Z_{k1}^+ Z_{l2}^+ - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^H Z_{k3}^+ Z_{l2}^+ \\
& + 2\lambda Z_{i2}^A Z_{j3}^H Z_{k4}^+ Z_{l2}^+ + \sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^H Z_{k4}^+ Z_{l2}^+ - 2\lambda Z_{i1}^A Z_{j3}^H Z_{k1}^+ Z_{l3}^+ \\
& - \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^H Z_{k1}^+ Z_{l3}^+ - 2\lambda Z_{i2}^A Z_{j3}^H Z_{k2}^+ Z_{l3}^+ + \sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l3}^+ \\
& + \sqrt{2}\Lambda_T Z_{i1}^A Z_{j4}^H Z_{k1}^+ Z_{l4}^+ + 2\lambda_T Z_{i1}^A Z_{j3}^H Z_{k2}^+ Z_{l4}^+ - \sqrt{2}\Lambda_T Z_{i2}^A Z_{j4}^H Z_{k2}^+ Z_{l4}^+ \\
& \left. - Z_{i3}^A \left( \sqrt{2}Z_{j4}^H \left( \lambda Z_{k1}^+ Z_{l1}^+ + Z_{k2}^+ \left( -\lambda_T Z_{l1}^+ + \lambda Z_{l2}^+ \right) \right) \right) \right. \\
& + 2 \left( Z_{j2}^H \left( -\lambda_T Z_{k3}^+ Z_{l1}^+ + \lambda Z_{k2}^+ Z_{l3}^+ + \lambda Z_{k4}^+ Z_{l2}^+ \right) \right. \\
& \left. - Z_{j1}^H \left( -\lambda_T Z_{k2}^+ Z_{l4}^+ + \lambda Z_{k1}^+ Z_{l3}^+ + \lambda Z_{k4}^+ Z_{l1}^+ \right) \right) \\
& + \sqrt{2}Z_{i4}^A \left( Z_{j3}^H \left( \lambda Z_{k1}^+ Z_{l1}^+ + Z_{k2}^+ \left( \lambda_T Z_{l1}^+ + \lambda Z_{l2}^+ \right) \right) \right. \\
& + \Lambda_T \left( Z_{j1}^H \left( Z_{k1}^+ \left( Z_{l3}^+ + Z_{l4}^+ \right) - Z_{k3}^+ Z_{l1}^+ - Z_{k4}^+ Z_{l1}^+ \right) \right. \\
& \left. \left. + Z_{j2}^H \left( Z_{k2}^+ \left( Z_{l3}^+ + Z_{l4}^+ \right) - Z_{k3}^+ Z_{l2}^+ - Z_{k4}^+ Z_{l2}^+ \right) \right) \right) \right) \right) \right) \tag{480}
\end{aligned}$$



$$\begin{aligned}
& \frac{1}{4} \delta_{\gamma\delta} \left( -2\lambda^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \left( Z_{i2}^A Z_{j3}^H + Z_{i3}^A Z_{j2}^H \right) \right. \\
& + \sqrt{2} \Lambda_T^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \left( Z_{i2}^A Z_{j4}^H + Z_{i4}^A Z_{j2}^H \right) \\
& \left. + \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D \left( 2\lambda Z_{i3}^A Z_{j2}^H - \sqrt{2} \Lambda_T Z_{i4}^A Z_{j2}^H + Z_{i2}^A \left( 2\lambda Z_{j3}^H - \sqrt{2} \Lambda_T Z_{j4}^H \right) \right) \right) \quad (481)
\end{aligned}$$



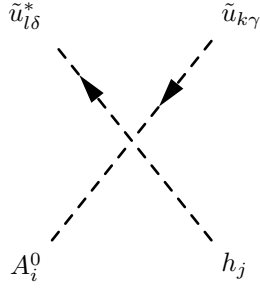
$$\begin{aligned}
& \frac{1}{4} \left( -2\lambda_{SR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^A Z_{j1}^H + 2\lambda Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i3}^A Z_{j1}^H \right. \\
& + 2Z_{k7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{l10+b}^E Z_{i3}^A Z_{j1}^H + 2 \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i3}^A Z_{j1}^H \\
& - 2 \sum_{c=1}^3 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^E Z_{i3}^A Z_{j1}^H - \sqrt{2} \lambda_{TR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^A Z_{j1}^H \\
& - \sqrt{2} \Lambda_T Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i4}^A Z_{j1}^H - 2\lambda \lambda_{SR}^* Z_{k8}^{E,*} Z_{i2}^A Z_{l7}^E Z_{j1}^H \\
& \left. + \Lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{i2}^A Z_{l7}^E Z_{j1}^H - 2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i3}^A Z_{l7}^E Z_{j1}^H \right)
\end{aligned}$$

$$\begin{aligned}
& -\lambda_{TR}\Lambda_T^* Z_{k7}^{E,*} Z_{i2}^A Z_{l8}^E Z_{j1}^H + 2\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i3}^A Z_{l8}^E Z_{j1}^H \\
& + \sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i4}^A Z_{l8}^E Z_{j1}^H + \sqrt{2}\Lambda_T^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i4}^A Z_{l8}^E Z_{j1}^H \\
& - 2\lambda_{SR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i3}^A Z_{j2}^H - 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i3}^A Z_{j2}^H \\
& + 2Z_{k8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i3}^A Z_{j2}^H + 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i3}^A Z_{j2}^H \\
& - \sqrt{2}\Lambda_T^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{l8+a}^E Z_{i4}^A Z_{j2}^H - \sqrt{2}\lambda_{TR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i4}^A Z_{j2}^H \\
& + \sqrt{2}\Lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i4}^A Z_{j2}^H - \sqrt{2}\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i4}^A Z_{j2}^H \\
& + \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i4}^A Z_{j2}^H - \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i4}^A Z_{j2}^H \\
& - 2\lambda\lambda_{SR}^* Z_{k8}^{E,*} Z_{i1}^A Z_{l7}^E Z_{j2}^H + \Lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{i1}^A Z_{l7}^E Z_{j2}^H \\
& - 2\lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i3}^A Z_{l7}^E Z_{j2}^H + 2\lambda_{SR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i3}^A Z_{l7}^E Z_{j2}^H \\
& + \sqrt{2}\Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i4}^A Z_{l7}^E Z_{j2}^H + \sqrt{2}\lambda_{TR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i4}^A Z_{l7}^E Z_{j2}^H \\
& - \lambda_{TR}\Lambda_T^* Z_{k7}^{E,*} Z_{i1}^A Z_{l8}^E Z_{j2}^H - 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{i3}^A Z_{l8}^E Z_{j2}^H \\
& + 2\lambda_{SR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{l8+a}^E Z_{i1}^A Z_{j3}^H + 2\lambda Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^A Z_{j3}^H \\
& - 2Z_{k7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a}^* Z_{l10+b}^E Z_{i1}^A Z_{j3}^H - 2 \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i1}^A Z_{j3}^H \\
& + 2 \sum_{c=1}^3 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^E Z_{i1}^A Z_{j3}^H + 2\lambda_{SR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i2}^A Z_{j3}^H \\
& - 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i2}^A Z_{j3}^H - 2Z_{k8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i2}^A Z_{j3}^H \\
& + 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i2}^A Z_{j3}^H + 2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i1}^A Z_{l7}^E Z_{j3}^H
\end{aligned}$$

$$\begin{aligned}
& - 2\lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i2}^A Z_{l7}^E Z_{j3}^H - 2\lambda_{SR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i2}^A Z_{l7}^E Z_{j3}^H \\
& + \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k7}^{E,*} Z_{i4}^A Z_{l7}^E Z_{j3}^H - \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k7}^{E,*} Z_{i4}^A Z_{l7}^E Z_{j3}^H \\
& - \sqrt{2}\lambda_T\lambda_{TR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{l7}^E Z_{j3}^H - 2\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i1}^A Z_{l8}^E Z_{j3}^H \\
& + 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{i2}^A Z_{l8}^E Z_{j3}^H + \sqrt{2}\lambda_{TR}\lambda_T^* Z_{k7}^{E,*} Z_{i4}^A Z_{l8}^E Z_{j3}^H \\
& + \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{l8}^E Z_{j3}^H - \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k8}^{E,*} Z_{i4}^A Z_{l8}^E Z_{j3}^H \\
& - 2\lambda^* \left( \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i3}^A Z_{l8}^E Z_{j1}^H - \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i3}^A Z_{j2}^H \right. \\
& + \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i3}^A Z_{j2}^H + \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E \left( Z_{i1}^A Z_{j2}^H + Z_{i2}^A Z_{j1}^H \right) \\
& \left. - \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^A Z_{j3}^H + \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^A Z_{j3}^H \right. \\
& + \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i1}^A Z_{l8}^E Z_{j3}^H \\
& \left. - Z_{k7}^{E,*} \left( \left( \lambda_{SR} Z_{i1}^A Z_{l8}^E + \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^A \right) Z_{j2}^H + Z_{i2}^A \left( \lambda_{SR} Z_{l8}^E Z_{j1}^H + \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{j3}^H \right) \right) \right) \\
& + \sqrt{2}\lambda_{TR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^A Z_{j4}^H - \sqrt{2}\lambda_T Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a} Z_{l10+a}^E Z_{i1}^A Z_{j4}^H \\
& - \sqrt{2}\lambda_T^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i2}^A Z_{j4}^H + \sqrt{2}\lambda_{TR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a} Z_{l10+a}^E Z_{i2}^A Z_{j4}^H \\
& + \sqrt{2}\lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i2}^A Z_{j4}^H - \sqrt{2}\lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^A Z_{j4}^H \\
& + \sqrt{2}\lambda_T^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^A Z_{j4}^H - \sqrt{2}\lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i2}^A Z_{j4}^H \\
& - 2\lambda_T^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i4}^A Z_{j4}^H + \sqrt{2}\lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{i2}^A Z_{l7}^E Z_{j4}^H \\
& - \sqrt{2}\lambda_{TR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i2}^A Z_{l7}^E Z_{j4}^H - \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{k7}^{E,*} Z_{i3}^A Z_{l7}^E Z_{j4}^H \\
& + \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{k7}^{E,*} Z_{i3}^A Z_{l7}^E Z_{j4}^H - \sqrt{2}\lambda_T\lambda_{TR}^* Z_{k8}^{E,*} Z_{i3}^A Z_{l7}^E Z_{j4}^H
\end{aligned}$$

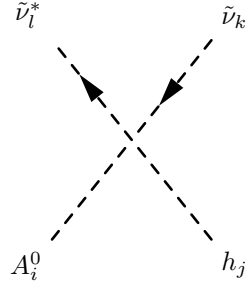
$$\begin{aligned}
& -2\lambda_T\lambda_{SR}^*Z_{k8}^{E,*}Z_{i4}^AZ_{l7}^EZ_{j4}^H - \sqrt{2}\lambda_{TR}\sum_{a=1}^2Y_{\hat{E},a}^*Z_{k8+a}^{E,*}Z_{i1}^AZ_{l8}^EZ_{j4}^H \\
& + \sqrt{2}\Lambda_T^*\sum_{a=1}^2Z_{k10+a}^{E,*}Y_{B\hat{a}rE,a}Z_{i1}^AZ_{l8}^EZ_{j4}^H + \sqrt{2}\lambda_{TR}\lambda_T^*Z_{k7}^{E,*}Z_{i3}^AZ_{l8}^EZ_{j4}^H \\
& - \sqrt{2}\lambda_{TR}\lambda_{SR}^*Z_{k8}^{E,*}Z_{i3}^AZ_{l8}^EZ_{j4}^H + \sqrt{2}\lambda_{SR}\lambda_{TR}^*Z_{k8}^{E,*}Z_{i3}^AZ_{l8}^EZ_{j4}^H \\
& + 2\lambda_{SR}\lambda_T^*Z_{k7}^{E,*}Z_{i4}^AZ_{l8}^EZ_{j4}^H \\
& + 2\sum_{b=1}^2Z_{k8+b}^{E,*}\sum_{a=1}^2\lambda_{SE,ba}^*Z_{l10+a}^E\left(\lambda_TZ_{i4}^AZ_{j4}^H + \lambda Z_{i1}^AZ_{j2}^H + \lambda Z_{i2}^AZ_{j1}^H\right)
\end{aligned} \tag{482}$$


---



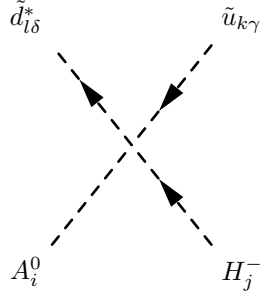
$$\begin{aligned}
& \frac{1}{4}\delta_{\gamma\delta}\left(-2\lambda^*\sum_{b=1}^3Z_{kb}^{U,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\left(Z_{i1}^AZ_{j3}^H + Z_{i3}^AZ_{j1}^H\right)\right. \\
& + \sqrt{2}\Lambda_T^*\sum_{b=1}^3Z_{kb}^{U,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\left(Z_{i1}^AZ_{j4}^H + Z_{i4}^AZ_{j1}^H\right) \\
& \left.+ \sum_{b=1}^3\sum_{a=1}^3Y_{u,ab}^*Z_{k3+a}^{U,*}Z_{lb}^U\left(2\lambda Z_{i3}^AZ_{j1}^H - \sqrt{2}\Lambda_TZ_{i4}^AZ_{j1}^H + Z_{i1}^A\left(2\lambda Z_{j3}^H - \sqrt{2}\Lambda_TZ_{j4}^H\right)\right)\right)
\end{aligned} \tag{483}$$


---

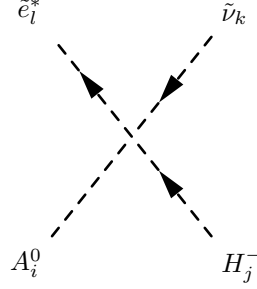


$$\frac{1}{4}\left(-Z_{k4}^{V,*}\left(\lambda_{TR}\Lambda_T^*\left(Z_{i1}^AZ_{j2}^H + Z_{i2}^AZ_{j1}^H\right) + 2\lambda_{SR}\lambda^*\left(Z_{i1}^AZ_{j2}^H + Z_{i2}^AZ_{j1}^H\right)\right)\right)$$

$$\begin{aligned}
& -\lambda_T^* \left( \sqrt{2} \lambda_{TR} Z_{i3}^A Z_{j4}^H + Z_{i4}^A \left( -2\lambda_{SR} Z_{j4}^H + \sqrt{2} \lambda_{TR} Z_{j3}^H \right) \right) Z_{l5}^V \\
& + \lambda_{SR}^* \left( \sqrt{2} \lambda_{TR} Z_{k4}^{V,*} \left( Z_{i3}^A Z_{j4}^H - Z_{i4}^A Z_{j3}^H \right) Z_{l4}^V \right. \\
& + Z_{k5}^{V,*} \left( 2\lambda Z_{i2}^A Z_{j1}^H Z_{l4}^V + 2\lambda Z_{i1}^A Z_{j2}^H Z_{l4}^V + 2\lambda_T Z_{i4}^A Z_{j4}^H Z_{l4}^V - \sqrt{2} \lambda_{TR} Z_{i4}^A Z_{j3}^H Z_{l5}^V \right. \\
& \left. \left. + \sqrt{2} \lambda_{TR} Z_{i3}^A Z_{j4}^H Z_{l5}^V \right) \right) \\
& + \lambda_{TR}^* \left( \sqrt{2} \lambda_{SR} Z_{k4}^{V,*} \left( -Z_{i3}^A Z_{j4}^H + Z_{i4}^A Z_{j3}^H \right) Z_{l4}^V \right. \\
& + Z_{k5}^{V,*} \left( \Lambda_T Z_{i2}^A Z_{j1}^H Z_{l4}^V + \Lambda_T Z_{i1}^A Z_{j2}^H Z_{l4}^V \right. \\
& \left. \left. - \sqrt{2} \left( Z_{i3}^A Z_{j4}^H \left( \lambda_{SR} Z_{l5}^V + \lambda_T Z_{l4}^V \right) + Z_{i4}^A Z_{j3}^H \left( -\lambda_{SR} Z_{l5}^V + \lambda_T Z_{l4}^V \right) \right) \right) \right) \quad (484)
\end{aligned}$$



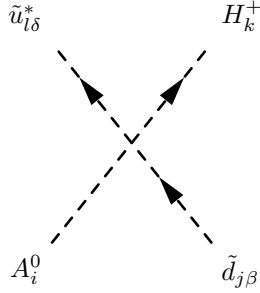
$$\begin{aligned}
& -\frac{1}{4} \delta_{\gamma\delta} \left( 2 \left( -\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D Z_{i1}^A Z_{j1}^+ \right. \right. \\
& - \sqrt{2} \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{i3}^A Z_{j1}^+ - \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{i4}^A Z_{j1}^+ \\
& + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^D Z_{i2}^A Z_{j2}^+ + \sqrt{2} \lambda^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i3}^A Z_{j2}^+ \\
& + \Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i4}^A Z_{j2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{d,ba} Z_{l3+b}^D \left( Z_{i1}^A Z_{j2}^+ - Z_{i2}^A Z_{j1}^+ \right) \\
& + \sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{i1}^A Z_{j3}^+ + \sqrt{2} \Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^A Z_{j4}^+ \left. \right) \\
& + g_2^2 \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^D \left( 2Z_{i4}^A \left( Z_{j3}^+ + Z_{j4}^+ \right) + \sqrt{2} Z_{i1}^A Z_{j1}^+ - \sqrt{2} Z_{i2}^A Z_{j2}^+ \right) \quad (485)
\end{aligned}$$



$$\begin{aligned}
& \frac{1}{4} \left( 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^E Z_{i1}^A Z_{j1}^+ \right. \\
& + 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E Z_{i1}^A Z_{j1}^+ - 2\sqrt{2} \lambda_{SR}^* Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^A Z_{j1}^+ \\
& + 2\sqrt{2} \lambda Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a} Z_{l10+a}^E Z_{i3}^A Z_{j1}^+ - 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i3}^A Z_{j1}^+ \\
& + 2\lambda_{TR}^* Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^A Z_{j1}^+ + 2\Lambda_T Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i4}^A Z_{j1}^+ \\
& + 2\sqrt{2} \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{i1}^A Z_{l7}^E Z_{j1}^+ + 2\sqrt{2} \Lambda_T \lambda_{TR}^* Z_{k5}^{V,*} Z_{i2}^A Z_{l7}^E Z_{j1}^+ \\
& - \sqrt{2} g_2^2 Z_{k5}^{V,*} Z_{i1}^A Z_{l8}^E Z_{j1}^+ - 2\sqrt{2} Z_{k5}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i3}^A Z_{j2}^+ \\
& + 2\sqrt{2} \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} Z_{l8+b}^E Z_{i3}^A Z_{j2}^+ - 2\sqrt{2} \lambda^* \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i3}^A Z_{j2}^+ \\
& + 2\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} Z_{l8+b}^E Z_{i4}^A Z_{j2}^+ - 2\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i4}^A Z_{j2}^+ \\
& + \sqrt{2} g_2^2 Z_{k5}^{V,*} Z_{i2}^A Z_{l8}^E Z_{j2}^+ - 2\sqrt{2} Z_{k5}^{V,*} \sum_{a=1}^2 |Y_{\hat{B}\hat{a}rE,a}|^2 Z_{i2}^A Z_{l8}^E Z_{j2}^+ \\
& - 2\sqrt{2} \Lambda_T Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^A Z_{j3}^+ - 2\sqrt{2} \lambda_T \lambda_{TR}^* Z_{k5}^{V,*} Z_{i3}^A Z_{l7}^E Z_{j3}^+ \\
& - 2\sqrt{2} \lambda_{TR} \lambda_{SR}^* Z_{k5}^{V,*} Z_{i3}^A Z_{l8}^E Z_{j3}^+ - 2g_2^2 Z_{k5}^{V,*} Z_{i4}^A Z_{l8}^E Z_{j3}^+ \\
& + 2|\lambda_{TR}|^2 Z_{k5}^{V,*} Z_{i4}^A Z_{l8}^E Z_{j3}^+ + 2\sqrt{2} \lambda_{TR}^* Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^A Z_{j4}^+
\end{aligned}$$

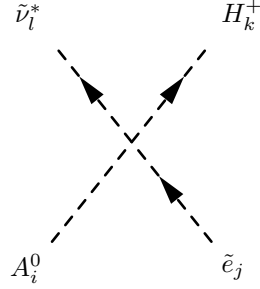


$$\begin{aligned}
& + 2\sqrt{2}\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^A Z_{j4}^+ - 2\sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^A Z_{j4}^+ \\
& + 2\sqrt{2}\lambda_{SR} \lambda_{TR}^* Z_{k5}^{V,*} Z_{i3}^A Z_{l8}^E Z_{j4}^+ - 2g_2^2 Z_{k5}^{V,*} Z_{i4}^A Z_{l8}^E Z_{j4}^+ + 2|\lambda_{TR}|^2 Z_{k5}^{V,*} Z_{i4}^A Z_{l8}^E Z_{j4}^+ \\
& + Z_{k4}^{V,*} \left( 2\sqrt{2} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{lb}^E Z_{i1}^A Z_{j1}^+ - 2\sqrt{2} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{l10+b}^E Z_{i3}^A Z_{j1}^+ \right. \\
& - \sqrt{2}g_2^2 Z_{i1}^A Z_{l7}^E Z_{j1}^+ + 2\sqrt{2} \sum_{a=1}^2 |Y_{\hat{E},a}|^2 Z_{i1}^A Z_{l7}^E Z_{j1}^+ + 2\sqrt{2}\lambda^* \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^A Z_{j2}^+ \\
& - 2\sqrt{2}\lambda_{SR} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{l10+a}^E Z_{i3}^A Z_{j2}^+ + 2\Lambda_T^* \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^A Z_{j2}^+ \\
& + 2\lambda_{TR} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{l10+a}^E Z_{i4}^A Z_{j2}^+ + \sqrt{2}g_2^2 Z_{i2}^A Z_{l7}^E Z_{j2}^+ - 2\sqrt{2}\lambda_{TR}\Lambda_T^* Z_{i1}^A Z_{l8}^E Z_{j2}^+ \\
& - 2\sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{B\hat{a}rE,a}^* Z_{l10+a}^E Z_{i2}^A Z_{j3}^+ + 2\sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{i3}^A Z_{l7}^E Z_{j3}^+ - 2g_2^2 Z_{i4}^A Z_{l7}^E Z_{j3}^+ \\
& + 2|\lambda_{TR}|^2 Z_{i4}^A Z_{l7}^E Z_{j3}^+ + 2\sqrt{2}\Lambda_T^* \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i2}^A Z_{j4}^+ - 2\sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{i3}^A Z_{l7}^E Z_{j4}^+ \\
& - 2g_2^2 Z_{i4}^A Z_{l7}^E Z_{j4}^+ + 2|\lambda_{TR}|^2 Z_{i4}^A Z_{l7}^E Z_{j4}^+ - 2\sqrt{2}\lambda_{TR}\lambda_T^* Z_{i3}^A Z_{l8}^E Z_{j4}^+ \left. \right) \\
& - g_2^2 \sum_{a=1}^3 Z_{ka}^{V,*} Z_{la}^E \left( 2Z_{i4}^A (Z_{j3}^+ + Z_{j4}^+) + \sqrt{2}Z_{i1}^A Z_{j1}^+ - \sqrt{2}Z_{i2}^A Z_{j2}^+ \right) \tag{486}
\end{aligned}$$



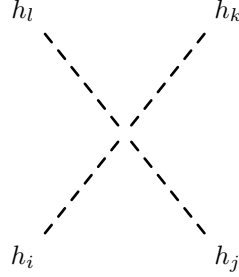
$$\begin{aligned}
& \frac{1}{4}\delta_{\beta\delta} \left( 2 \left( -\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^U Z_{i1}^A Z_{k1}^+ \right. \right. \\
& - \sqrt{2}\lambda^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i3}^A Z_{k1}^+ - \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i4}^A Z_{k1}^+ \\
& \left. \left. + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U Z_{i2}^A Z_{k2}^+ + \sqrt{2}\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U Z_{i3}^A Z_{k2}^+ \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U Z_{i4}^A Z_{k2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{u,ba} Z_{l3+b}^U \left( Z_{i1}^A Z_{k2}^+ - Z_{i2}^A Z_{k1}^+ \right) \\
& + \sqrt{2} \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i1}^A Z_{k3}^+ + \sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U Z_{i2}^A Z_{k4}^+ \\
& + g_2^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^U \left( 2Z_{i4}^A \left( Z_{k3}^+ + Z_{k4}^+ \right) + \sqrt{2} Z_{i1}^A Z_{k1}^+ - \sqrt{2} Z_{i2}^A Z_{k2}^+ \right)
\end{aligned} \tag{487}$$



$$\begin{aligned}
& \frac{1}{4} \left( -2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^V Z_{i1}^A Z_{k1}^+ \right. \\
& - 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^V Z_{i1}^A Z_{k1}^+ \\
& + 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^V Z_{i3}^A Z_{k1}^+ \\
& - 2\sqrt{2} \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^V Z_{i3}^A Z_{k2}^+ + 2\sqrt{2} \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V Z_{i3}^A Z_{k2}^+ \\
& - 2\Lambda_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^V Z_{i4}^A Z_{k2}^+ + 2\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V Z_{i4}^A Z_{k2}^+ \\
& - 2\sqrt{2} \Lambda_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^V Z_{i2}^A Z_{k4}^+ + 2\sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V Z_{i2}^A Z_{k4}^+ \\
& + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^V \left( 2Z_{i4}^A \left( Z_{k3}^+ + Z_{k4}^+ \right) + \sqrt{2} Z_{i1}^A Z_{k1}^+ - \sqrt{2} Z_{i2}^A Z_{k2}^+ \right) \\
& \left. - 2\sqrt{2} \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{\tilde{E},a}^* Y_{L,ba} Z_{i1}^A Z_{k1}^+ Z_{l4}^V + 2\sqrt{2} \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{\tilde{E},a}^* \lambda_{SE,ab} Z_{i3}^A Z_{k1}^+ Z_{l4}^V \right)
\end{aligned}$$

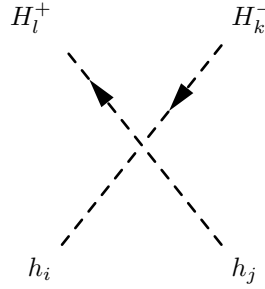
$$\begin{aligned}
& + 2\sqrt{2}\Lambda_T\lambda_{TR}^*Z_{j8}^{E,*}Z_{i1}^AZ_{k2}^+Z_{l4}^V - 2\sqrt{2}\lambda\sum_{a=1}^2Y_{\hat{E},a}^*Z_{j8+a}^{E,*}Z_{i3}^AZ_{k2}^+Z_{l4}^V \\
& + 2\sqrt{2}\lambda_{SR}^*\sum_{a=1}^2Z_{j10+a}^{E,*}Y_{\hat{B}\hat{a}rE,a}Z_{i3}^AZ_{k2}^+Z_{l4}^V - 2\Lambda_T\sum_{a=1}^2Y_{\hat{E},a}^*Z_{j8+a}^{E,*}Z_{i4}^AZ_{k2}^+Z_{l4}^V \\
& - 2\lambda_{TR}^*\sum_{a=1}^2Z_{j10+a}^{E,*}Y_{\hat{B}\hat{a}rE,a}Z_{i4}^AZ_{k2}^+Z_{l4}^V + 2\sqrt{2}\lambda_{TR}^*\sum_{a=1}^2Z_{j10+a}^{E,*}Y_{\hat{B}\hat{a}rE,a}Z_{i2}^AZ_{k3}^+Z_{l4}^V \\
& - 2\sqrt{2}\Lambda_T\sum_{a=1}^2Y_{\hat{E},a}^*Z_{j8+a}^{E,*}Z_{i2}^AZ_{k4}^+Z_{l4}^V + 2\sqrt{2}\lambda_T\lambda_{TR}^*Z_{j8}^{E,*}Z_{i3}^AZ_{k4}^+Z_{l4}^V \\
& + \sqrt{2}g_2^2Z_{j8}^{E,*}Z_{i1}^AZ_{k1}^+Z_{l5}^V + 2\sqrt{2}\lambda_{SR}\sum_{a=1}^2Y_{\hat{E},a}^*Z_{j8+a}^{E,*}Z_{i3}^AZ_{k1}^+Z_{l5}^V \\
& - 2\sqrt{2}\lambda^*\sum_{a=1}^2Z_{j10+a}^{E,*}Y_{\hat{B}\hat{a}rE,a}Z_{i3}^AZ_{k1}^+Z_{l5}^V - 2\lambda_{TR}\sum_{a=1}^2Y_{\hat{E},a}^*Z_{j8+a}^{E,*}Z_{i4}^AZ_{k1}^+Z_{l5}^V \\
& - 2\Lambda_T^*\sum_{a=1}^2Z_{j10+a}^{E,*}Y_{\hat{B}\hat{a}rE,a}Z_{i4}^AZ_{k1}^+Z_{l5}^V - \sqrt{2}g_2^2Z_{j8}^{E,*}Z_{i2}^AZ_{k2}^+Z_{l5}^V \\
& + 2\sqrt{2}Z_{j8}^{E,*}\sum_{a=1}^2|Y_{\hat{B}\hat{a}rE,a}|^2Z_{i2}^AZ_{k2}^+Z_{l5}^V + 2\sqrt{2}\sum_{b=1}^2Z_{j8+b}^{E,*}\sum_{a=1}^2\lambda_{SE,ba}^*Y_{\hat{B}\hat{a}rE,a}Z_{i3}^AZ_{k2}^+Z_{l5}^V \\
& + 2\sqrt{2}\Lambda_T^*\sum_{a=1}^2Z_{j10+a}^{E,*}Y_{\hat{B}\hat{a}rE,a}Z_{i1}^AZ_{k3}^+Z_{l5}^V + 2\sqrt{2}\lambda_{SR}\lambda_{TR}^*Z_{j8}^{E,*}Z_{i3}^AZ_{k3}^+Z_{l5}^V \\
& + 2g_2^2Z_{j8}^{E,*}Z_{i4}^AZ_{k3}^+Z_{l5}^V - 2|\lambda_{TR}|^2Z_{j8}^{E,*}Z_{i4}^AZ_{k3}^+Z_{l5}^V \\
& - 2\sqrt{2}\lambda_{TR}\sum_{a=1}^2Y_{\hat{E},a}^*Z_{j8+a}^{E,*}Z_{i1}^AZ_{k4}^+Z_{l5}^V - 2\sqrt{2}\lambda_{TR}\lambda_{SR}^*Z_{j8}^{E,*}Z_{i3}^AZ_{k4}^+Z_{l5}^V \\
& + 2g_2^2Z_{j8}^{E,*}Z_{i4}^AZ_{k4}^+Z_{l5}^V - 2|\lambda_{TR}|^2Z_{j8}^{E,*}Z_{i4}^AZ_{k4}^+Z_{l5}^V \\
& - Z_{j7}^{E,*}\left(2\sqrt{2}\sum_{b=1}^3\sum_{a=1}^2Y_{L,ba}^*Y_{\hat{E},a}Z_{l_b}^VZ_{i1}^+Z_{k1}^+ - \sqrt{2}\left(-2\sum_{a=1}^2|Y_{\hat{E},a}|^2 + g_2^2\right)Z_{i1}^+Z_{k1}^+Z_{l4}^V\right. \\
& + \sqrt{2}g_2^2Z_{i2}^AZ_{k2}^+Z_{l4}^V + 2\sqrt{2}\lambda_{SR}\lambda_{TR}^*Z_{i3}^AZ_{k3}^+Z_{l4}^V - 2g_2^2Z_{i4}^AZ_{k3}^+Z_{l4}^V \\
& + 2|\lambda_{TR}|^2Z_{i4}^AZ_{k3}^+Z_{l4}^V - 2\sqrt{2}\lambda_{TR}\lambda_{SR}^*Z_{i3}^AZ_{k4}^+Z_{l4}^V - 2g_2^2Z_{i4}^AZ_{k4}^+Z_{l4}^V \\
& \left. + 2|\lambda_{TR}|^2Z_{i4}^AZ_{k4}^+Z_{l4}^V + 2\sqrt{2}\lambda_{TR}\Lambda_T^*Z_{i2}^AZ_{k1}^+Z_{l5}^V - 2\sqrt{2}\lambda_{TR}\lambda_T^*Z_{i3}^AZ_{k3}^+Z_{l5}^V\right)
\end{aligned} \tag{488}$$



$$\begin{aligned}
& -\frac{i}{8} \left( 8|\lambda|^2 Z_{i3}^H Z_{j3}^H Z_{k1}^H Z_{l1}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l1}^H \right. \\
& - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l1}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l1}^H \\
& - 2\sqrt{2}\Lambda_T\lambda^* Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l1}^H + 4|\Lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k1}^H Z_{l1}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l1}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l1}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l1}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l1}^H \\
& + 2\lambda\lambda_T^* Z_{i4}^H Z_{j4}^H Z_{k2}^H Z_{l1}^H + 2\lambda_T\lambda^* Z_{i4}^H Z_{j4}^H Z_{k2}^H Z_{l1}^H + 8|\lambda|^2 Z_{i3}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l1}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l1}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l1}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H - 2\sqrt{2}\Lambda_T\lambda^* Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H \\
& + 4|\Lambda_T|^2 Z_{i4}^H Z_{j1}^H Z_{k4}^H Z_{l1}^H - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l1}^H \\
& - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l1}^H + 2\lambda\lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l1}^H + 2\lambda_T\lambda^* Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l1}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l2}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k1}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l2}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k1}^H Z_{l2}^H \\
& + 2\lambda\lambda_T^* Z_{i4}^H Z_{j4}^H Z_{k1}^H Z_{l2}^H + 2\lambda_T\lambda^* Z_{i4}^H Z_{j4}^H Z_{k1}^H Z_{l2}^H + 8|\lambda|^2 Z_{i3}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^H Z_{j3}^H Z_{k2}^H Z_{l2}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H - 2\sqrt{2}\Lambda_T\lambda^* Z_{i3}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H \\
& + 4|\Lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k2}^H Z_{l2}^H - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l2}^H \\
& - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k3}^H Z_{l2}^H + 8|\lambda|^2 Z_{i3}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^H Z_{j2}^H Z_{k3}^H Z_{l2}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l2}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k4}^H Z_{l2}^H \\
& + 2\lambda\lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k4}^H Z_{l2}^H + 2\lambda_T\lambda^* Z_{i4}^H Z_{j1}^H Z_{k4}^H Z_{l2}^H - 2\sqrt{2}\lambda\Lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H \\
& - 2\sqrt{2}\Lambda_T\lambda^* Z_{i3}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H + 4|\Lambda_T|^2 Z_{i4}^H Z_{j2}^H Z_{k4}^H Z_{l2}^H + 8|\lambda|^2 Z_{i3}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^* Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H - 2\sqrt{2}\Lambda_T\lambda^* Z_{i4}^H Z_{j1}^H Z_{k1}^H Z_{l3}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k1}^H Z_{l3}^H - \sqrt{2}\lambda_T\Lambda_T^* Z_{i4}^H Z_{j2}^H Z_{k1}^H Z_{l3}^H
\end{aligned}$$

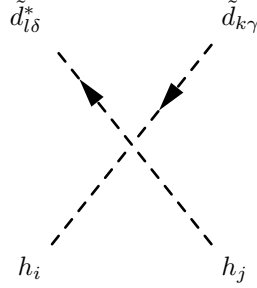
$$\begin{aligned}
& -\sqrt{2}\Lambda_T\lambda_T^*Z_{i4}^HZ_{j1}^HZ_{k2}^HZ_{l3}^H - \sqrt{2}\lambda_T\Lambda_T^*Z_{i4}^HZ_{j1}^HZ_{k2}^HZ_{l3}^H \\
& + 8|\lambda|^2Z_{i3}^HZ_{j2}^HZ_{k2}^HZ_{l3}^H - 2\sqrt{2}\lambda\Lambda_T^*Z_{i4}^HZ_{j2}^HZ_{k2}^HZ_{l3}^H \\
& - 2\sqrt{2}\Lambda_T\lambda^*Z_{i4}^HZ_{j2}^HZ_{k2}^HZ_{l3}^H + 8|\lambda_T|^2Z_{i4}^HZ_{j4}^HZ_{k3}^HZ_{l3}^H + 8|\lambda_T|^2Z_{i4}^HZ_{j3}^HZ_{k4}^HZ_{l3}^H \\
& + 8|\lambda_T|^2Z_{i3}^HZ_{j4}^HZ_{k4}^HZ_{l3}^H - 2\sqrt{2}\lambda\Lambda_T^*Z_{i3}^HZ_{j1}^HZ_{k1}^HZ_{l4}^H \\
& - 2\sqrt{2}\Lambda_T\lambda^*Z_{i3}^HZ_{j1}^HZ_{k1}^HZ_{l4}^H + 4|\Lambda_T|^2Z_{i4}^HZ_{j1}^HZ_{k1}^HZ_{l4}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^*Z_{i3}^HZ_{j2}^HZ_{k1}^HZ_{l4}^H - \sqrt{2}\lambda_T\Lambda_T^*Z_{i3}^HZ_{j2}^HZ_{k1}^HZ_{l4}^H \\
& + 2\lambda\lambda_T^*Z_{i4}^HZ_{j2}^HZ_{k1}^HZ_{l4}^H + 2\lambda_T\lambda^*Z_{i4}^HZ_{j2}^HZ_{k1}^HZ_{l4}^H - \sqrt{2}\Lambda_T\lambda_T^*Z_{i3}^HZ_{j1}^HZ_{k2}^HZ_{l4}^H \\
& - \sqrt{2}\lambda_T\Lambda_T^*Z_{i3}^HZ_{j1}^HZ_{k2}^HZ_{l4}^H + 2\lambda\lambda_T^*Z_{i4}^HZ_{j1}^HZ_{k2}^HZ_{l4}^H + 2\lambda_T\lambda^*Z_{i4}^HZ_{j1}^HZ_{k2}^HZ_{l4}^H \\
& - 2\sqrt{2}\lambda\Lambda_T^*Z_{i3}^HZ_{j2}^HZ_{k2}^HZ_{l4}^H - 2\sqrt{2}\Lambda_T\lambda^*Z_{i3}^HZ_{j2}^HZ_{k2}^HZ_{l4}^H \\
& + 4|\Lambda_T|^2Z_{i4}^HZ_{j2}^HZ_{k2}^HZ_{l4}^H + 8|\lambda_T|^2Z_{i4}^HZ_{j3}^HZ_{k3}^HZ_{l4}^H + 8|\lambda_T|^2Z_{i3}^HZ_{j4}^HZ_{k3}^HZ_{l4}^H \\
& + 8|\lambda_T|^2Z_{i3}^HZ_{j3}^HZ_{k4}^HZ_{l4}^H + 12|\lambda_T|^2Z_{i4}^HZ_{j4}^HZ_{k4}^HZ_{l4}^H \\
& - Z_{i2}^H\left(\sqrt{2}\Lambda_T\lambda_T^*Z_{j4}^HZ_{k3}^HZ_{l1}^H + \sqrt{2}\lambda_T\Lambda_T^*Z_{j4}^HZ_{k3}^HZ_{l1}^H + \sqrt{2}\Lambda_T\lambda_T^*Z_{j3}^HZ_{k4}^HZ_{l1}^H\right. \\
& + \sqrt{2}\lambda_T\Lambda_T^*Z_{j3}^HZ_{k4}^HZ_{l1}^H - 2\lambda\lambda_T^*Z_{j4}^HZ_{k4}^HZ_{l1}^H - 2\lambda_T\lambda^*Z_{j4}^HZ_{k4}^HZ_{l1}^H \\
& - 8|\lambda|^2Z_{j3}^HZ_{k3}^HZ_{l2}^H + 2\sqrt{2}\lambda\Lambda_T^*Z_{j4}^HZ_{k3}^HZ_{l2}^H + 2\sqrt{2}\Lambda_T\lambda^*Z_{j4}^HZ_{k3}^HZ_{l2}^H \\
& + 2\sqrt{2}\lambda\Lambda_T^*Z_{j3}^HZ_{k4}^HZ_{l2}^H + 2\sqrt{2}\Lambda_T\lambda^*Z_{j3}^HZ_{k4}^HZ_{l2}^H - 4|\Lambda_T|^2Z_{j4}^HZ_{k4}^HZ_{l2}^H \\
& + \sqrt{2}\Lambda_T\lambda_T^*Z_{j4}^HZ_{k1}^HZ_{l3}^H + \sqrt{2}\lambda_T\Lambda_T^*Z_{j4}^HZ_{k1}^HZ_{l3}^H - 8|\lambda|^2Z_{j3}^HZ_{k2}^HZ_{l3}^H \\
& + 2\sqrt{2}\lambda\Lambda_T^*Z_{j4}^HZ_{k2}^HZ_{l3}^H + 2\sqrt{2}\Lambda_T\lambda^*Z_{j4}^HZ_{k2}^HZ_{l3}^H + \sqrt{2}\Lambda_T\lambda_T^*Z_{j3}^HZ_{k1}^HZ_{l4}^H \\
& + \sqrt{2}\lambda_T\Lambda_T^*Z_{j3}^HZ_{k1}^HZ_{l4}^H - 2\lambda\lambda_T^*Z_{j4}^HZ_{k1}^HZ_{l4}^H - 2\lambda_T\lambda^*Z_{j4}^HZ_{k1}^HZ_{l4}^H \\
& + 2\sqrt{2}\lambda\Lambda_T^*Z_{j3}^HZ_{k2}^HZ_{l4}^H + 2\sqrt{2}\Lambda_T\lambda^*Z_{j3}^HZ_{k2}^HZ_{l4}^H - 4|\Lambda_T|^2Z_{j4}^HZ_{k2}^HZ_{l4}^H \\
& + 2Z_{j2}^H\left(\left(-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2\right)Z_{k1}^HZ_{l1}^H - 3\left(g_1^2 + g_2^2\right)Z_{k2}^HZ_{l2}^H - 4|\lambda|^2Z_{k3}^HZ_{l3}^H\right. \\
& + \sqrt{2}\lambda\Lambda_T^*Z_{k4}^HZ_{l3}^H + \sqrt{2}\Lambda_T\lambda^*Z_{k4}^HZ_{l3}^H + \sqrt{2}\lambda\Lambda_T^*Z_{k3}^HZ_{l4}^H + \sqrt{2}\Lambda_T\lambda^*Z_{k3}^HZ_{l4}^H \\
& \left. - 2|\Lambda_T|^2Z_{k4}^HZ_{l4}^H\right) \\
& + Z_{j1}^H\left(2\left(-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2\right)Z_{k2}^HZ_{l1}^H + 2\left(-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2\right)Z_{k1}^HZ_{l2}^H\right. \\
& + \sqrt{2}\Lambda_T\lambda_T^*Z_{k4}^HZ_{l3}^H + \sqrt{2}\lambda_T\Lambda_T^*Z_{k4}^HZ_{l3}^H + \sqrt{2}\Lambda_T\lambda_T^*Z_{k3}^HZ_{l4}^H + \sqrt{2}\lambda_T\Lambda_T^*Z_{k3}^HZ_{l4}^H \\
& \left. - 2\lambda\lambda_T^*Z_{k4}^HZ_{l4}^H - 2\lambda_T\lambda^*Z_{k4}^HZ_{l4}^H\right) \\
& + Z_{i1}^H\left(8|\lambda|^2Z_{j3}^HZ_{k3}^HZ_{l1}^H - 2\sqrt{2}\lambda\Lambda_T^*Z_{j4}^HZ_{k3}^HZ_{l1}^H - 2\sqrt{2}\Lambda_T\lambda^*Z_{j4}^HZ_{k3}^HZ_{l1}^H\right. \\
& - 2\sqrt{2}\lambda\Lambda_T^*Z_{j3}^HZ_{k4}^HZ_{l1}^H - 2\sqrt{2}\Lambda_T\lambda^*Z_{j3}^HZ_{k4}^HZ_{l1}^H + 4|\Lambda_T|^2Z_{j4}^HZ_{k4}^HZ_{l1}^H \\
& - \sqrt{2}\Lambda_T\lambda_T^*Z_{j4}^HZ_{k3}^HZ_{l2}^H - \sqrt{2}\lambda_T\Lambda_T^*Z_{j4}^HZ_{k3}^HZ_{l2}^H - \sqrt{2}\Lambda_T\lambda_T^*Z_{j3}^HZ_{k4}^HZ_{l2}^H \\
& - \sqrt{2}\lambda_T\Lambda_T^*Z_{j3}^HZ_{k4}^HZ_{l2}^H + 2\lambda\lambda_T^*Z_{j4}^HZ_{k4}^HZ_{l2}^H + 2\lambda_T\lambda^*Z_{j4}^HZ_{k4}^HZ_{l2}^H \\
& \left. + 8|\lambda|^2Z_{j3}^HZ_{k1}^HZ_{l3}^H - 2\sqrt{2}\lambda\Lambda_T^*Z_{j4}^HZ_{k1}^HZ_{l3}^H - 2\sqrt{2}\Lambda_T\lambda^*Z_{j4}^HZ_{k1}^HZ_{l3}^H\right)
\end{aligned}$$

$$\begin{aligned}
& -\sqrt{2}\Lambda_T\lambda^*Z_{j_4}^HZ_{k_2}^HZ_{l_3}^H - \sqrt{2}\lambda_T\Lambda_T^*Z_{j_4}^HZ_{k_2}^HZ_{l_3}^H - 2\sqrt{2}\lambda\Lambda_T^*Z_{j_3}^HZ_{k_1}^HZ_{l_4}^H \\
& - 2\sqrt{2}\Lambda_T\lambda^*Z_{j_3}^HZ_{k_1}^HZ_{l_4}^H + 4|\Lambda_T|^2Z_{j_4}^HZ_{k_1}^HZ_{l_4}^H - \sqrt{2}\Lambda_T\lambda^*Z_{j_3}^HZ_{k_2}^HZ_{l_4}^H \\
& - \sqrt{2}\lambda_T\Lambda_T^*Z_{j_3}^HZ_{k_2}^HZ_{l_4}^H + 2\lambda\lambda_T^*Z_{j_4}^HZ_{k_2}^HZ_{l_4}^H + 2\lambda_T\lambda^*Z_{j_4}^HZ_{k_2}^HZ_{l_4}^H \\
& - Z_{j_2}^H\left(2\left(-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2\right)Z_{k_2}^HZ_{l_1}^H + 2\left(-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2\right)Z_{k_1}^HZ_{l_2}^H\right) \\
& + \sqrt{2}\Lambda_T\lambda^*Z_{k_4}^HZ_{l_3}^H + \sqrt{2}\lambda_T\Lambda_T^*Z_{k_4}^HZ_{l_3}^H + \sqrt{2}\Lambda_T\lambda^*Z_{k_3}^HZ_{l_4}^H + \sqrt{2}\lambda_T\Lambda_T^*Z_{k_3}^HZ_{l_4}^H \\
& - 2\lambda\lambda_T^*Z_{k_4}^HZ_{l_4}^H - 2\lambda_T\lambda^*Z_{k_4}^HZ_{l_4}^H) \\
& + Z_{j_1}^H\left(6\left(g_1^2 + g_2^2\right)Z_{k_1}^HZ_{l_1}^H\right. \\
& \left. - 2\left(\left(-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2\right)Z_{k_2}^HZ_{l_2}^H + \Lambda_T^*\left(\sqrt{2}\lambda Z_{k_3}^HZ_{l_4}^H + Z_{k_4}^H\left(-2\Lambda_T Z_{l_4}^H + \sqrt{2}\lambda Z_{l_3}^H\right)\right)\right.\right. \\
& \left.\left. + \lambda^*\left(\sqrt{2}\Lambda_T Z_{k_4}^HZ_{l_3}^H + Z_{k_3}^H\left(-4\lambda Z_{l_3}^H + \sqrt{2}\Lambda_T Z_{l_4}^H\right)\right)\right)\right)
\end{aligned} \tag{489}$$

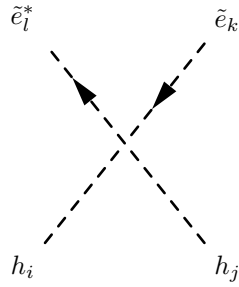


$$\begin{aligned}
& -\frac{i}{4}\left(4|\lambda|^2Z_{i_3}^HZ_{j_3}^HZ_{k_1}^+Z_{l_1}^+ + \sqrt{2}\lambda\Lambda_T^*Z_{i_4}^HZ_{j_3}^HZ_{k_1}^+Z_{l_1}^+ + \sqrt{2}\Lambda_T\lambda^*Z_{i_4}^HZ_{j_3}^HZ_{k_1}^+Z_{l_1}^+\right. \\
& + \sqrt{2}\lambda\Lambda_T^*Z_{i_3}^HZ_{j_4}^HZ_{k_1}^+Z_{l_1}^+ + \sqrt{2}\Lambda_T\lambda^*Z_{i_3}^HZ_{j_4}^HZ_{k_1}^+Z_{l_1}^+ + 2|\Lambda_T|^2Z_{i_4}^HZ_{j_4}^HZ_{k_1}^+Z_{l_1}^+ \\
& - \sqrt{2}\lambda_T\Lambda_T^*Z_{i_4}^HZ_{j_3}^HZ_{k_2}^+Z_{l_1}^+ - \sqrt{2}\lambda_T\Lambda_T^*Z_{i_3}^HZ_{j_4}^HZ_{k_2}^+Z_{l_1}^+ \\
& - 2\lambda_T\lambda^*Z_{i_4}^HZ_{j_4}^HZ_{k_2}^+Z_{l_1}^+ - 2\Lambda_T\lambda^*Z_{i_3}^HZ_{j_1}^HZ_{k_3}^+Z_{l_1}^+ + \sqrt{2}g_2^2Z_{i_4}^HZ_{j_1}^HZ_{k_3}^+Z_{l_1}^+ \\
& - \sqrt{2}|\Lambda_T|^2Z_{i_4}^HZ_{j_1}^HZ_{k_3}^+Z_{l_1}^+ - 2\lambda_T\Lambda_T^*Z_{i_3}^HZ_{j_2}^HZ_{k_3}^+Z_{l_1}^+ \\
& - 2\lambda\Lambda_T^*Z_{i_3}^HZ_{j_1}^HZ_{k_4}^+Z_{l_1}^+ - \sqrt{2}g_2^2Z_{i_4}^HZ_{j_1}^HZ_{k_4}^+Z_{l_1}^+ + \sqrt{2}|\Lambda_T|^2Z_{i_4}^HZ_{j_1}^HZ_{k_4}^+Z_{l_1}^+ \\
& - \sqrt{2}\Lambda_T\lambda^*Z_{i_4}^HZ_{j_3}^HZ_{k_1}^+Z_{l_2}^+ - \sqrt{2}\Lambda_T\lambda^*Z_{i_3}^HZ_{j_4}^HZ_{k_1}^+Z_{l_2}^+ \\
& - 2\lambda\lambda_T^*Z_{i_4}^HZ_{j_4}^HZ_{k_1}^+Z_{l_2}^+ + 4|\lambda|^2Z_{i_3}^HZ_{j_3}^HZ_{k_2}^+Z_{l_2}^+ + \sqrt{2}\lambda\Lambda_T^*Z_{i_4}^HZ_{j_3}^HZ_{k_2}^+Z_{l_2}^+ \\
& + \sqrt{2}\Lambda_T\lambda^*Z_{i_4}^HZ_{j_3}^HZ_{k_2}^+Z_{l_2}^+ + \sqrt{2}\lambda\Lambda_T^*Z_{i_3}^HZ_{j_4}^HZ_{k_2}^+Z_{l_2}^+ + \sqrt{2}\Lambda_T\lambda^*Z_{i_3}^HZ_{j_4}^HZ_{k_2}^+Z_{l_2}^+ \\
& + 2|\Lambda_T|^2Z_{i_4}^HZ_{j_4}^HZ_{k_2}^+Z_{l_2}^+ + 2\Lambda_T\lambda^*Z_{i_3}^HZ_{j_2}^HZ_{k_3}^+Z_{l_2}^+ + \sqrt{2}g_2^2Z_{i_4}^HZ_{j_2}^HZ_{k_3}^+Z_{l_2}^+ \\
& - \sqrt{2}|\Lambda_T|^2Z_{i_4}^HZ_{j_2}^HZ_{k_3}^+Z_{l_2}^+ + 2\Lambda_T\lambda^*Z_{i_3}^HZ_{j_1}^HZ_{k_4}^+Z_{l_2}^+ + 2\lambda\Lambda_T^*Z_{i_3}^HZ_{j_2}^HZ_{k_4}^+Z_{l_2}^+ \\
& - \sqrt{2}g_2^2Z_{i_4}^HZ_{j_2}^HZ_{k_4}^+Z_{l_2}^+ + \sqrt{2}|\Lambda_T|^2Z_{i_4}^HZ_{j_2}^HZ_{k_4}^+Z_{l_2}^+ - 2\lambda\Lambda_T^*Z_{i_3}^HZ_{j_1}^HZ_{k_1}^+Z_{l_3}^+ \\
& \left. + \sqrt{2}g_2^2Z_{i_4}^HZ_{j_1}^HZ_{k_1}^+Z_{l_3}^+ - \sqrt{2}|\Lambda_T|^2Z_{i_4}^HZ_{j_1}^HZ_{k_1}^+Z_{l_3}^+ - 2\Lambda_T\lambda^*Z_{i_3}^HZ_{j_2}^HZ_{k_1}^+Z_{l_3}^+\right)
\end{aligned}$$

$$\begin{aligned}
& + 2\lambda\Lambda_T^* Z_{i3}^H Z_{j2}^H Z_{k2}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_T|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l3}^+ \\
& + 4|\lambda_T|^2 Z_{i3}^H Z_{j3}^H Z_{k3}^+ Z_{l3}^+ + 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k3}^+ Z_{l3}^+ - 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k4}^+ Z_{l3}^+ \\
& + 2|\lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k4}^+ Z_{l3}^+ - 2\Lambda_T\lambda^* Z_{i3}^H Z_{j1}^H Z_{k1}^+ Z_{l4}^+ - \sqrt{2}g_2^2 Z_{i4}^H Z_{j1}^H Z_{k1}^+ Z_{l4}^+ \\
& + \sqrt{2}|\Lambda_T|^2 Z_{i4}^H Z_{j1}^H Z_{k1}^+ Z_{l4}^+ + 2\lambda_T\Lambda_T^* Z_{i3}^H Z_{j1}^H Z_{k2}^+ Z_{l4}^+ + 2\Lambda_T\lambda^* Z_{i3}^H Z_{j2}^H Z_{k2}^+ Z_{l4}^+ \\
& - \sqrt{2}g_2^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_T|^2 Z_{i4}^H Z_{j2}^H Z_{k2}^+ Z_{l4}^+ - 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k3}^+ Z_{l4}^+ \\
& + 2|\lambda_T|^2 Z_{i4}^H Z_{j4}^H Z_{k3}^+ Z_{l4}^+ + 4|\lambda_T|^2 Z_{i3}^H Z_{j3}^H Z_{k4}^+ Z_{l4}^+ + 4g_2^2 Z_{i4}^H Z_{j4}^H Z_{k4}^+ Z_{l4}^+ \\
& + Z_{i2}^H \left( -2\lambda_T\Lambda_T^* Z_{j3}^H Z_{k3}^+ Z_{l1}^+ + 2\Lambda_T\lambda^* Z_{j3}^H Z_{k3}^+ Z_{l2}^+ + \sqrt{2}g_2^2 Z_{j4}^H Z_{k3}^+ Z_{l2}^+ \right. \\
& \left. - \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k3}^+ Z_{l2}^+ + 2\lambda\Lambda_T^* Z_{j3}^H Z_{k4}^+ Z_{l2}^+ - \sqrt{2}g_2^2 Z_{j4}^H Z_{k4}^+ Z_{l2}^+ \right. \\
& \left. + \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k4}^+ Z_{l2}^+ - 2\Lambda_T\lambda^* Z_{j3}^H Z_{k1}^+ Z_{l3}^+ + 2\lambda\Lambda_T^* Z_{j3}^H Z_{k2}^+ Z_{l3}^+ \right. \\
& \left. + \sqrt{2}g_2^2 Z_{j4}^H Z_{k2}^+ Z_{l3}^+ - \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k2}^+ Z_{l3}^+ + 2\Lambda_T\lambda^* Z_{j3}^H Z_{k2}^+ Z_{l4}^+ \right. \\
& \left. - \sqrt{2}g_2^2 Z_{j4}^H Z_{k2}^+ Z_{l4}^+ + \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k2}^+ Z_{l4}^+ \right. \\
& \left. + Z_{j2}^H \left( \left( 4|\Lambda_T|^2 - g_1^2 + g_2^2 \right) Z_{k1}^+ Z_{l1}^+ + \left( g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ + 2g_2^2 Z_{k3}^+ Z_{l3}^+ - 2g_2^2 Z_{k4}^+ Z_{l4}^+ \right. \right. \\
& \left. \left. + 4|\Lambda_T|^2 Z_{k4}^+ Z_{l4}^+ \right) \right. \\
& \left. + Z_{j1}^H \left( \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k2}^+ Z_{l1}^+ + \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k1}^+ Z_{l2}^+ \right. \right. \\
& \left. \left. + 2 \left( \lambda\lambda_T^* Z_{k4}^+ Z_{l3}^+ + \lambda_T\lambda^* Z_{k3}^+ Z_{l4}^+ \right) \right) \right) \\
& + Z_{i1}^H \left( -2\Lambda_T\lambda^* Z_{j3}^H Z_{k3}^+ Z_{l1}^+ + \sqrt{2}g_2^2 Z_{j4}^H Z_{k3}^+ Z_{l1}^+ - \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k3}^+ Z_{l1}^+ \right. \\
& \left. - 2\lambda\Lambda_T^* Z_{j3}^H Z_{k4}^+ Z_{l1}^+ - \sqrt{2}g_2^2 Z_{j4}^H Z_{k4}^+ Z_{l1}^+ + \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k4}^+ Z_{l1}^+ \right. \\
& \left. + 2\Lambda_T\lambda_T^* Z_{j3}^H Z_{k4}^+ Z_{l2}^+ - 2\lambda\Lambda_T^* Z_{j3}^H Z_{k1}^+ Z_{l3}^+ + \sqrt{2}g_2^2 Z_{j4}^H Z_{k1}^+ Z_{l3}^+ \right. \\
& \left. - \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k1}^+ Z_{l3}^+ - 2\Lambda_T\lambda^* Z_{j3}^H Z_{k1}^+ Z_{l4}^+ - \sqrt{2}g_2^2 Z_{j4}^H Z_{k1}^+ Z_{l4}^+ \right. \\
& \left. + \sqrt{2}|\Lambda_T|^2 Z_{j4}^H Z_{k1}^+ Z_{l4}^+ + 2\lambda_T\Lambda_T^* Z_{j3}^H Z_{k2}^+ Z_{l4}^+ \right. \\
& \left. + Z_{j1}^H \left( \left( g_1^2 + g_2^2 \right) Z_{k1}^+ Z_{l1}^+ + \left( 4|\Lambda_T|^2 - g_1^2 + g_2^2 \right) Z_{k2}^+ Z_{l2}^+ - 2g_2^2 Z_{k3}^+ Z_{l3}^+ + 4|\Lambda_T|^2 Z_{k3}^+ Z_{l3}^+ \right. \right. \\
& \left. \left. + 2g_2^2 Z_{k4}^+ Z_{l4}^+ \right) \right. \\
& \left. + Z_{j2}^H \left( \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k2}^+ Z_{l1}^+ + \left( -2|\lambda|^2 + g_2^2 + |\Lambda_T|^2 \right) Z_{k1}^+ Z_{l2}^+ \right. \right. \\
& \left. \left. + 2 \left( \lambda\lambda_T^* Z_{k4}^+ Z_{l3}^+ + \lambda_T\lambda^* Z_{k3}^+ Z_{l4}^+ \right) \right) \right) \right) \tag{490}
\end{aligned}$$



$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{D,*} Z_{la}^D (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right. \\
& + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{D,*} Z_{l3+a}^D (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \\
& - 3 \left( 4 \sum_{c=1}^3 Z_{k3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D Z_{i1}^H Z_{j1}^H \right. \\
& + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D Z_{i1}^H Z_{j1}^H + 2\lambda^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i3}^H Z_{j2}^H \\
& + 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i3}^H Z_{j2}^H - \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i4}^H Z_{j2}^H \\
& - \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i4}^H Z_{j2}^H + 2\lambda^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^H Z_{j3}^H \\
& + 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i2}^H Z_{j3}^H - \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^H Z_{j4}^H \\
& \left. \left. - \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{k3+a}^{D,*} Z_{lb}^D Z_{i2}^H Z_{j4}^H \right) \right) \tag{491}
\end{aligned}$$



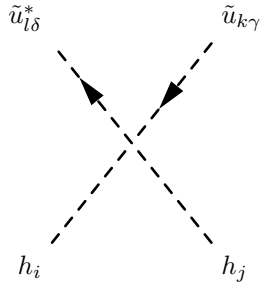


$$\begin{aligned}
& -\frac{i}{4} \left( g_1^2 \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E Z_{i1}^H Z_{j1}^H - g_2^2 \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E Z_{i1}^H Z_{j1}^H \right. \\
& - 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E Z_{i1}^H Z_{j1}^H + 4 \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{k8+b}^{E,*} Z_{i1}^H Z_{j1}^H \\
& + 4Z_{k7}^{E,*} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{lb}^E Z_{i1}^H Z_{j1}^H + 4 \sum_{c=1}^2 Z_{k8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ac}^* Y_{L,ab} Z_{l8+b}^E Z_{i1}^H Z_{j1}^H \\
& - 4 \sum_{c=1}^2 Z_{k8+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{L,ac}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^H Z_{j1}^H \\
& - 4 \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{e,ca}^* Y_{L,ab} Z_{l8+b}^E Z_{i1}^H Z_{j1}^H \\
& + 4 \sum_{c=1}^3 Z_{k3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^H Z_{j1}^H \\
& + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^E Z_{i1}^H Z_{j1}^H + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E Z_{i1}^H Z_{j1}^H \\
& + g_1^2 Z_{k7}^{E,*} Z_{l7}^E Z_{i1}^H Z_{j1}^H - g_2^2 Z_{k7}^{E,*} Z_{l7}^E Z_{i1}^H Z_{j1}^H + 4Z_{k7}^{E,*} \sum_{a=1}^2 |Y_{\hat{E},a}|^2 Z_{l7}^E Z_{i1}^H Z_{j1}^H \\
& + 4 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{l7}^E Z_{i1}^H Z_{j1}^H - g_1^2 Z_{k8}^{E,*} Z_{l8}^E Z_{i1}^H Z_{j1}^H \\
& + g_2^2 Z_{k8}^{E,*} Z_{l8}^E Z_{i1}^H Z_{j1}^H + 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i2}^H Z_{j1}^H \\
& + 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i2}^H Z_{j1}^H - 2\lambda\lambda_{SR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i2}^H Z_{j1}^H \\
& + \Lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i2}^H Z_{j1}^H + \lambda_{TR} \Lambda_T^* Z_{k7}^{E,*} Z_{l8}^E Z_{i2}^H Z_{j1}^H - 2\lambda_{SR} \lambda^* Z_{k7}^{E,*} Z_{l8}^E Z_{i2}^H Z_{j1}^H \\
& + 2\lambda_{SR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^H Z_{j1}^H + 2\lambda Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{l10+a}^E Z_{i3}^H Z_{j1}^H \\
& - 2Z_{k7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{l10+b}^E Z_{i3}^H Z_{j1}^H - 2 \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i3}^H Z_{j1}^H \\
& - 2 \sum_{c=1}^3 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^E Z_{i3}^H Z_{j1}^H - 2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{l7}^E Z_{i3}^H Z_{j1}^H \\
& + 2\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l8}^E Z_{i3}^H Z_{j1}^H + 2\lambda^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{l8}^E Z_{i3}^H Z_{j1}^H
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2}\lambda_{TR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^H Z_{j1}^H - \sqrt{2}\Lambda_T Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{l10+a}^E Z_{i4}^H Z_{j1}^H \\
& + \sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l8}^E Z_{i4}^H Z_{j1}^H - \sqrt{2}\Lambda_T^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{l8}^E Z_{i4}^H Z_{j1}^H \\
& + 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i1}^H Z_{j2}^H + 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i1}^H Z_{j2}^H \\
& - 2\lambda \lambda_{SR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i1}^H Z_{j2}^H + \Lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i1}^H Z_{j2}^H + \lambda_{TR} \Lambda_T^* Z_{k7}^{E,*} Z_{l8}^E Z_{i1}^H Z_{j2}^H \\
& - 2\lambda_{SR} \lambda^* Z_{k7}^{E,*} Z_{l8}^E Z_{i1}^H Z_{j2}^H - g_1^2 \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E Z_{i2}^H Z_{j2}^H \\
& + g_2^2 \sum_{a=1}^3 Z_{ka}^{E,*} Z_{la}^E Z_{i2}^H Z_{j2}^H + 2g_1^2 \sum_{a=1}^3 Z_{k3+a}^{E,*} Z_{l3+a}^E Z_{i2}^H Z_{j2}^H \\
& + 4 \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} \sum_{b=1}^2 Y_{\hat{B}arE,b}^* Z_{l10+b}^E Z_{i2}^H Z_{j2}^H - g_1^2 Z_{k7}^{E,*} Z_{l7}^E Z_{i2}^H Z_{j2}^H \\
& + g_2^2 Z_{k7}^{E,*} Z_{l7}^E Z_{i2}^H Z_{j2}^H + g_1^2 Z_{k8}^{E,*} Z_{l8}^E Z_{i2}^H Z_{j2}^H - g_2^2 Z_{k8}^{E,*} Z_{l8}^E Z_{i2}^H Z_{j2}^H \\
& + 4Z_{k8}^{E,*} \sum_{a=1}^2 |Y_{\hat{B}arE,a}|^2 Z_{l8}^E Z_{i2}^H Z_{j2}^H - 2\lambda^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^H Z_{j2}^H \\
& - 2\lambda_{SR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{l10+a}^E Z_{i3}^H Z_{j2}^H - 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i3}^H Z_{j2}^H \\
& + 2Z_{k8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}arE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i3}^H Z_{j2}^H - 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i3}^H Z_{j2}^H \\
& + 2\lambda^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i3}^H Z_{j2}^H + 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i3}^H Z_{j2}^H \\
& - 2\lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l7}^E Z_{i3}^H Z_{j2}^H - 2\lambda_{SR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}arE,a} Z_{l7}^E Z_{i3}^H Z_{j2}^H \\
& + 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}arE,a} Z_{l8}^E Z_{i3}^H Z_{j2}^H + \sqrt{2}\Lambda_T^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^H Z_{j2}^H \\
& - \sqrt{2}\lambda_{TR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}arE,a}^* Z_{l10+a}^E Z_{i4}^H Z_{j2}^H + \sqrt{2}\Lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i4}^H Z_{j2}^H \\
& + \sqrt{2}\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i4}^H Z_{j2}^H - \sqrt{2}\Lambda_T \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i4}^H Z_{j2}^H \\
& - \sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i4}^H Z_{j2}^H + \sqrt{2}\Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l7}^E Z_{i4}^H Z_{j2}^H
\end{aligned}$$

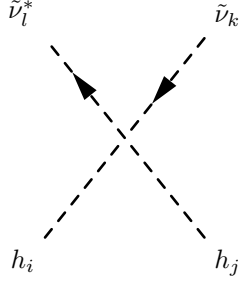
$$\begin{aligned}
& -\sqrt{2}\lambda_{TR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l7}^E Z_{i4}^H Z_{j2}^H + 2g_1^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} Z_{l10+a}^E \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) \\
& + 2g_1^2 \sum_{a=1}^2 Z_{k8+a}^{E,*} Z_{l8+a}^E \left( -Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) + 2\lambda_{SR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^H Z_{j3}^H \\
& + 2\lambda_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^H Z_{j3}^H - 2Z_{k7}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{l10+b}^E Z_{i1}^H Z_{j3}^H \\
& - 2 \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i1}^H Z_{j3}^H \\
& - 2 \sum_{c=1}^3 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^E Z_{i1}^H Z_{j3}^H - 2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{l7}^E Z_{i1}^H Z_{j3}^H \\
& + 2\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l8}^E Z_{i1}^H Z_{j3}^H + 2\lambda^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l8}^E Z_{i1}^H Z_{j3}^H \\
& - 2\lambda^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i2}^H Z_{j3}^H - 2\lambda_{SR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i2}^H Z_{j3}^H \\
& - 2\lambda \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i2}^H Z_{j3}^H + 2Z_{k8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i2}^H Z_{j3}^H \\
& - 2\lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^H Z_{j3}^H + 2\lambda^* \sum_{b=1}^3 Z_{kb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^H Z_{j3}^H \\
& + 2\lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{lb}^E Z_{i2}^H Z_{j3}^H - 2\lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l7}^E Z_{i2}^H Z_{j3}^H \\
& - 2\lambda_{SR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l7}^E Z_{i2}^H Z_{j3}^H + 2 \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{l8}^E Z_{i2}^H Z_{j3}^H \\
& + 4 \sum_{c=1}^2 Z_{k8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ca}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i3}^H Z_{j3}^H \\
& + 4 \sum_{c=1}^2 \sum_{b=1}^2 Z_{k10+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ac}^* \lambda_{SE,ab} Z_{l10+c}^E Z_{i3}^H Z_{j3}^H + 4|\lambda_{SR}|^2 Z_{k7}^{E,*} Z_{l7}^E Z_{i3}^H Z_{j3}^H \\
& + 4|\lambda_{SR}|^2 Z_{k8}^{E,*} Z_{l8}^E Z_{i3}^H Z_{j3}^H + \sqrt{2}\lambda_{TR} \lambda_{SR}^* Z_{k7}^{E,*} Z_{l7}^E Z_{i4}^H Z_{j3}^H \\
& + \sqrt{2}\lambda_{SR} \lambda_{TR}^* Z_{k7}^{E,*} Z_{l7}^E Z_{i4}^H Z_{j3}^H - \sqrt{2}\lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i4}^H Z_{j3}^H \\
& - \sqrt{2}\lambda_{TR} \lambda_T^* Z_{k7}^{E,*} Z_{l8}^E Z_{i4}^H Z_{j3}^H + \sqrt{2}\lambda_{TR} \lambda_{SR}^* Z_{k8}^{E,*} Z_{l8}^E Z_{i4}^H Z_{j3}^H \\
& + \sqrt{2}\lambda_{SR} \lambda_{TR}^* Z_{k8}^{E,*} Z_{l8}^E Z_{i4}^H Z_{j3}^H + \sqrt{2}\lambda_{TR}^* Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^H Z_{j4}^H
\end{aligned}$$

$$\begin{aligned}
& -\sqrt{2}\Lambda_T Z_{k8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^H Z_{j4}^H + \sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l8}^E Z_{i1}^H Z_{j4}^H \\
& -\sqrt{2}\Lambda_T^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l8}^E Z_{i1}^H Z_{j4}^H + \sqrt{2}\Lambda_T^* Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i2}^H Z_{j4}^H \\
& -\sqrt{2}\lambda_{TR} Z_{k7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i2}^H Z_{j4}^H + \sqrt{2}\Lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{l_a}^E Z_{i2}^H Z_{j4}^H \\
& + \sqrt{2}\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{k_a}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^H Z_{j4}^H - \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{k_b}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^H Z_{j4}^H \\
& -\sqrt{2}\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{k3+a}^{E,*} Z_{l_b}^E Z_{i2}^H Z_{j4}^H + \sqrt{2}\Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{k8+a}^{E,*} Z_{l7}^E Z_{i2}^H Z_{j4}^H \\
& -\sqrt{2}\lambda_{TR}^* \sum_{a=1}^2 Z_{k10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l7}^E Z_{i2}^H Z_{j4}^H + \sqrt{2}\lambda_{TR} \lambda_{SR}^* Z_{k7}^{E,*} Z_{l7}^E Z_{i3}^H Z_{j4}^H \\
& + \sqrt{2}\lambda_{SR} \lambda_{TR}^* Z_{k7}^{E,*} Z_{l7}^E Z_{i3}^H Z_{j4}^H - \sqrt{2}\lambda_T \lambda_{TR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i3}^H Z_{j4}^H \\
& -\sqrt{2}\lambda_{TR} \lambda_T^* Z_{k7}^{E,*} Z_{l8}^E Z_{i3}^H Z_{j4}^H + \sqrt{2}\lambda_{TR} \lambda_{SR}^* Z_{k8}^{E,*} Z_{l8}^E Z_{i3}^H Z_{j4}^H \\
& + \sqrt{2}\lambda_{SR} \lambda_{TR}^* Z_{k8}^{E,*} Z_{l8}^E Z_{i3}^H Z_{j4}^H + 2\lambda_T \sum_{b=1}^2 Z_{k8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i4}^H Z_{j4}^H \\
& + 2\lambda_T^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{k10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i4}^H Z_{j4}^H + 2|\lambda_{TR}|^2 Z_{k7}^{E,*} Z_{l7}^E Z_{i4}^H Z_{j4}^H \\
& - 2\lambda_T \lambda_{SR}^* Z_{k8}^{E,*} Z_{l7}^E Z_{i4}^H Z_{j4}^H - 2\lambda_{SR} \lambda_T^* Z_{k7}^{E,*} Z_{l8}^E Z_{i4}^H Z_{j4}^H + 2|\lambda_{TR}|^2 Z_{k8}^{E,*} Z_{l8}^E Z_{i4}^H Z_{j4}^H
\end{aligned} \tag{492}$$



$$\begin{aligned}
& \frac{i}{12} \delta_{\gamma\delta} \left( (-3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U (Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H) \right. \\
& \left. + 4g_1^2 \sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U (-Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H) \right)
\end{aligned}$$

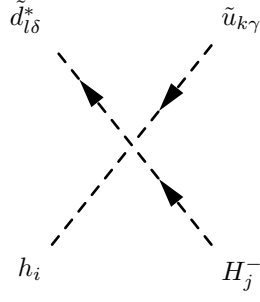
$$\begin{aligned}
& - 3 \left( -\sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i4}^H Z_{j1}^H \right. \\
& + 4 \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U Z_{i2}^H Z_{j2}^H \\
& + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U Z_{i2}^H Z_{j2}^H \\
& + 2\lambda^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \left( Z_{i1}^H Z_{j3}^H + Z_{i3}^H Z_{j1}^H \right) \\
& - \sqrt{2}\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i1}^H Z_{j4}^H \\
& \left. + \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^U \left( 2\lambda Z_{i3}^H Z_{j1}^H - \sqrt{2}\Lambda_T Z_{i4}^H Z_{j1}^H + Z_{i1}^H \left( 2\lambda Z_{j3}^H - \sqrt{2}\Lambda_T Z_{j4}^H \right) \right) \right) \quad (493)
\end{aligned}$$



$$\begin{aligned}
& - \frac{i}{4} \left( (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{ka}^{V,*} Z_{la}^V \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) \right. \\
& + Z_{k4}^{V,*} \left( 4|\lambda_{SR}|^2 Z_{i3}^H Z_{j3}^H Z_{l4}^V - \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{i4}^H Z_{j3}^H Z_{l4}^V - \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{i4}^H Z_{j3}^H Z_{l4}^V \right. \\
& - \sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{i3}^H Z_{j4}^H Z_{l4}^V - \sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{i3}^H Z_{j4}^H Z_{l4}^V + 2|\lambda_{TR}|^2 Z_{i4}^H Z_{j4}^H Z_{l4}^V \\
& - \sqrt{2}\lambda_{TR}\lambda_T^* Z_{i4}^H Z_{j3}^H Z_{l5}^V - \sqrt{2}\lambda_{TR}\lambda_T^* Z_{i3}^H Z_{j4}^H Z_{l5}^V + 2\lambda_{SR}\lambda_T^* Z_{i4}^H Z_{j4}^H Z_{l5}^V \\
& \left. + Z_{i2}^H \left( (2\lambda_{SR}\lambda^* + \lambda_{TR}\Lambda_T^*) Z_{j1}^H Z_{l5}^V - (g_1^2 + g_2^2) Z_{j2}^H Z_{l4}^V \right) \right. \\
& \left. + Z_{i1}^H \left( (2\lambda_{SR}\lambda^* + \lambda_{TR}\Lambda_T^*) Z_{j2}^H Z_{l5}^V + (g_1^2 + g_2^2) Z_{j1}^H Z_{l4}^V \right) \right) \\
& + Z_{k5}^{V,*} \left( - (g_1^2 + g_2^2) \left( Z_{i1}^H Z_{j1}^H - Z_{i2}^H Z_{j2}^H \right) Z_{l5}^V \right. \\
& \left. + \lambda_{SR}^* \left( 2\lambda Z_{i2}^H Z_{j1}^H Z_{l4}^V + 2\lambda Z_{i1}^H Z_{j2}^H Z_{l4}^V + 2\lambda_T Z_{i4}^H Z_{j4}^H Z_{l4}^V + 4\lambda_{SR} Z_{i3}^H Z_{j3}^H Z_{l5}^V \right. \right. \\
& \left. \left. - \sqrt{2}\lambda_{TR} Z_{i4}^H Z_{j3}^H Z_{l5}^V - \sqrt{2}\lambda_{TR} Z_{i3}^H Z_{j4}^H Z_{l5}^V \right) \right)
\end{aligned}$$

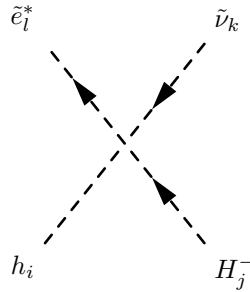
$$\begin{aligned}
& + \lambda_{TR}^* \left( \Lambda_T Z_{i2}^H Z_{j1}^H Z_{l4}^V + \Lambda_T Z_{i1}^H Z_{j2}^H Z_{l4}^V - \sqrt{2} \lambda_T Z_{i4}^H Z_{j3}^H Z_{l4}^V - \sqrt{2} \lambda_T Z_{i3}^H Z_{j4}^H Z_{l4}^V \right. \\
& \left. - \sqrt{2} \lambda_{SR} Z_{i4}^H Z_{j3}^H Z_{l5}^V - \sqrt{2} \lambda_{SR} Z_{i3}^H Z_{j4}^H Z_{l5}^V + 2 \lambda_{TR} Z_{i4}^H Z_{j4}^H Z_{l5}^V \right) \Big) \tag{494}
\end{aligned}$$


---



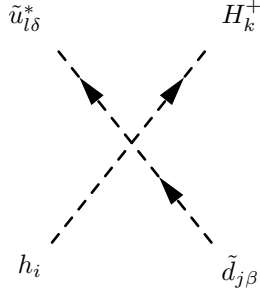
$$\begin{aligned}
& - \frac{i}{4} \delta_{\gamma\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^D \left( 2 Z_{i4}^H \left( -Z_{j4}^+ + Z_{j3}^+ \right) + \sqrt{2} Z_{i1}^H Z_{j1}^+ + \sqrt{2} Z_{i2}^H Z_{j2}^+ \right) \right. \\
& - 2 \left( \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^D Z_{i1}^H Z_{j1}^+ - \sqrt{2} \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{i3}^H Z_{j1}^+ \right. \\
& - \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{i4}^H Z_{j1}^+ + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^D Z_{i2}^H Z_{j2}^+ \\
& - \sqrt{2} \lambda^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i3}^H Z_{j2}^+ - \Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i4}^H Z_{j2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 Z_{k3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{d,ba} Z_{l3+b}^D \left( Z_{i1}^H Z_{j2}^+ + Z_{i2}^H Z_{j1}^+ \right) \\
& \left. + \sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{k3+a}^{U,*} Z_{lb}^D Z_{i1}^H Z_{j3}^+ - \sqrt{2} \Lambda_T^* \sum_{b=1}^3 Z_{kb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^H Z_{j4}^+ \right) \Big) \tag{495}
\end{aligned}$$


---



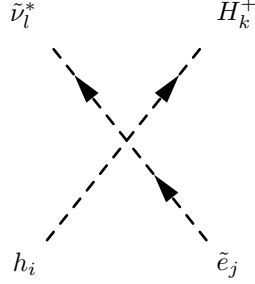
$$\begin{aligned}
& -\frac{i}{4} \left( -2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^E Z_{i1}^H Z_{j1}^+ \right. \\
& - 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^E Z_{i1}^H Z_{j1}^+ \\
& - 2\sqrt{2} \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{l7}^E Z_{i1}^H Z_{j1}^+ + \sqrt{2} g_2^2 Z_{k5}^{V,*} Z_{l8}^E Z_{i1}^H Z_{j1}^+ \\
& + 2\sqrt{2} \Lambda_T \lambda_{TR}^* Z_{k5}^{V,*} Z_{l7}^E Z_{i2}^H Z_{j1}^+ + 2\sqrt{2} \lambda_{SR}^* Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^H Z_{j1}^+ \\
& + 2\sqrt{2} \lambda Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i3}^H Z_{j1}^+ + 2\sqrt{2} \sum_{c=1}^2 \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^2 \lambda_{SE,ac}^* Y_{L,ba} Z_{l10+c}^E Z_{i3}^H Z_{j1}^+ \\
& - 2\lambda_{TR}^* Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i4}^H Z_{j1}^+ + 2\Lambda_T Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i4}^H Z_{j1}^+ \\
& + \sqrt{2} g_2^2 Z_{k5}^{V,*} Z_{l8}^E Z_{i2}^H Z_{j2}^+ - 2\sqrt{2} Z_{k5}^{V,*} \sum_{a=1}^2 |Y_{\hat{B}\hat{a}rE,a}|^2 Z_{l8}^E Z_{i2}^H Z_{j2}^+ \\
& - 2\sqrt{2} Z_{k5}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* \lambda_{SE,ba} Z_{l8+b}^E Z_{i3}^H Z_{j2}^+ - 2\sqrt{2} \lambda^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} Z_{l8+b}^E Z_{i3}^H Z_{j2}^+ \\
& + 2\sqrt{2} \lambda^* \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i3}^H Z_{j2}^+ - 2\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} Z_{l8+b}^E Z_{i4}^H Z_{j2}^+ \\
& + 2\Lambda_T^* \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i4}^H Z_{j2}^+ - 2\sqrt{2} \Lambda_T Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^H Z_{j3}^+ \\
& - 2\sqrt{2} \lambda_T \lambda_{TR}^* Z_{k5}^{V,*} Z_{l7}^E Z_{i3}^H Z_{j3}^+ + 2\sqrt{2} \lambda_{TR} \lambda_{SR}^* Z_{k5}^{V,*} Z_{l8}^E Z_{i3}^H Z_{j3}^+ \\
& + 2g_2^2 Z_{k5}^{V,*} Z_{l8}^E Z_{i4}^H Z_{j3}^+ - 2|\lambda_{TR}|^2 Z_{k5}^{V,*} Z_{l8}^E Z_{i4}^H Z_{j3}^+ \\
& + g_2^2 \sum_{a=1}^3 Z_{ka}^{V,*} Z_{la}^E \left( 2Z_{i4}^H \left( -Z_{j4}^+ + Z_{j3}^+ \right) + \sqrt{2} Z_{i1}^H Z_{j1}^+ + \sqrt{2} Z_{i2}^H Z_{j2}^+ \right) \\
& + 2\sqrt{2} \lambda_{TR}^* Z_{k5}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^H Z_{j4}^+ - 2\sqrt{2} \Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ka}^{V,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^H Z_{j4}^+ \\
& + 2\sqrt{2} \Lambda_T^* \sum_{b=1}^3 Z_{kb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^H Z_{j4}^+ + 2\sqrt{2} \lambda_{SR} \lambda_{TR}^* Z_{k5}^{V,*} Z_{l8}^E Z_{i3}^H Z_{j4}^+ \\
& - 2g_2^2 Z_{k5}^{V,*} Z_{l8}^E Z_{i4}^H Z_{j4}^+ + 2|\lambda_{TR}|^2 Z_{k5}^{V,*} Z_{l8}^E Z_{i4}^H Z_{j4}^+ \\
& + Z_{k4}^{V,*} \left( -2\sqrt{2} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{lb}^E Z_{i1}^H Z_{j1}^+ \right.
\end{aligned}$$

$$\begin{aligned}
& + Z_{l7}^E \left( \sqrt{2} \left( -2 \sum_{a=1}^2 |Y_{\hat{E},a}|^2 + g_2^2 \right) Z_{i1}^H Z_{j1}^+ + \sqrt{2} g_2^2 Z_{i2}^H Z_{j2}^+ \right. \\
& - 2 \left( - \left( -|\lambda_{TR}|^2 + g_2^2 \right) Z_{i4}^H \left( -Z_{j4}^+ + Z_{j3}^+ \right) + \sqrt{2} \lambda_{SR} \lambda_{TR}^* Z_{i3}^H Z_{j4}^+ + \sqrt{2} \lambda_{TR} \lambda_{SR}^* Z_{i3}^H Z_{j3}^+ \right) \\
& + 2 \left( \sqrt{2} \sum_{b=1}^2 \sum_{a=1}^2 \lambda_{SE,ab}^* Y_{\hat{E},a} Z_{l10+b}^E Z_{i3}^H Z_{j1}^+ - \sqrt{2} \lambda^* \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i3}^H Z_{j2}^+ \right. \\
& - \sqrt{2} \lambda_{SR} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i3}^H Z_{j2}^+ + \lambda_{TR} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i4}^H Z_{j2}^+ \\
& + \sqrt{2} \lambda_{TR} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i2}^H Z_{j3}^+ + \sqrt{2} \lambda_{TR} \lambda_T^* Z_{l8}^E Z_{i3}^H Z_{j4}^+ \\
& \left. \left. + \Lambda_T^* \left( \sqrt{2} \lambda_{TR} Z_{l8}^E Z_{i1}^H Z_{j2}^+ - \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \left( \sqrt{2} Z_{i2}^H Z_{j4}^+ + Z_{i4}^H Z_{j2}^+ \right) \right) \right) \right) \quad (496)
\end{aligned}$$



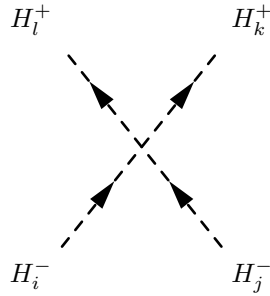
$$\begin{aligned}
& - \frac{i}{4} \delta_{\beta\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^U \left( 2 Z_{i4}^H \left( -Z_{k4}^+ + Z_{k3}^+ \right) + \sqrt{2} Z_{i1}^H Z_{k1}^+ + \sqrt{2} Z_{i2}^H Z_{k2}^+ \right) \right. \\
& - 2 \left( \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^U Z_{i1}^H Z_{k1}^+ - \sqrt{2} \lambda^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i3}^H Z_{k1}^+ \right. \\
& - \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i4}^H Z_{k1}^+ + \sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^U Z_{i2}^H Z_{k2}^+ \\
& - \sqrt{2} \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U Z_{i3}^H Z_{k2}^+ - \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U Z_{i4}^H Z_{k2}^+ \\
& + \sqrt{2} \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{u,ba} Z_{l3+b}^U \left( Z_{i1}^H Z_{k2}^+ + Z_{i2}^H Z_{k1}^+ \right) \\
& \left. \left. + \sqrt{2} \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i1}^H Z_{k3}^+ - \sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^U Z_{i2}^H Z_{k4}^+ \right) \right) \quad (497)
\end{aligned}$$





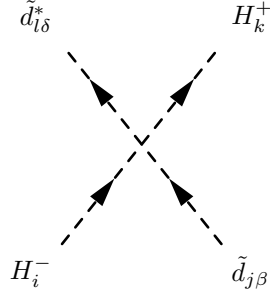
$$\begin{aligned}
& -\frac{i}{4} \left( -2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^V Z_{i1}^H Z_{k1}^+ \right. \\
& - 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{e,ac}^* Y_{e,ab} Z_{lc}^V Z_{i1}^H Z_{k1}^+ \\
& + 2\sqrt{2} \sum_{c=1}^3 \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{L,ca}^* \lambda_{SE,ab} Z_{lc}^V Z_{i3}^H Z_{k1}^+ \\
& - 2\sqrt{2} \lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^V Z_{i3}^H Z_{k2}^+ + 2\sqrt{2} \lambda \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V Z_{i3}^H Z_{k2}^+ \\
& - 2\Lambda_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^V Z_{i4}^H Z_{k2}^+ + 2\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V Z_{i4}^H Z_{k2}^+ \\
& + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^V \left( 2Z_{i4}^H \left( -Z_{k4}^+ + Z_{k3}^+ \right) + \sqrt{2} Z_{i1}^H Z_{k1}^+ + \sqrt{2} Z_{i2}^H Z_{k2}^+ \right) \\
& - 2\sqrt{2} \Lambda_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^V Z_{i2}^H Z_{k4}^+ + 2\sqrt{2} \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^V Z_{i2}^H Z_{k4}^+ \\
& - 2\sqrt{2} \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{i1}^H Z_{k1}^+ Z_{l4}^V + 2\sqrt{2} \sum_{b=1}^2 Z_{j10+b}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a}^* \lambda_{SE,ab} Z_{i3}^H Z_{k1}^+ Z_{l4}^V \\
& + 2\sqrt{2} \Lambda_T \lambda_{TR}^* Z_{j8}^{E,*} Z_{i1}^H Z_{k2}^+ Z_{l4}^V - 2\sqrt{2} \lambda \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i3}^H Z_{k2}^+ Z_{l4}^V \\
& - 2\sqrt{2} \lambda_{SR}^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i3}^H Z_{k2}^+ Z_{l4}^V - 2\Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i4}^H Z_{k2}^+ Z_{l4}^V \\
& + 2\lambda_{TR}^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i4}^H Z_{k2}^+ Z_{l4}^V + 2\sqrt{2} \lambda_{TR}^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i2}^H Z_{k3}^+ Z_{l4}^V \\
& - 2\sqrt{2} \Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i2}^H Z_{k4}^+ Z_{l4}^V + 2\sqrt{2} \lambda_{TR} \lambda_{TR}^* Z_{j8}^{E,*} Z_{i3}^H Z_{k4}^+ Z_{l4}^V
\end{aligned}$$

$$\begin{aligned}
& + \sqrt{2}g_2^2 Z_{j8}^{E,*} Z_{i1}^H Z_{k1}^+ Z_{l5}^V + 2\sqrt{2}\lambda_{SR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i3}^H Z_{k1}^+ Z_{l5}^V \\
& + 2\sqrt{2}\lambda^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i3}^H Z_{k1}^+ Z_{l5}^V - 2\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i4}^H Z_{k1}^+ Z_{l5}^V \\
& + 2\Lambda_T^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i4}^H Z_{k1}^+ Z_{l5}^V + \sqrt{2}g_2^2 Z_{j8}^{E,*} Z_{i2}^H Z_{k2}^+ Z_{l5}^V \\
& - 2\sqrt{2}Z_{j8}^{E,*} \sum_{a=1}^2 |Y_{\hat{B}\hat{a}rE,a}|^2 Z_{i2}^H Z_{k2}^+ Z_{l5}^V - 2\sqrt{2} \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Y_{\hat{B}\hat{a}rE,a} Z_{i3}^H Z_{k2}^+ Z_{l5}^V \\
& - 2\sqrt{2}\Lambda_T^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{i1}^H Z_{k3}^+ Z_{l5}^V + 2\sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{j8}^{E,*} Z_{i3}^H Z_{k3}^+ Z_{l5}^V \\
& + 2g_2^2 Z_{j8}^{E,*} Z_{i4}^H Z_{k3}^+ Z_{l5}^V - 2|\lambda_{TR}|^2 Z_{j8}^{E,*} Z_{i4}^H Z_{k3}^+ Z_{l5}^V \\
& + 2\sqrt{2}\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{i1}^H Z_{k4}^+ Z_{l5}^V + 2\sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{j8}^{E,*} Z_{i3}^H Z_{k4}^+ Z_{l5}^V \\
& - 2g_2^2 Z_{j8}^{E,*} Z_{i4}^H Z_{k4}^+ Z_{l5}^V + 2|\lambda_{TR}|^2 Z_{j8}^{E,*} Z_{i4}^H Z_{k4}^+ Z_{l5}^V \\
& + Z_{j7}^{E,*} \left( -2\sqrt{2} \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\hat{E},a} Z_{lb}^V Z_{i1}^H Z_{k1}^+ + \sqrt{2} \left( -2 \sum_{a=1}^2 |Y_{\hat{E},a}|^2 + g_2^2 \right) Z_{i1}^H Z_{k1}^+ Z_{l4}^V \right. \\
& + \sqrt{2}g_2^2 Z_{i2}^H Z_{k2}^+ Z_{l4}^V - 2\sqrt{2}\lambda_{SR}\lambda_{TR}^* Z_{i3}^H Z_{k3}^+ Z_{l4}^V + 2g_2^2 Z_{i4}^H Z_{k3}^+ Z_{l4}^V \\
& \left. - 2|\lambda_{TR}|^2 Z_{i4}^H Z_{k3}^+ Z_{l4}^V - 2\sqrt{2}\lambda_{TR}\lambda_{SR}^* Z_{i3}^H Z_{k4}^+ Z_{l4}^V - 2g_2^2 Z_{i4}^H Z_{k4}^+ Z_{l4}^V \right. \\
& \left. + 2|\lambda_{TR}|^2 Z_{i4}^H Z_{k4}^+ Z_{l4}^V + 2\sqrt{2}\lambda_{TR}\Lambda_T^* Z_{i2}^H Z_{k1}^+ Z_{l5}^V - 2\sqrt{2}\lambda_{TR}\lambda_T^* Z_{i3}^H Z_{k3}^+ Z_{l5}^V \right) \tag{498}
\end{aligned}$$

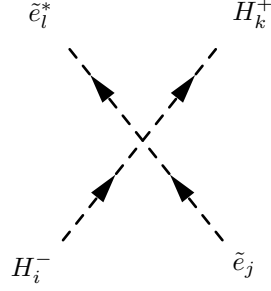


$$\begin{aligned}
& - \frac{i}{4} \left( -Z_{i2}^+ \left( (-2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2) Z_{j1}^+ (Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+) \right. \right. \\
& + 2 \left( - (g_1^2 + g_2^2) Z_{j2}^+ Z_{k2}^+ Z_{l2}^+ + g_2^2 Z_{j3}^+ Z_{k3}^+ Z_{l2}^+ - 2|\Lambda_T|^2 Z_{j3}^+ Z_{k3}^+ Z_{l2}^+ \right. \\
& \left. \left. - g_2^2 Z_{j4}^+ Z_{k4}^+ Z_{l2}^+ + g_2^2 Z_{j3}^+ Z_{k2}^+ Z_{l3}^+ - 2|\Lambda_T|^2 Z_{j3}^+ Z_{k2}^+ Z_{l3}^+ - g_2^2 Z_{j4}^+ Z_{k2}^+ Z_{l4}^+ \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + 2\lambda_T \lambda^* Z_{j3}^+ \left( Z_{k1}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l1}^+ \right) \\
& + 2 \left( Z_{i3}^+ \left( -g_2^2 Z_{j2}^+ Z_{k3}^+ Z_{l2}^+ + 2|\Lambda_T|^2 Z_{j2}^+ Z_{k3}^+ Z_{l2}^+ - g_2^2 Z_{j2}^+ Z_{k2}^+ Z_{l3}^+ \right. \right. \\
& + 2|\Lambda_T|^2 Z_{j2}^+ Z_{k2}^+ Z_{l3}^+ + 4g_2^2 Z_{j3}^+ Z_{k3}^+ Z_{l3}^+ - 2g_2^2 Z_{j4}^+ Z_{k4}^+ Z_{l3}^+ \\
& + 2|\lambda_T|^2 Z_{j4}^+ Z_{k4}^+ Z_{l3}^+ + g_2^2 Z_{j1}^+ \left( Z_{k1}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l1}^+ \right) - 2g_2^2 Z_{j4}^+ Z_{k3}^+ Z_{l4}^+ \\
& + 2|\lambda_T|^2 Z_{j4}^+ Z_{k3}^+ Z_{l4}^+ - 2\lambda_T \lambda^* Z_{j2}^+ \left( Z_{k1}^+ Z_{l4}^+ + Z_{k4}^+ Z_{l1}^+ \right) \\
& + Z_{i4}^+ \left( g_2^2 Z_{j2}^+ Z_{k4}^+ Z_{l2}^+ - 2g_2^2 Z_{j3}^+ Z_{k4}^+ Z_{l3}^+ + 2|\lambda_T|^2 Z_{j3}^+ Z_{k4}^+ Z_{l3}^+ + g_2^2 Z_{j2}^+ Z_{k2}^+ Z_{l4}^+ \right. \\
& - 2g_2^2 Z_{j3}^+ Z_{k3}^+ Z_{l4}^+ + 2|\lambda_T|^2 Z_{j3}^+ Z_{k3}^+ Z_{l4}^+ + 4g_2^2 Z_{j4}^+ Z_{k4}^+ Z_{l4}^+ \\
& \left. - Z_{j1}^+ \left( 2\lambda\lambda_T^* \left( Z_{k2}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l2}^+ \right) + \left( -2|\Lambda_T|^2 + g_2^2 \right) Z_{k1}^+ Z_{l4}^+ + \left( -2|\Lambda_T|^2 + g_2^2 \right) Z_{k4}^+ Z_{l1}^+ \right) \right) \\
& + Z_{i1}^+ \left( 2 \left( g_1^2 + g_2^2 \right) Z_{j1}^+ Z_{k1}^+ Z_{l1}^+ - \left( -2|\Lambda_T|^2 - 4|\lambda|^2 + g_1^2 + g_2^2 \right) Z_{j2}^+ \left( Z_{k1}^+ Z_{l2}^+ + Z_{k2}^+ Z_{l1}^+ \right) \right. \\
& + 2 \left( g_2^2 Z_{j3}^+ \left( Z_{k1}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l1}^+ \right) \right. \\
& \left. \left. - Z_{j4}^+ \left( 2\lambda\lambda_T^* \left( Z_{k2}^+ Z_{l3}^+ + Z_{k3}^+ Z_{l2}^+ \right) + \left( -2|\Lambda_T|^2 + g_2^2 \right) Z_{k1}^+ Z_{l4}^+ + \left( -2|\Lambda_T|^2 + g_2^2 \right) Z_{k4}^+ Z_{l1}^+ \right) \right) \right) \quad (499)
\end{aligned}$$

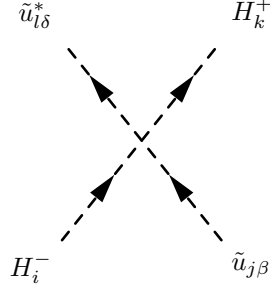


$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\delta} \left( 2 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \right. \\
& - 6 \left( \sum_{c=1}^3 Z_{j3+c}^{D,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ca}^* Y_{d,ba} Z_{l3+b}^D Z_{i1}^+ Z_{k1}^+ + \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{u,ac}^* Y_{u,ab} Z_{lc}^D Z_{i2}^+ Z_{k2}^+ \right. \\
& + \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{d,ab}^* Z_{j3+a}^{D,*} Z_{lb}^D Z_{i3}^+ Z_{k2}^+ + \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D Z_{i2}^+ Z_{k3}^+ \left. \left. \right) \right) \\
& + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( \left( -3g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ - \left( -3g_2^2 + g_1^2 \right) Z_{i2}^+ Z_{k2}^+ + 6g_2^2 \left( -Z_{i3}^+ Z_{k3}^+ + Z_{i4}^+ Z_{k4}^+ \right) \right) \quad (500)
\end{aligned}$$

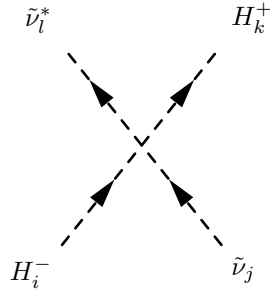


$$\begin{aligned}
& -\frac{i}{4} \left( g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{i1}^+ Z_{k1}^+ + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{i1}^+ Z_{k1}^+ \right. \\
& - 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E Z_{i1}^+ Z_{k1}^+ + 4 \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{j8+b}^{E,*} Z_{i1}^+ Z_{k1}^+ \\
& + 4 \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{L,ac}^* Y_{L,ab} Z_{l8+b}^E Z_{i1}^+ Z_{k1}^+ \\
& - 4 \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{L,ac}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^+ Z_{k1}^+ \\
& - 4 \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^2 \sum_{a=1}^3 Y_{e,ca}^* Y_{L,ab} Z_{l8+b}^E Z_{i1}^+ Z_{k1}^+ \\
& + 4 \sum_{c=1}^3 Z_{j3+c}^{E,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ca}^* Y_{e,ba} Z_{l3+b}^E Z_{i1}^+ Z_{k1}^+ + g_1^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i1}^+ Z_{k1}^+ \\
& + g_2^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i1}^+ Z_{k1}^+ - g_1^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i1}^+ Z_{k1}^+ - g_2^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i1}^+ Z_{k1}^+ \\
& - 4\lambda^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i2}^+ Z_{k1}^+ + 2\lambda_{TR} \Lambda_T^* Z_{j7}^{E,*} Z_{l8}^E Z_{i2}^+ Z_{k1}^+ \\
& + 4\lambda_{SR} \lambda^* Z_{j7}^{E,*} Z_{l8}^E Z_{i2}^+ Z_{k1}^+ + 4\lambda_{TR} \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{l8}^E Z_{i3}^+ Z_{k1}^+ \\
& - 4\Lambda_T^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l8}^E Z_{i4}^+ Z_{k1}^+ - 4\lambda \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i1}^+ Z_{k2}^+ \\
& + 4\lambda \lambda_{SR}^* Z_{j8}^{E,*} Z_{l7}^E Z_{i1}^+ Z_{k2}^+ + 2\Lambda_T \lambda_{TR}^* Z_{j8}^{E,*} Z_{l7}^E Z_{i1}^+ Z_{k2}^+ - g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{i2}^+ Z_{k2}^+ \\
& - g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{i2}^+ Z_{k2}^+ + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E Z_{i2}^+ Z_{k2}^+
\end{aligned}$$

$$\begin{aligned}
& + 4 \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} \sum_{b=1}^2 Y_{\hat{B}\hat{a}rE,b}^* Z_{l10+b}^E Z_{i2}^+ Z_{k2}^+ - g_1^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i2}^+ Z_{k2}^+ \\
& - g_2^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i2}^+ Z_{k2}^+ + g_1^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i2}^+ Z_{k2}^+ + g_2^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i2}^+ Z_{k2}^+ \\
& - 4\Lambda_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^3 Y_{L,ab}^* Z_{la}^E Z_{i3}^+ Z_{k2}^+ + 4\Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{e,ab}^* Z_{j3+a}^{E,*} Z_{lb}^E Z_{i3}^+ Z_{k2}^+ \\
& - 4\Lambda_T \sum_{a=1}^2 Y_{\hat{E},a}^* Z_{j8+a}^{E,*} Z_{l7}^E Z_{i3}^+ Z_{k2}^+ + 4\lambda_{TR}^* \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} Z_{l7}^E Z_{i4}^+ Z_{k2}^+ \\
& + 2g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{l10+a}^E \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \\
& + 2g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{l8+a}^E \left( -Z_{i1}^+ Z_{k1}^+ + Z_{i2}^+ Z_{k2}^+ \right) + 4\lambda_{TR}^* Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i1}^+ Z_{k3}^+ \\
& - 4\Lambda_T^* Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E Z_{i2}^+ Z_{k3}^+ - 4\Lambda_T^* \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{l8+b}^E Z_{i2}^+ Z_{k3}^+ \\
& + 4\Lambda_T^* \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E Z_{i2}^+ Z_{k3}^+ + 2g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{i3}^+ Z_{k3}^+ \\
& + 2g_2^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i3}^+ Z_{k3}^+ - 2g_2^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i3}^+ Z_{k3}^+ + 4|\lambda_{TR}|^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i3}^+ Z_{k3}^+ \\
& + 4\lambda_T^* \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{i4}^+ Z_{k3}^+ - 4\lambda_{SR} \lambda_T^* Z_{j7}^{E,*} Z_{l8}^E Z_{i4}^+ Z_{k3}^+ \\
& - 4\Lambda_T Z_{j8}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a}^* Z_{l10+a}^E Z_{i1}^+ Z_{k4}^+ + 4\lambda_{TR} Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{B}\hat{a}rE,a} Z_{l10+a}^E Z_{i2}^+ Z_{k4}^+ \\
& + 4\lambda_T \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{i3}^+ Z_{k4}^+ - 4\lambda_T \lambda_{SR}^* Z_{j8}^{E,*} Z_{l7}^E Z_{i3}^+ Z_{k4}^+ \\
& - 2g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{i4}^+ Z_{k4}^+ - 2g_2^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i4}^+ Z_{k4}^+ + 4|\lambda_{TR}|^2 Z_{j7}^{E,*} Z_{l7}^E Z_{i4}^+ Z_{k4}^+ \\
& + 2g_2^2 Z_{j8}^{E,*} Z_{l8}^E Z_{i4}^+ Z_{k4}^+ \Big) \tag{501}
\end{aligned}$$



$$\begin{aligned}
& \frac{i}{12} \delta_{\beta\delta} \left( -4 \left( g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( Z_{i1}^+ Z_{k1}^+ - Z_{i2}^+ Z_{k2}^+ \right) \right. \right. \\
& + 3 \left( \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ac}^* Y_{d,ab} Z_{lc}^U Z_{i1}^+ Z_{k1}^+ - \Lambda_T^* \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U Z_{i4}^+ Z_{k1}^+ \right. \\
& + \left. \sum_{c=1}^3 Z_{j3+c}^{U,*} \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ca}^* Y_{u,ba} Z_{l3+b}^U Z_{i2}^+ Z_{k2}^+ - \Lambda_T \sum_{b=1}^3 \sum_{a=1}^3 Y_{u,ab}^* Z_{j3+a}^{U,*} Z_{lb}^U Z_{i1}^+ Z_{k4}^+ \right) \\
& \left. + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( (3g_2^2 + g_1^2) Z_{i1}^+ Z_{k1}^+ - (3g_2^2 + g_1^2) Z_{i2}^+ Z_{k2}^+ + 6g_2^2 (Z_{i3}^+ Z_{k3}^+ - Z_{i4}^+ Z_{k4}^+) \right) \right) \quad (502)
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{4} \left( 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^2 Y_{L,ca}^* Y_{L,ba} Z_{lc}^V Z_{i1}^+ Z_{k1}^+ + 4 \sum_{c=1}^3 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ac}^* Y_{e,ab} Z_{lc}^V Z_{i1}^+ Z_{k1}^+ \right. \\
& + \sum_{a=1}^3 Z_{ja}^{V,*} Z_{la}^V \left( 2g_2^2 \left( -Z_{i3}^+ Z_{k3}^+ + Z_{i4}^+ Z_{k4}^+ \right) + \left( -g_1^2 + g_2^2 \right) Z_{i2}^+ Z_{k2}^+ + \left( -g_2^2 + g_1^2 \right) Z_{i1}^+ Z_{k1}^+ \right) \\
& + 4 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a}^* Y_{L,ba} Z_{i1}^+ Z_{k1}^+ Z_{l4}^V - 4\lambda\lambda_{SR}^* Z_{j5}^{V,*} Z_{i1}^+ Z_{k2}^+ Z_{l4}^V \\
& + 2\Lambda_T \lambda_{TR}^* Z_{j5}^{V,*} Z_{i1}^+ Z_{k2}^+ Z_{l4}^V + 4\lambda_T \lambda_{SR}^* Z_{j5}^{V,*} Z_{i3}^+ Z_{k4}^+ Z_{l4}^V - g_1^2 Z_{j5}^{V,*} Z_{i1}^+ Z_{k1}^+ Z_{l5}^V \\
& \left. + g_2^2 Z_{j5}^{V,*} Z_{i1}^+ Z_{k1}^+ Z_{l5}^V + g_1^2 Z_{j5}^{V,*} Z_{i2}^+ Z_{k2}^+ Z_{l5}^V - g_2^2 Z_{j5}^{V,*} Z_{i2}^+ Z_{k2}^+ Z_{l5}^V \right)
\end{aligned}$$

$$\begin{aligned}
& + 4Z_{j_5}^{V,*} \sum_{a=1}^2 |Y_{\widehat{Bar}E,a}|^2 Z_{i_2}^+ Z_{k_2}^+ Z_{l_5}^V + 2g_2^2 Z_{j_5}^{V,*} Z_{i_3}^+ Z_{k_3}^+ Z_{l_5}^V - 2g_2^2 Z_{j_5}^{V,*} Z_{i_4}^+ Z_{k_4}^+ Z_{l_5}^V \\
& + 4|\lambda_{TR}|^2 Z_{j_5}^{V,*} Z_{i_4}^+ Z_{k_4}^+ Z_{l_5}^V \\
& + Z_{j_4}^{V,*} \left( 4 \sum_{b=1}^3 \sum_{a=1}^2 Y_{L,ba}^* Y_{\widehat{E},a} Z_{lb}^V Z_{i_1}^+ Z_{k_1}^+ + \left( 4 \sum_{a=1}^2 |Y_{\widehat{E},a}|^2 - g_2^2 + g_1^2 \right) Z_{i_1}^+ Z_{k_1}^+ Z_{l_4}^V \right. \\
& - g_1^2 Z_{i_2}^+ Z_{k_2}^+ Z_{l_4}^V + g_2^2 Z_{i_2}^+ Z_{k_2}^+ Z_{l_4}^V - 2g_2^2 Z_{i_3}^+ Z_{k_3}^+ Z_{l_4}^V + 4|\lambda_{TR}|^2 Z_{i_3}^+ Z_{k_3}^+ Z_{l_4}^V \\
& + 2g_2^2 Z_{i_4}^+ Z_{k_4}^+ Z_{l_4}^V + 2\lambda_{TR} \Lambda_T^* Z_{i_2}^+ Z_{k_1}^+ Z_{l_5}^V - 4\lambda_{SR} \lambda^* Z_{i_2}^+ Z_{k_1}^+ Z_{l_5}^V \\
& \left. + 4\lambda_{SR} \lambda_T^* Z_{i_4}^+ Z_{k_3}^+ Z_{l_5}^V \right) \tag{503}
\end{aligned}$$

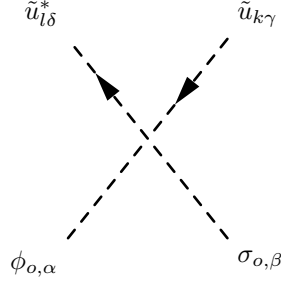

---

$$\begin{aligned}
& \begin{array}{ccc}
\sigma_{o,\delta} & & \sigma_{o,\gamma} \\
& \diagdown & / \\
& & \times \\
& / & \diagdown \\
\phi_{o,\alpha} & & \phi_{o,\beta}
\end{array} \\
& - i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) \tag{504}
\end{aligned}$$

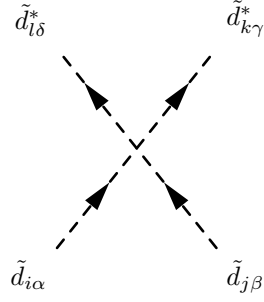

---

$$\begin{aligned}
& \begin{array}{ccc}
\tilde{d}_{l\delta}^* & & \sigma_{o,\gamma} \\
& \diagdown & / \\
& & \times \\
& / & \diagdown \\
\phi_{o,\alpha} & & \tilde{d}_{j\beta}
\end{array} \\
& - \frac{i}{2} g_3^2 \left( - \sum_{a=1}^3 Z_{j_{3+a}}^{D,*} Z_{l_{3+a}}^D + \sum_{a=1}^3 Z_{j_a}^{D,*} Z_{l_a}^D \right) \sum_{b=1}^8 f_{\alpha,\gamma,b} \lambda_{\delta,\beta}^b \tag{505}
\end{aligned}$$


---



$$-\frac{i}{2}g_3^2 \left( -\sum_{a=1}^3 Z_{k3+a}^{U,*} Z_{l3+a}^U + \sum_{a=1}^3 Z_{ka}^{U,*} Z_{la}^U \right) \sum_{b=1}^8 f_{\alpha,\beta,b} \lambda_{\delta,\gamma}^b \quad (506)$$

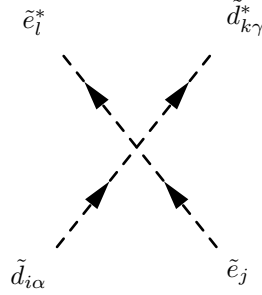


$$\begin{aligned} & -\frac{i}{72} \left( \delta_{\alpha\delta} \delta_{\beta\gamma} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \right. \right. \\ & - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \\ & + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \\ & + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( -\sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\ & - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( -\sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\ & + 2g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D \\ & \left. + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D \right) \end{aligned}$$



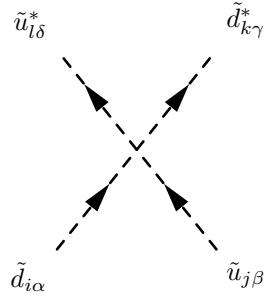
$$\begin{aligned}
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D + 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D \\
& - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D + 2g_1^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 72 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{j3+c}^{D,*} Z_{kd}^D \\
& + 72 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{ld}^D \\
& + \delta_{\alpha\gamma} \delta_{\beta\delta} \left( 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{kb}^D \right. \\
& + 2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{l3+a}^D \left( (2g_1^2 - 3g_3^2) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + (3g_3^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& + \sum_{a=1}^3 Z_{ja}^{D,*} Z_{la}^D \left( 2(3g_3^2 + g_1^2) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + (-6g_3^2 + 9g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{l3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{k3+b}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^D \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D
\end{aligned}$$

$$\begin{aligned}
& -6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{D,*} Z_{lb}^D - 18g_3^2 \sum_{a=1}^3 Z_{ja}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D \\
& + 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{l3+b}^D + 2g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{D,*} Z_{l3+b}^D \\
& + 72 \sum_{b=1}^3 Z_{jb}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{l3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& + 72 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{j3+c}^{D,*} Z_{ld}^D \Big) \tag{507}
\end{aligned}$$



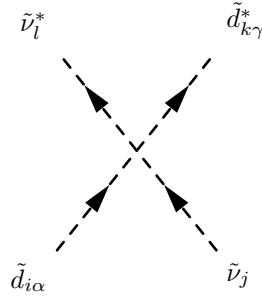
$$\begin{aligned}
& -\frac{i}{24} \delta_{\alpha\gamma} \left( 2g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{l8+a}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D - 2g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{l10+a}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right. \\
& - g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D + 3g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \\
& + 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D + 4g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{l8+a}^E \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D \\
& - 4g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{l10+a}^E \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D - 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D \\
& \left. + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D - 24Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{d,bc}^* Z_{i3+b}^{D,*} Z_{kc}^D \right)
\end{aligned}$$

$$\begin{aligned}
& -24 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^E \\
& -24 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& +24 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{kd}^D \\
& +24 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{ld}^E \\
& -24 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{c=1}^2 Y_{E,c}^* Z_{j8+c}^{E,*} Z_{l7}^E \\
& +2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \left( 2 \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{l8+b}^E - 2 \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{l10+b}^E - \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E + 2 \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E - 2Z_{j7}^{E,*} Z_{l7}^E \right. \\
& \left. + 2Z_{j8}^{E,*} Z_{l8}^E \right) \\
& + \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \left( 2g_1^2 \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{l8+b}^E - 2g_1^2 \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{l10+b}^E - g_1^2 \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \right. \\
& + 3g_2^2 \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E + 2g_1^2 \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E - 2g_1^2 Z_{j7}^{E,*} Z_{l7}^E + 6g_2^2 Z_{j7}^{E,*} Z_{l7}^E \\
& \left. + 2g_1^2 Z_{j8}^{E,*} Z_{l8}^E - 6g_2^2 Z_{j8}^{E,*} Z_{l8}^E \right) \tag{508}
\end{aligned}$$



$$\begin{aligned}
& -\frac{i}{72} \left( \delta_{\alpha\gamma} \delta_{\beta\delta} \left( \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( 2 \left( 3g_3^2 + g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \left( -6g_3^2 - 9g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right. \right. \\
& \left. \left. - 2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( \left( 2g_1^2 - 3g_3^2 \right) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D + \left( 3g_3^2 + 4g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D \right) \right) \right)
\end{aligned}$$

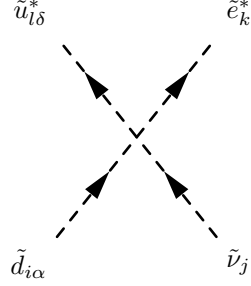
$$\begin{aligned}
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 9g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U + 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U - 8g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \Big) \\
& + 18\delta_{\alpha\delta}\delta_{\beta\gamma} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^D + g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right. \\
& + g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( - \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D + \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D \right) \\
& + g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^D \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^U + g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - g_3^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + g_3^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U + 4 \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd} Z_{j3+c}^{U,*} Z_{kd}^D \\
& \left. + 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd} Z_{i3+c}^{D,*} Z_{ld}^U \right) \tag{509}
\end{aligned}$$



$$\frac{i}{24} \delta_{\alpha\gamma} \left( \sum_{a=1}^3 Z_{ja}^{V,*} Z_{la}^V \left( 2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{D,*} Z_{k3+b}^D + (3g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{D,*} Z_{kb}^D \right) \right)$$

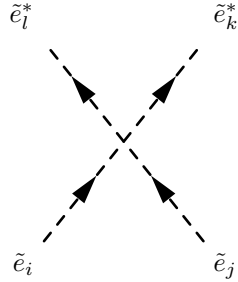
$$+ \left( 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{k3+a}^D + \left( 3g_2^2 + g_1^2 \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ka}^D \right) \left( 2Z_{j4}^{V,*} Z_{l4}^V - 2Z_{j5}^{V,*} Z_{l5}^V + \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V \right) \quad (510)$$


---



$$\begin{aligned} & -\frac{i}{4} \delta_{\alpha\delta} \left( g_2^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{D,*} Z_{lb}^U + 4Z_{j5}^{V,*} \sum_{b=1}^3 Z_{ib}^{D,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{c=1}^2 Y_{\hat{B}arE,c}^* Z_{k10+c}^E \right. \\ & - 4Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{d,bc}^* Z_{i3+b}^{D,*} Z_{lc}^U \\ & - 4 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{ld}^U \\ & + 4 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{d,cd}^* Z_{i3+c}^{D,*} Z_{ld}^U \\ & \left. + g_2^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{la}^U \left( 2Z_{j4}^{V,*} Z_{k7}^E + 2Z_{j5}^{V,*} Z_{k8}^E + \sum_{b=1}^3 Z_{jb}^{V,*} Z_{kb}^E \right) \right) \quad (511) \end{aligned}$$


---



$$-\frac{i}{8} \left( -2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{k8+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{k8+b}^E \right)$$

$$\begin{aligned}
& + 4g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{l8+a}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{k8+b}^E - 4g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{l10+a}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{k8+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{k8+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{k8+b}^E \\
& + 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{k10+b}^E - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{k10+b}^E \\
& - 4g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{l8+a}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{k10+b}^E + 4g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{l10+a}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{k10+b}^E \\
& + 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{k10+b}^E - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{k10+b}^E \\
& + 4g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{l8+b}^E - 4g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{l8+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{l8+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{l8+b}^E \\
& + 4g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{l8+b}^E - 4g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{l8+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{l8+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^2 Z_{j8+b}^{E,*} Z_{l8+b}^E \\
& - 4g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{l10+b}^E + 4g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{l10+b}^E \\
& + 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{l10+b}^E - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{l10+b}^E \\
& - 4g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{l10+b}^E + 4g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{l10+b}^E \\
& + 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{l10+b}^E - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^2 Z_{j10+b}^{E,*} Z_{l10+b}^E \\
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E - 2g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{l8+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E
\end{aligned}$$

$$\begin{aligned}
& + 2g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{l10+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E \\
& + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{kb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E \\
& + 4g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{l8+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{k3+b}^E - 4g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{l10+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{k3+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{k3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{k3+b}^E \\
& - 2g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + 2g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E \\
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E + g_2^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^E - 2g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + 2g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{jb}^{E,*} Z_{lb}^E \\
& + 4g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E - 4g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{l3+b}^E \\
& + 4g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E - 4g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& - 2g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E + 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{j3+b}^{E,*} Z_{l3+b}^E \\
& + 8Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{c=1}^2 Z_{i8+c}^{E,*} \sum_{b=1}^3 Y_{L,bc}^* Z_{kb}^E
\end{aligned}$$

$$\begin{aligned}
& + 8Z_{i7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^3 Y_{L,bc}^* Z_{kb}^E \\
& + 8Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^2 Z_{i8+c}^{E,*} \sum_{b=1}^3 Y_{L,bc}^* Z_{lb}^E \\
& + 8Z_{i7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^2 Z_{j8+c}^{E,*} \sum_{b=1}^3 Y_{L,bc}^* Z_{lb}^E \\
& - 8Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{e,bc}^* Z_{i3+b}^{E,*} Z_{kc}^E \\
& - 8Z_{i7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{e,bc}^* Z_{j3+b}^{E,*} Z_{kc}^E \\
& - 8Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{e,bc}^* Z_{i3+b}^{E,*} Z_{lc}^E \\
& - 8Z_{i7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{e,bc}^* Z_{j3+b}^{E,*} Z_{lc}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^2 \lambda_{SE,dc}^* Z_{k10+c}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^2 \lambda_{SE,dc}^* Z_{k10+c}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^2 \lambda_{SE,dc}^* Z_{l10+c}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^2 \lambda_{SE,dc}^* Z_{l10+c}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{kc}^E \\
& - 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{kc}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ia}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{kc}^E \\
& - 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{kc}^E
\end{aligned}$$

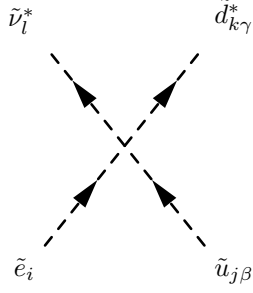


$$\begin{aligned}
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^E \\
& - 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ia}^{E,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^E \\
& - 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^2 Z_{j8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^E \\
& - 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{kd}^E \\
& + 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{kd}^E \\
& - 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ia}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{kd}^E \\
& + 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{kd}^E \\
& - 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^E \\
& + 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^E \\
& - 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ia}^{E,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{ld}^E \\
& + 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{j3+c}^{E,*} Z_{ld}^E - 4g_1^2 Z_{j7}^{E,*} \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{l8+a}^E Z_{k7}^E \\
& + 4g_1^2 Z_{j7}^{E,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{l10+a}^E Z_{k7}^E + 2g_1^2 Z_{j7}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E Z_{k7}^E \\
& + 2g_2^2 Z_{j7}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E Z_{k7}^E + 2g_1^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{k7}^E \\
& + 2g_2^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{k7}^E - 4g_1^2 Z_{j7}^{E,*} \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E Z_{k7}^E
\end{aligned}$$

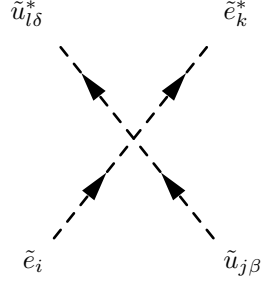
$$\begin{aligned}
& -4g_1^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E Z_{k7}^E + 8Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{i8+b}^{E,*} Z_{k7}^E \\
& + 8Z_{i7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{l8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{j8+b}^{E,*} Z_{k7}^E - 8\lambda_{SR}^* Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{k7}^E \\
& - 8\lambda_{SR}^* Z_{i8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{l8+b}^E Z_{k7}^E + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{i8+c}^{E,*} Z_{k7}^E \\
& - 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{i8+c}^{E,*} Z_{k7}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ia}^{E,*} Y_{L,ab} Z_{l8+b}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{j8+c}^{E,*} Z_{k7}^E \\
& - 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{l3+a}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{j8+c}^{E,*} Z_{k7}^E + 4g_1^2 Z_{j8}^{E,*} \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{l8+a}^E Z_{k8}^E \\
& - 4g_1^2 Z_{j8}^{E,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{l10+a}^E Z_{k8}^E - 2g_1^2 Z_{j8}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E Z_{k8}^E \\
& - 2g_2^2 Z_{j8}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^E Z_{k8}^E - 2g_1^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{k8}^E \\
& - 2g_2^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{la}^E Z_{k8}^E + 4g_1^2 Z_{j8}^{E,*} \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{l3+a}^E Z_{k8}^E \\
& + 4g_1^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{l3+a}^E Z_{k8}^E - 8\lambda_{SR} Z_{j7}^{E,*} \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{k8}^E \\
& - 8\lambda_{SR} Z_{i7}^{E,*} \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{l10+a}^E Z_{k8}^E + 8Z_{j8}^{E,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} \sum_{b=1}^2 Y_{\hat{B}\hat{a}rE,b}^* Z_{l10+b}^E Z_{k8}^E \\
& + 8Z_{i8}^{E,*} \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\hat{B}\hat{a}rE,a} \sum_{b=1}^2 Y_{\hat{B}\hat{a}rE,b}^* Z_{l10+b}^E Z_{k8}^E \\
& + 2g_1^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{l10+a}^E \left( -2 \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{k8+b}^E + 2 \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{k10+b}^E + \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E - 2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + 2Z_{i7}^{E,*} Z_{k7}^E \right. \\
& \left. - 2Z_{i8}^{E,*} Z_{k8}^E \right) \\
& + 2g_1^2 \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{l8+a}^E \left( 2 \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{k8+b}^E - 2 \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{k10+b}^E - \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E + 2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E - 2Z_{i7}^{E,*} Z_{k7}^E \right. \\
& \left. + 2Z_{i8}^{E,*} Z_{k8}^E \right)
\end{aligned}$$

$$\begin{aligned}
& -4g_1^2 Z_{j7}^{E,*} \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E Z_{l7}^E - 4g_1^2 Z_{i7}^{E,*} \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E Z_{l7}^E \\
& + 4g_1^2 Z_{j7}^{E,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E Z_{l7}^E + 4g_1^2 Z_{i7}^{E,*} \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{l7}^E \\
& + 2g_1^2 Z_{j7}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l7}^E + 2g_2^2 Z_{j7}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l7}^E \\
& + 2g_1^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{l7}^E + 2g_2^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{l7}^E \\
& - 4g_1^2 Z_{j7}^{E,*} \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E Z_{l7}^E - 4g_1^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{l7}^E \\
& + 8Z_{j7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{i8+b}^{E,*} Z_{l7}^E + 8Z_{i7}^{E,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{j8+b}^{E,*} Z_{l7}^E \\
& - 8\lambda_{SR}^* Z_{j8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{l7}^E - 8\lambda_{SR}^* Z_{i8}^{E,*} \sum_{b=1}^2 \sum_{a=1}^2 Z_{j10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{l7}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{E,*} Y_{L,ab} Z_{k8+b}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{i8+c}^{E,*} Z_{l7}^E \\
& - 8 \sum_{b=1}^3 Z_{jb}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{i8+c}^{E,*} Z_{l7}^E \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ia}^{E,*} Y_{L,ab} Z_{k8+b}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{j8+c}^{E,*} Z_{l7}^E \\
& - 8 \sum_{b=1}^3 Z_{ib}^{E,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{j8+c}^{E,*} Z_{l7}^E + 4g_1^2 Z_{i7}^{E,*} Z_{j7}^{E,*} Z_{k7}^E Z_{l7}^E \\
& + 4g_2^2 Z_{i7}^{E,*} Z_{j7}^{E,*} Z_{k7}^E Z_{l7}^E - 2g_1^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k8}^E Z_{l7}^E - 2g_2^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k8}^E Z_{l7}^E \\
& + 8|\lambda_{SR}|^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k8}^E Z_{l7}^E + 4|\lambda_{TR}|^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k8}^E Z_{l7}^E - 2g_1^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k8}^E Z_{l7}^E \\
& - 2g_2^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k8}^E Z_{l7}^E + 8|\lambda_{SR}|^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k8}^E Z_{l7}^E + 4|\lambda_{TR}|^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k8}^E Z_{l7}^E \\
& + 4g_1^2 Z_{j8}^{E,*} \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E Z_{l8}^E + 4g_1^2 Z_{i8}^{E,*} \sum_{a=1}^2 Z_{j8+a}^{E,*} Z_{k8+a}^E Z_{l8}^E \\
& - 4g_1^2 Z_{j8}^{E,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E Z_{l8}^E - 4g_1^2 Z_{i8}^{E,*} \sum_{a=1}^2 Z_{j10+a}^{E,*} Z_{k10+a}^E Z_{l8}^E \\
& - 2g_1^2 Z_{j8}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l8}^E - 2g_2^2 Z_{j8}^{E,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l8}^E
\end{aligned}$$

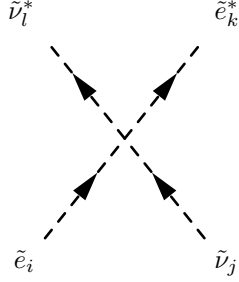
$$\begin{aligned}
& -2g_1^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{l8}^E - 2g_2^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{ja}^{E,*} Z_{ka}^E Z_{l8}^E \\
& + 4g_1^2 Z_{j8}^{E,*} \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E Z_{l8}^E + 4g_1^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{j3+a}^{E,*} Z_{k3+a}^E Z_{l8}^E \\
& - 8\lambda_{SR} Z_{j7}^{E,*} \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{l8}^E - 8\lambda_{SR} Z_{i7}^{E,*} \sum_{b=1}^2 Z_{j8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{l8}^E \\
& + 8Z_{j8}^{E,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{\widehat{Bar}E,a} \sum_{b=1}^2 Y_{\widehat{Bar}E,b}^* Z_{k10+b}^E Z_{l8}^E + 8Z_{i8}^{E,*} \sum_{a=1}^2 Z_{j10+a}^{E,*} Y_{\widehat{Bar}E,a} \sum_{b=1}^2 Y_{\widehat{Bar}E,b}^* Z_{k10+b}^E Z_{l8}^E \\
& - 2g_1^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k7}^E Z_{l8}^E - 2g_2^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k7}^E Z_{l8}^E + 8|\lambda_{SR}|^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k7}^E Z_{l8}^E \\
& + 4|\lambda_{TR}|^2 Z_{i8}^{E,*} Z_{j7}^{E,*} Z_{k7}^E Z_{l8}^E - 2g_1^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k7}^E Z_{l8}^E - 2g_2^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k7}^E Z_{l8}^E \\
& + 8|\lambda_{SR}|^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k7}^E Z_{l8}^E + 4|\lambda_{TR}|^2 Z_{i7}^{E,*} Z_{j8}^{E,*} Z_{k7}^E Z_{l8}^E + 4g_1^2 Z_{i8}^{E,*} Z_{j8}^{E,*} Z_{k8}^E Z_{l8}^E \\
& + 4g_2^2 Z_{i8}^{E,*} Z_{j8}^{E,*} Z_{k8}^E Z_{l8}^E
\end{aligned} \tag{512}$$



$$\begin{aligned}
& -\frac{i}{4} \delta_{\beta\gamma} \left( g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^V \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^D - 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^V \right. \\
& + 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^V \\
& - 4 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{d,ab} Z_{k3+a}^D \sum_{c=1}^2 Y_{\widehat{E},c}^* Z_{i8+c}^{E,*} Z_{l4}^V \\
& + 4 \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{\widehat{Bar}E,a} \sum_{c=1}^3 \sum_{b=1}^3 Y_{u,bc}^* Z_{j3+b}^{U,*} Z_{kc}^D Z_{l5}^V \\
& \left. + g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^D \left( 2Z_{i7}^{E,*} Z_{l4}^V + 2Z_{i8}^{E,*} Z_{l5}^V + \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^V \right) \right)
\end{aligned} \tag{513}$$

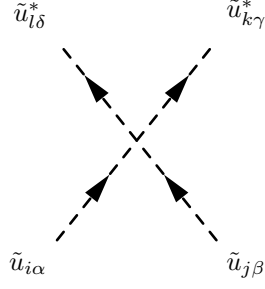


$$\begin{aligned}
& -\frac{i}{24}\delta_{\beta\delta}\left(2g_1^2\sum_{a=1}^2Z_{i8+a}^{E,*}Z_{k8+a}^E\sum_{b=1}^3Z_{jb}^{U,*}Z_{lb}^U-2g_1^2\sum_{a=1}^2Z_{i10+a}^{E,*}Z_{k10+a}^E\sum_{b=1}^3Z_{jb}^{U,*}Z_{lb}^U\right. \\
& -g_1^2\sum_{a=1}^3Z_{ia}^{E,*}Z_{ka}^E\sum_{b=1}^3Z_{jb}^{U,*}Z_{lb}^U-3g_2^2\sum_{a=1}^3Z_{ia}^{E,*}Z_{ka}^E\sum_{b=1}^3Z_{jb}^{U,*}Z_{lb}^U \\
& +2g_1^2\sum_{a=1}^3Z_{i3+a}^{E,*}Z_{k3+a}^E\sum_{b=1}^3Z_{jb}^{U,*}Z_{lb}^U-8g_1^2\sum_{a=1}^2Z_{i8+a}^{E,*}Z_{k8+a}^E\sum_{b=1}^3Z_{j3+b}^{U,*}Z_{l3+b}^U \\
& +8g_1^2\sum_{a=1}^2Z_{i10+a}^{E,*}Z_{k10+a}^E\sum_{b=1}^3Z_{j3+b}^{U,*}Z_{l3+b}^U+4g_1^2\sum_{a=1}^3Z_{ia}^{E,*}Z_{ka}^E\sum_{b=1}^3Z_{j3+b}^{U,*}Z_{l3+b}^U \\
& -8g_1^2\sum_{a=1}^3Z_{i3+a}^{E,*}Z_{k3+a}^E\sum_{b=1}^3Z_{j3+b}^{U,*}Z_{l3+b}^U+24Z_{i8}^{E,*}\sum_{b=1}^3Z_{jb}^{U,*}\sum_{a=1}^3Y_{u,ab}Z_{l3+a}^U\sum_{c=1}^2Y_{B\hat{a}rE,c}^*Z_{k10+c}^E \\
& +24\sum_{a=1}^2Z_{i10+a}^{E,*}Y_{B\hat{a}rE,a}\sum_{c=1}^3\sum_{b=1}^3Y_{u,bc}^*Z_{j3+b}^{U,*}Z_{lc}^UZ_{k8}^E \\
& +4g_1^2\sum_{a=1}^3Z_{j3+a}^{U,*}Z_{l3+a}^U\left(-2\sum_{b=1}^2Z_{i8+b}^{E,*}Z_{k8+b}^E+2\sum_{b=1}^2Z_{i10+b}^{E,*}Z_{k10+b}^E+\sum_{b=1}^3Z_{ib}^{E,*}Z_{kb}^E-2\sum_{b=1}^3Z_{i3+b}^{E,*}Z_{k3+b}^E+2Z_{i7}^{E,*}Z_{k7}^E\right. \\
& \left.-2Z_{i8}^{E,*}Z_{k8}^E\right) \\
& +\sum_{a=1}^3Z_{ja}^{U,*}Z_{la}^U\left(2g_1^2\sum_{b=1}^2Z_{i8+b}^{E,*}Z_{k8+b}^E-2g_1^2\sum_{b=1}^2Z_{i10+b}^{E,*}Z_{k10+b}^E-g_1^2\sum_{b=1}^3Z_{ib}^{E,*}Z_{kb}^E\right. \\
& \left.-3g_2^2\sum_{b=1}^3Z_{ib}^{E,*}Z_{kb}^E+2g_1^2\sum_{b=1}^3Z_{i3+b}^{E,*}Z_{k3+b}^E-2g_1^2Z_{i7}^{E,*}Z_{k7}^E-6g_2^2Z_{i7}^{E,*}Z_{k7}^E\right. \\
& \left.+2g_1^2Z_{i8}^{E,*}Z_{k8}^E+6g_2^2Z_{i8}^{E,*}Z_{k8}^E\right)
\end{aligned} \tag{514}$$



$$\begin{aligned}
& -\frac{i}{8} \left( 2g_2^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E \sum_{b=1}^3 Z_{ib}^{E,*} Z_{lb}^V - 2g_1^2 \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V \right. \\
& + 2g_1^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V + g_1^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V \\
& - g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V - 2g_1^2 \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V \\
& + 8Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^2 Z_{i8+c}^{E,*} \sum_{b=1}^3 Y_{L,bc}^* Z_{lb}^V \\
& - 8Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{c=1}^3 \sum_{b=1}^3 Y_{e,bc}^* Z_{i3+b}^{E,*} Z_{lc}^V \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^V \\
& - 8 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^2 Z_{i8+d}^{E,*} \sum_{c=1}^3 Y_{L,cd}^* Z_{lc}^V \\
& - 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^V \\
& + 8 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{d=1}^3 \sum_{c=1}^3 Y_{e,cd}^* Z_{i3+c}^{E,*} Z_{ld}^V \\
& + \sum_{a=1}^3 Z_{ja}^{V,*} Z_{la}^V \left( -2g_1^2 \sum_{b=1}^2 Z_{i8+b}^{E,*} Z_{k8+b}^E + 2g_1^2 \sum_{b=1}^2 Z_{i10+b}^{E,*} Z_{k10+b}^E + g_1^2 \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E \right. \\
& - g_2^2 \sum_{b=1}^3 Z_{ib}^{E,*} Z_{kb}^E - 2g_1^2 \sum_{b=1}^3 Z_{i3+b}^{E,*} Z_{k3+b}^E + 2g_1^2 Z_{i7}^{E,*} Z_{k7}^E - 2g_2^2 Z_{i7}^{E,*} Z_{k7}^E \\
& \left. - 2g_1^2 Z_{i8}^{E,*} Z_{k8}^E + 2g_2^2 Z_{i8}^{E,*} Z_{k8}^E \right)
\end{aligned}$$

$$\begin{aligned}
& + 2g_2^2 \sum_{a=1}^3 Z_{ia}^{E,*} Z_{la}^V \left( 2Z_{j4}^{V,*} Z_{k7}^E + 2Z_{j5}^{V,*} Z_{k8}^E + \sum_{b=1}^3 Z_{jb}^{V,*} Z_{kb}^E \right) \\
& - 4g_1^2 Z_{j4}^{V,*} \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E Z_{l4}^V + 4g_1^2 Z_{j4}^{V,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E Z_{l4}^V \\
& + 2g_1^2 Z_{j4}^{V,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l4}^V - 2g_2^2 Z_{j4}^{V,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l4}^V \\
& + 4g_2^2 Z_{i7}^{E,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{l4}^V - 4g_1^2 Z_{j4}^{V,*} \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E Z_{l4}^V \\
& + 8Z_{j4}^{V,*} \sum_{a=1}^2 Y_{\hat{E},a} Z_{k8+a}^E \sum_{b=1}^2 Y_{\hat{E},b}^* Z_{i8+b}^{E,*} Z_{l4}^V + 8\lambda_{SR}^* Z_{j5}^{V,*} \sum_{b=1}^2 \sum_{a=1}^2 Z_{i10+a}^{E,*} \lambda_{SE,ba} Z_{k8+b}^E Z_{l4}^V \\
& + 8 \sum_{b=1}^2 \sum_{a=1}^3 Z_{ja}^{V,*} Y_{L,ab} Z_{k8+b}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{i8+c}^{E,*} Z_{l4}^V \\
& - 8 \sum_{b=1}^3 Z_{jb}^{V,*} \sum_{a=1}^3 Y_{e,ab} Z_{k3+a}^E \sum_{c=1}^2 Y_{\hat{E},c}^* Z_{i8+c}^{E,*} Z_{l4}^V + 2g_1^2 Z_{i7}^{E,*} Z_{j4}^{V,*} Z_{k7}^E Z_{l4}^V \\
& + 2g_2^2 Z_{i7}^{E,*} Z_{j4}^{V,*} Z_{k7}^E Z_{l4}^V - 2g_1^2 Z_{i8}^{E,*} Z_{j4}^{V,*} Z_{k8}^E Z_{l4}^V + 2g_2^2 Z_{i8}^{E,*} Z_{j4}^{V,*} Z_{k8}^E Z_{l4}^V \\
& + 8|\lambda_{TR}|^2 Z_{i8}^{E,*} Z_{j4}^{V,*} Z_{k8}^E Z_{l4}^V + 4g_2^2 Z_{i7}^{E,*} Z_{j5}^{V,*} Z_{k8}^E Z_{l4}^V - 8|\lambda_{SR}|^2 Z_{i7}^{E,*} Z_{j5}^{V,*} Z_{k8}^E Z_{l4}^V \\
& + 4|\lambda_{TR}|^2 Z_{i7}^{E,*} Z_{j5}^{V,*} Z_{k8}^E Z_{l4}^V + 4g_1^2 Z_{j5}^{V,*} \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{k8+a}^E Z_{l5}^V \\
& - 4g_1^2 Z_{j5}^{V,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{k10+a}^E Z_{l5}^V - 2g_1^2 Z_{j5}^{V,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l5}^V \\
& + 2g_2^2 Z_{j5}^{V,*} \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ka}^E Z_{l5}^V + 4g_2^2 Z_{i8}^{E,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^E Z_{l5}^V \\
& + 4g_1^2 Z_{j5}^{V,*} \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{k3+a}^E Z_{l5}^V + 8\lambda_{SR} Z_{j4}^{V,*} \sum_{b=1}^2 Z_{i8+b}^{E,*} \sum_{a=1}^2 \lambda_{SE,ba}^* Z_{k10+a}^E Z_{l5}^V \\
& + 8Z_{j5}^{V,*} \sum_{a=1}^2 Z_{i10+a}^{E,*} Y_{\hat{B}arE,a} \sum_{b=1}^2 Y_{\hat{B}arE,b}^* Z_{k10+b}^E Z_{l5}^V + 4g_2^2 Z_{i8}^{E,*} Z_{j4}^{V,*} Z_{k7}^E Z_{l5}^V \\
& - 8|\lambda_{SR}|^2 Z_{i8}^{E,*} Z_{j4}^{V,*} Z_{k7}^E Z_{l5}^V + 4|\lambda_{TR}|^2 Z_{i8}^{E,*} Z_{j4}^{V,*} Z_{k7}^E Z_{l5}^V - 2g_1^2 Z_{i7}^{E,*} Z_{j5}^{V,*} Z_{k7}^E Z_{l5}^V \\
& + 2g_2^2 Z_{i7}^{E,*} Z_{j5}^{V,*} Z_{k7}^E Z_{l5}^V + 8|\lambda_{TR}|^2 Z_{i7}^{E,*} Z_{j5}^{V,*} Z_{k7}^E Z_{l5}^V + 2g_1^2 Z_{i8}^{E,*} Z_{j5}^{V,*} Z_{k8}^E Z_{l5}^V \\
& + 2g_2^2 Z_{i8}^{E,*} Z_{j5}^{V,*} Z_{k8}^E Z_{l5}^V \Big) \tag{515}
\end{aligned}$$



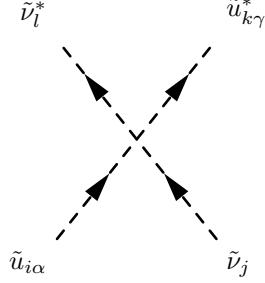
$$\begin{aligned}
& -\frac{i}{72} \left( \delta_{\alpha\delta} \delta_{\beta\gamma} \left( g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \right. \right. \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( - \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\
& + 16g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\
& + g_1^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U + 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U + 16g_1^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U
\end{aligned}$$



$$\begin{aligned}
& -6g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 72 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd}^* Z_{j3+c}^{U,*} Z_{kd}^U \\
& + 72 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd}^* Z_{i3+c}^{U,*} Z_{ld}^U \\
& + \delta_{\alpha\gamma} \delta_{\beta\delta} \left( 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U - 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{kb}^U \right. \\
& + \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{l3+a}^U \left( 2 \left( -3g_3^2 + 8g_1^2 \right) \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \left( -4g_1^2 + 6g_3^2 \right) \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& + \sum_{a=1}^3 Z_{ja}^{U,*} Z_{la}^U \left( 2 \left( -2g_1^2 + 3g_3^2 \right) \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U + \left( -6g_3^2 + 9g_2^2 + g_1^2 \right) \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U \right) \\
& - 18g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{la}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U + 18g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{l3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{k3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U - 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{ib}^{U,*} Z_{lb}^U \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U + 9g_2^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{jb}^{U,*} Z_{lb}^U - 18g_3^2 \sum_{a=1}^3 Z_{ja}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U \\
& + 18g_3^2 \sum_{a=1}^3 Z_{j3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{l3+b}^U - 4g_1^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& + 6g_3^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U + 16g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U \\
& - 6g_3^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \sum_{b=1}^3 Z_{j3+b}^{U,*} Z_{l3+b}^U
\end{aligned}$$

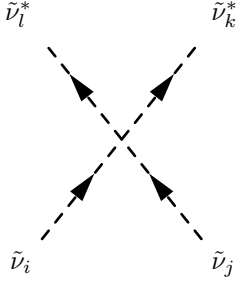
$$\begin{aligned}
& + 72 \sum_{b=1}^3 Z_{jb}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{l3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd} Z_{i3+c}^{U,*} Z_{kd}^U \\
& + 72 \sum_{b=1}^3 Z_{ib}^{U,*} \sum_{a=1}^3 Y_{u,ab} Z_{k3+a}^U \sum_{d=1}^3 \sum_{c=1}^3 Y_{u,cd} Z_{j3+c}^{U,*} Z_{ld}^U
\end{aligned} \tag{516}$$


---



$$\begin{aligned}
& \frac{i}{24} \delta_{\alpha\gamma} \left( \sum_{a=1}^3 Z_{ja}^{V,*} Z_{la}^V \left( (-3g_2^2 + g_1^2) \sum_{b=1}^3 Z_{ib}^{U,*} Z_{kb}^U - 4g_1^2 \sum_{b=1}^3 Z_{i3+b}^{U,*} Z_{k3+b}^U \right) \right. \\
& \left. + \left( (-3g_2^2 + g_1^2) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ka}^U - 4g_1^2 \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{k3+a}^U \right) \left( 2Z_{j4}^{V,*} Z_{l4}^V - 2Z_{j5}^{V,*} Z_{l5}^V + \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V \right) \right)
\end{aligned} \tag{517}$$

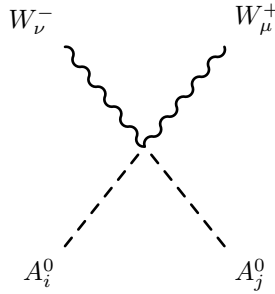

---



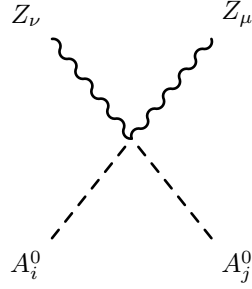
$$\begin{aligned}
& - \frac{i}{8} \left( g_1^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V \sum_{b=1}^3 Z_{ib}^{V,*} Z_{lb}^V + g_2^2 \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V \sum_{b=1}^3 Z_{ib}^{V,*} Z_{lb}^V \right. \\
& + g_1^2 \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ka}^V \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V + g_2^2 \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ka}^V \sum_{b=1}^3 Z_{jb}^{V,*} Z_{lb}^V \\
& \left. + (g_1^2 + g_2^2) \sum_{a=1}^3 Z_{ja}^{V,*} Z_{la}^V \left( 2Z_{i4}^{V,*} Z_{k4}^V - 2Z_{i5}^{V,*} Z_{k5}^V + \sum_{b=1}^3 Z_{ib}^{V,*} Z_{kb}^V \right) \right)
\end{aligned}$$

$$\begin{aligned}
& + \left( g_1^2 + g_2^2 \right) \sum_{a=1}^3 Z_{ia}^{V,*} Z_{la}^V \left( 2Z_{j4}^{V,*} Z_{k4}^V - 2Z_{j5}^{V,*} Z_{k5}^V + \sum_{b=1}^3 Z_{jb}^{V,*} Z_{kb}^V \right) \\
& + 2g_1^2 Z_{j4}^{V,*} \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ka}^V Z_{l4}^V + 2g_2^2 Z_{j4}^{V,*} \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ka}^V Z_{l4}^V \\
& + 2g_1^2 Z_{i4}^{V,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V Z_{l4}^V + 2g_2^2 Z_{i4}^{V,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V Z_{l4}^V \\
& + 4g_1^2 Z_{i4}^{V,*} Z_{j4}^{V,*} Z_{k4}^V Z_{l4}^V + 4g_2^2 Z_{i4}^{V,*} Z_{j4}^{V,*} Z_{k4}^V Z_{l4}^V - 2g_1^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k5}^V Z_{l4}^V \\
& - 2g_2^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k5}^V Z_{l4}^V + 8|\lambda_{SR}|^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k5}^V Z_{l4}^V + 4|\lambda_{TR}|^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k5}^V Z_{l4}^V \\
& - 2g_1^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k5}^V Z_{l4}^V - 2g_2^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k5}^V Z_{l4}^V + 8|\lambda_{SR}|^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k5}^V Z_{l4}^V \\
& + 4|\lambda_{TR}|^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k5}^V Z_{l4}^V - 2g_1^2 Z_{j5}^{V,*} \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ka}^V Z_{l5}^V \\
& - 2g_2^2 Z_{j5}^{V,*} \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ka}^V Z_{l5}^V - 2g_1^2 Z_{i5}^{V,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V Z_{l5}^V \\
& - 2g_2^2 Z_{i5}^{V,*} \sum_{a=1}^3 Z_{ja}^{V,*} Z_{ka}^V Z_{l5}^V - 2g_1^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k4}^V Z_{l5}^V - 2g_2^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k4}^V Z_{l5}^V \\
& + 8|\lambda_{SR}|^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k4}^V Z_{l5}^V + 4|\lambda_{TR}|^2 Z_{i5}^{V,*} Z_{j4}^{V,*} Z_{k4}^V Z_{l5}^V - 2g_1^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k4}^V Z_{l5}^V \\
& - 2g_2^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k4}^V Z_{l5}^V + 8|\lambda_{SR}|^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k4}^V Z_{l5}^V + 4|\lambda_{TR}|^2 Z_{i4}^{V,*} Z_{j5}^{V,*} Z_{k4}^V Z_{l5}^V \\
& + 4g_1^2 Z_{i5}^{V,*} Z_{j5}^{V,*} Z_{k5}^V Z_{l5}^V + 4g_2^2 Z_{i5}^{V,*} Z_{j5}^{V,*} Z_{k5}^V Z_{l5}^V \tag{518}
\end{aligned}$$

## 9.8 Two Scalar-Two Vector Boson-Interaction

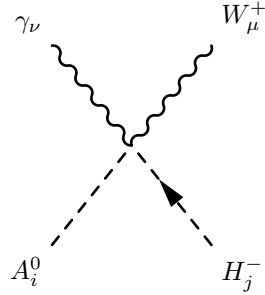


$$\frac{i}{2} g_2^2 \left( 4Z_{i4}^A Z_{j4}^A + Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) \left( g_{\mu\nu} \right) \tag{519}$$



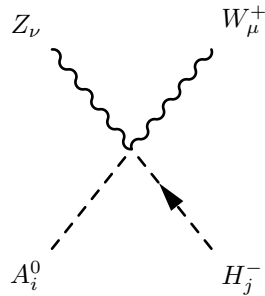
$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \left( Z_{i1}^A Z_{j1}^A + Z_{i2}^A Z_{j2}^A \right) \left( g_{\mu\nu} \right) \quad (520)$$


---



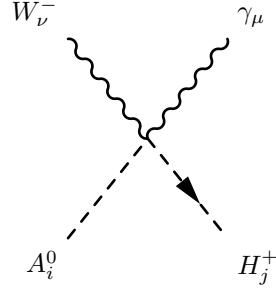
$$-\frac{1}{2} g_2 \left( g_1 \cos \Theta_W Z_{i1}^A Z_{j1}^+ + g_1 \cos \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2} g_2 \sin \Theta_W Z_{i4}^A \left( -Z_{j4}^+ + Z_{j3}^+ \right) \right) \left( g_{\mu\nu} \right) \quad (521)$$


---



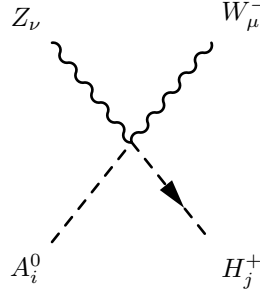
$$\frac{1}{2} g_2 \left( g_1 \sin \Theta_W Z_{i1}^A Z_{j1}^+ + g_1 \sin \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2} g_2 \cos \Theta_W Z_{i4}^A \left( -Z_{j3}^+ + Z_{j4}^+ \right) \right) \left( g_{\mu\nu} \right) \quad (522)$$


---



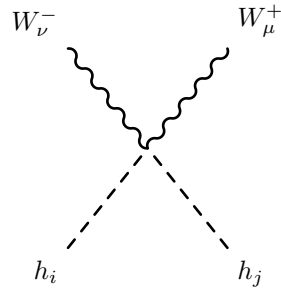
$$\frac{1}{2}g_2 \left( g_1 \cos \Theta_W Z_{i1}^A Z_{j1}^+ + g_1 \cos \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2}g_2 \sin \Theta_W Z_{i4}^A (-Z_{j4}^+ + Z_{j3}^+) \right) (g_{\mu\nu}) \quad (523)$$


---



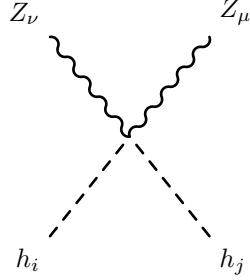
$$\frac{1}{2}g_2 \left( -g_1 \sin \Theta_W Z_{i1}^A Z_{j1}^+ - g_1 \sin \Theta_W Z_{i2}^A Z_{j2}^+ + \sqrt{2}g_2 \cos \Theta_W Z_{i4}^A (-Z_{j4}^+ + Z_{j3}^+) \right) (g_{\mu\nu}) \quad (524)$$


---



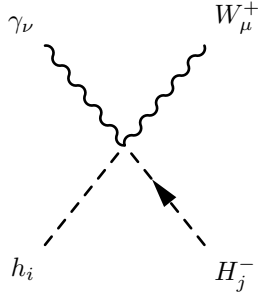
$$\frac{i}{2}g_2^2 \left( 4Z_{i4}^H Z_{j4}^H + Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) (g_{\mu\nu}) \quad (525)$$


---



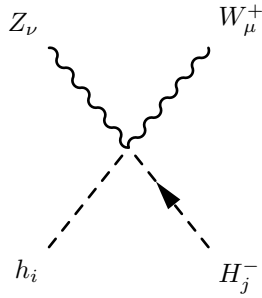
$$\frac{i}{2} \left( g_1 \sin \Theta_W + g_2 \cos \Theta_W \right)^2 \left( Z_{i1}^H Z_{j1}^H + Z_{i2}^H Z_{j2}^H \right) \left( g_{\mu\nu} \right) \quad (526)$$


---



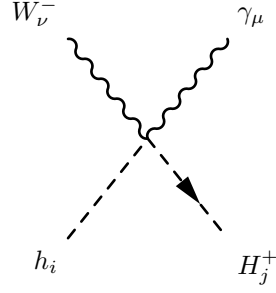
$$-\frac{i}{2} g_2 \left( g_1 \cos \Theta_W Z_{i1}^H Z_{j1}^+ - g_1 \cos \Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2} g_2 \sin \Theta_W Z_{i4}^H \left( Z_{j3}^+ + Z_{j4}^+ \right) \right) \left( g_{\mu\nu} \right) \quad (527)$$


---



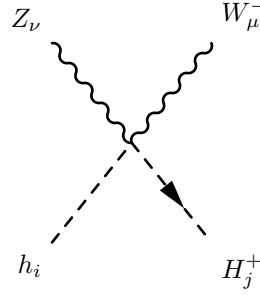
$$-\frac{i}{2} g_2 \left( -g_1 \sin \Theta_W Z_{i1}^H Z_{j1}^+ + g_1 \sin \Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2} g_2 \cos \Theta_W Z_{i4}^H \left( Z_{j3}^+ + Z_{j4}^+ \right) \right) \left( g_{\mu\nu} \right) \quad (528)$$


---



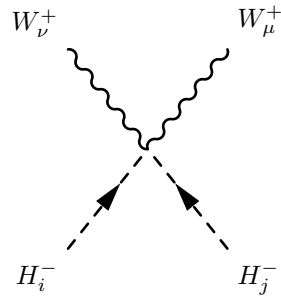
$$-\frac{i}{2}g_2\left(g_1\cos\Theta_W Z_{i1}^H Z_{j1}^+ - g_1\cos\Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2}g_2\sin\Theta_W Z_{i4}^H\left(Z_{j3}^+ + Z_{j4}^+\right)\right)\left(g_{\mu\nu}\right) \quad (529)$$


---



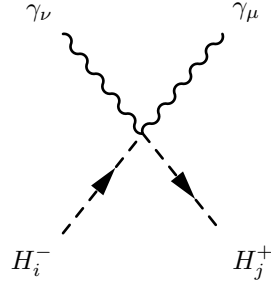
$$-\frac{i}{2}g_2\left(-g_1\sin\Theta_W Z_{i1}^H Z_{j1}^+ + g_1\sin\Theta_W Z_{i2}^H Z_{j2}^+ + \sqrt{2}g_2\cos\Theta_W Z_{i4}^H\left(Z_{j3}^+ + Z_{j4}^+\right)\right)\left(g_{\mu\nu}\right) \quad (530)$$


---



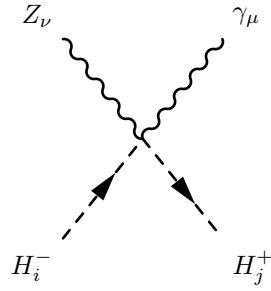
$$-2ig_2^2\left(Z_{i3}^+ Z_{j4}^+ + Z_{i4}^+ Z_{j3}^+\right)\left(g_{\mu\nu}\right) \quad (531)$$


---



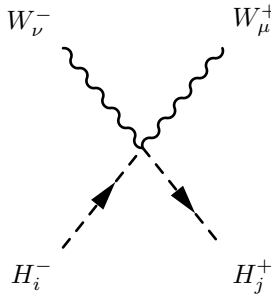
$$\begin{aligned} & \frac{i}{2} \left( (g_1 \cos \Theta_W + g_2 \sin \Theta_W)^2 Z_{i1}^+ Z_{j1}^+ + (g_1 \cos \Theta_W + g_2 \sin \Theta_W)^2 Z_{i2}^+ Z_{j2}^+ \right. \\ & \left. + 4g_2^2 \sin^2 \Theta_W (Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+) \right) (g_{\mu\nu}) \end{aligned} \quad (532)$$


---



$$\begin{aligned} & -\frac{i}{4} \left( (-2g_1 g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W) Z_{i1}^+ Z_{j1}^+ \right. \\ & \left. + (-2g_1 g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W) Z_{i2}^+ Z_{j2}^+ \right. \\ & \left. - 4g_2^2 \sin 2\Theta_W (Z_{i3}^+ Z_{j3}^+ + Z_{i4}^+ Z_{j4}^+) \right) (g_{\mu\nu}) \end{aligned} \quad (533)$$

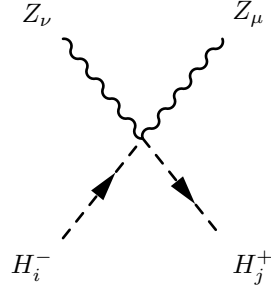

---





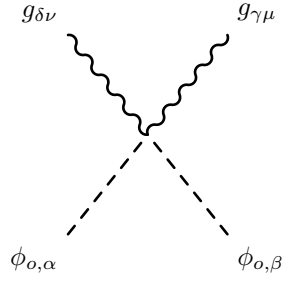
$$\frac{i}{2}g_2^2\left(2Z_{i3}^+Z_{j3}^+ + 2Z_{i4}^+Z_{j4}^+ + Z_{i1}^+Z_{j1}^+ + Z_{i2}^+Z_{j2}^+\right)(g_{\mu\nu}) \quad (534)$$


---



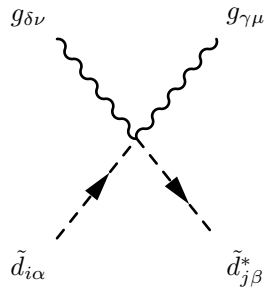
$$\frac{i}{2}\left(\left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W\right)^2 Z_{i1}^+Z_{j1}^+ + \left(-g_1 \sin \Theta_W + g_2 \cos \Theta_W\right)^2 Z_{i2}^+Z_{j2}^+ + 4g_2^2 \cos^2 \Theta_W \left(Z_{i3}^+Z_{j3}^+ + Z_{i4}^+Z_{j4}^+\right)\right)(g_{\mu\nu}) \quad (535)$$


---



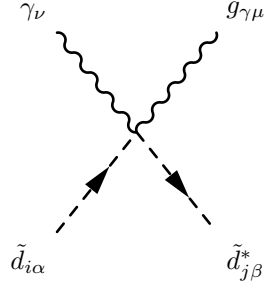
$$ig_3^2\left(\sum_{a=1}^8 f_{\alpha,\delta,a}f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a}f_{\beta,\delta,a}\right)(g_{\mu\nu}) \quad (536)$$


---



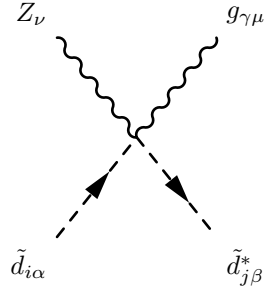
$$\frac{i}{4} g_3^2 \delta_{ij} \left( \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta + \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta \right) (g_{\mu\nu}) \quad (537)$$


---



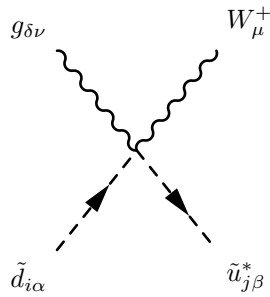
$$\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( -2g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D + \left( -3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D \right) (g_{\mu\nu}) \quad (538)$$


---



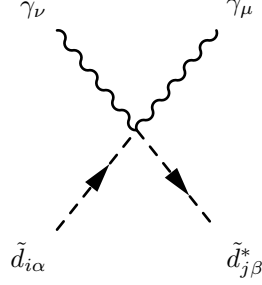
$$-\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( -2g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D + \left( 3g_2 \cos \Theta_W + g_1 \sin \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D \right) (g_{\mu\nu}) \quad (539)$$


---



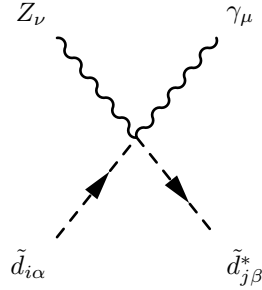
$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda_{\beta, \alpha}^{\delta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U (g_{\mu\nu}) \quad (540)$$


---



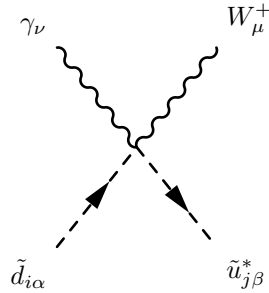
$$\frac{i}{18} \delta_{\alpha\beta} \left( \left( -3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (541)$$


---



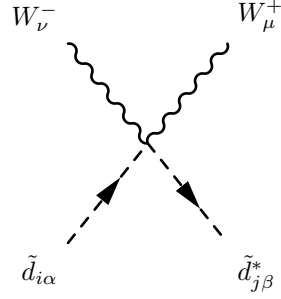
$$- \frac{i}{36} \delta_{\alpha\beta} \left( \left( 6g_1 g_2 \cos 2\Theta_W + \left( -9g_2^2 + g_1^2 \right) \sin 2\Theta_W \right) \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (542)$$


---



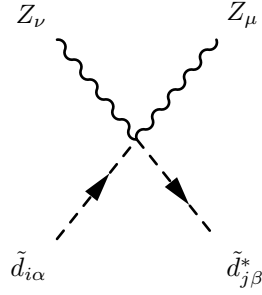
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^U (g_{\mu\nu}) \quad (543)$$


---



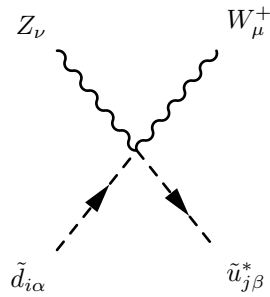
$$\frac{i}{2} g_2^2 \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D (g_{\mu\nu}) \quad (544)$$


---

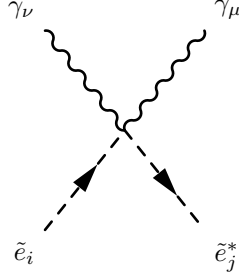


$$\frac{i}{18} \delta_{\alpha\beta} \left( (3g_2 \cos \Theta_W + g_1 \sin \Theta_W)^2 \sum_{a=1}^3 Z_{ia}^{D,*} Z_{ja}^D + 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{D,*} Z_{j3+a}^D \right) (g_{\mu\nu}) \quad (545)$$

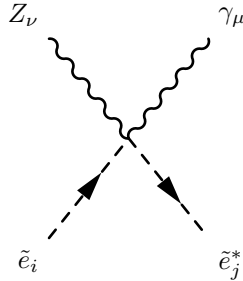

---



$$-\frac{i}{3}\frac{1}{\sqrt{2}}g_1g_2\delta_{\alpha\beta}\sin\Theta_W\sum_{a=1}^3Z_{ia}^{D,*}Z_{ja}^U(g_{\mu\nu}) \quad (546)$$



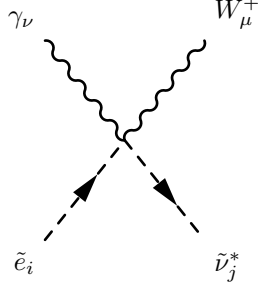
$$\begin{aligned} & \frac{i}{2}\left(4g_1^2\cos^2\Theta_W\sum_{a=1}^2Z_{i8+a}^{E,*}Z_{j8+a}^E+4g_1^2\cos^2\Theta_W\sum_{a=1}^2Z_{i10+a}^{E,*}Z_{j10+a}^E\right. \\ & +g_1^2\cos^2\Theta_W\sum_{a=1}^3Z_{ia}^{E,*}Z_{ja}^E+g_2^2\sin^2\Theta_W\sum_{a=1}^3Z_{ia}^{E,*}Z_{ja}^E \\ & +g_1g_2\sin 2\Theta_W\sum_{a=1}^3Z_{ia}^{E,*}Z_{ja}^E+4g_1^2\cos^2\Theta_W\sum_{a=1}^3Z_{i3+a}^{E,*}Z_{j3+a}^E \\ & +g_1^2Z_{i7}^{E,*}\cos^2\Theta_W Z_{j7}^E+g_2^2Z_{i7}^{E,*}\sin^2\Theta_W Z_{j7}^E+g_1g_2Z_{i7}^{E,*}\sin 2\Theta_W Z_{j7}^E \\ & \left.+g_1^2Z_{i8}^{E,*}\cos^2\Theta_W Z_{j8}^E+g_2^2Z_{i8}^{E,*}\sin^2\Theta_W Z_{j8}^E+g_1g_2Z_{i8}^{E,*}\sin 2\Theta_W Z_{j8}^E\right)(g_{\mu\nu}) \quad (547) \end{aligned}$$



$$\begin{aligned} & -\frac{i}{4}\left(4g_1^2\sin 2\Theta_W\sum_{a=1}^2Z_{i8+a}^{E,*}Z_{j8+a}^E+4g_1^2\sin 2\Theta_W\sum_{a=1}^2Z_{i10+a}^{E,*}Z_{j10+a}^E\right. \\ & \left.-2g_1g_2\cos 2\Theta_W\sum_{a=1}^3Z_{ia}^{E,*}Z_{ja}^E+g_1^2\sin 2\Theta_W\sum_{a=1}^3Z_{ia}^{E,*}Z_{ja}^E\right) \end{aligned}$$

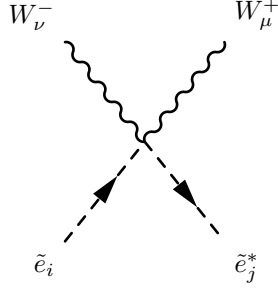
$$\begin{aligned}
& -g_2^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + 4g_1^2 \sin 2\Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E \\
& - 2g_1 g_2 Z_{i7}^{E,*} \cos 2\Theta_W Z_{j7}^E + g_1^2 Z_{i7}^{E,*} \sin 2\Theta_W Z_{j7}^E - g_2^2 Z_{i7}^{E,*} \sin 2\Theta_W Z_{j7}^E \\
& - 2g_1 g_2 Z_{i8}^{E,*} \cos 2\Theta_W Z_{j8}^E + g_1^2 Z_{i8}^{E,*} \sin 2\Theta_W Z_{j8}^E - g_2^2 Z_{i8}^{E,*} \sin 2\Theta_W Z_{j8}^E \Big( g_{\mu\nu} \Big)
\end{aligned} \tag{548}$$


---



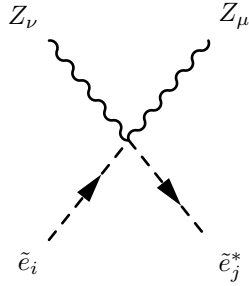
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \left( Z_{i7}^{E,*} Z_{j4}^V - Z_{i8}^{E,*} Z_{j5}^V + \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^V \right) \Big( g_{\mu\nu} \Big) \tag{549}$$


---



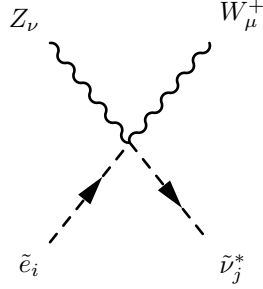
$$\frac{i}{2} g_2^2 \left( Z_{i7}^{E,*} Z_{j7}^E + Z_{i8}^{E,*} Z_{j8}^E + \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \right) \Big( g_{\mu\nu} \Big) \tag{550}$$


---



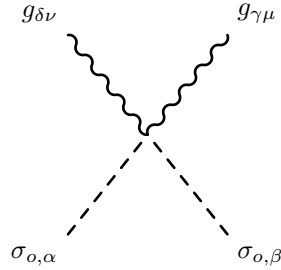
$$\begin{aligned}
& \frac{i}{2} \left( 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^2 Z_{i8+a}^{E,*} Z_{j8+a}^E + 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^2 Z_{i10+a}^{E,*} Z_{j10+a}^E \right. \\
& + g_2^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E - 2g_1 g_2 \cos \Theta_W \sin \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E \\
& + g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^E + 4g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{E,*} Z_{j3+a}^E \\
& + g_2^2 Z_{i7}^{E,*} \cos^2 \Theta_W Z_{j7}^E - 2g_1 g_2 Z_{i7}^{E,*} \cos \Theta_W \sin \Theta_W Z_{j7}^E \\
& + g_1^2 Z_{i7}^{E,*} \sin^2 \Theta_W Z_{j7}^E + g_2^2 Z_{i8}^{E,*} \cos^2 \Theta_W Z_{j8}^E \\
& \left. - 2g_1 g_2 Z_{i8}^{E,*} \cos \Theta_W \sin \Theta_W Z_{j8}^E + g_1^2 Z_{i8}^{E,*} \sin^2 \Theta_W Z_{j8}^E \right) (g_{\mu\nu})
\end{aligned} \tag{551}$$


---



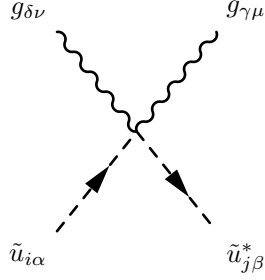
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W \left( Z_{i7}^{E,*} Z_{j4}^V - Z_{i8}^{E,*} Z_{j5}^V + \sum_{a=1}^3 Z_{ia}^{E,*} Z_{ja}^V \right) (g_{\mu\nu}) \tag{552}$$


---



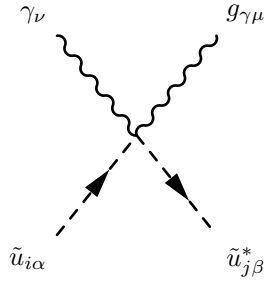
$$i g_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\mu\nu}) \tag{553}$$


---



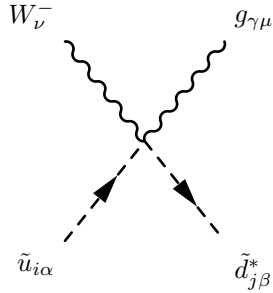
$$\frac{i}{4} g_3^2 \delta_{ij} \left( \sum_{a=1}^3 \lambda_{a,\alpha}^\gamma \lambda_{\beta,a}^\delta + \sum_{a=1}^3 \lambda_{\beta,a}^\gamma \lambda_{a,\alpha}^\delta \right) (g_{\mu\nu}) \quad (554)$$


---



$$\frac{i}{6} g_3 \lambda_{\beta,\alpha}^\gamma \left( (3g_2 \sin \Theta_W + g_1 \cos \Theta_W) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U + 4g_1 \cos \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (555)$$

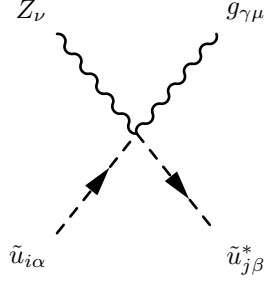

---



$$i \frac{1}{\sqrt{2}} g_2 g_3 \lambda_{\beta,\alpha}^\gamma \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (556)$$

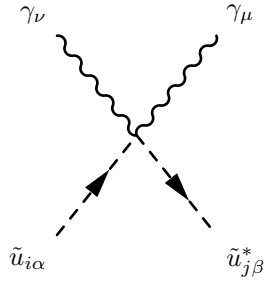

---





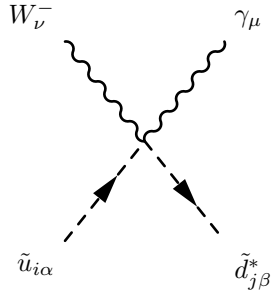
$$\frac{i}{6} g_3 \lambda_{\beta, \alpha}^{\gamma} \left( \left( 3g_2 \cos \Theta_W - g_1 \sin \Theta_W \right) \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U - 4g_1 \sin \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U \right) (g_{\mu\nu}) \quad (557)$$


---



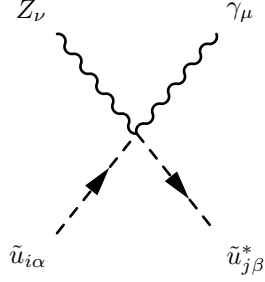
$$\frac{i}{18} \delta_{\alpha\beta} \left( 16g_1^2 \cos^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U + \left( 3g_2 \sin \Theta_W + g_1 \cos \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right) (g_{\mu\nu}) \quad (558)$$


---



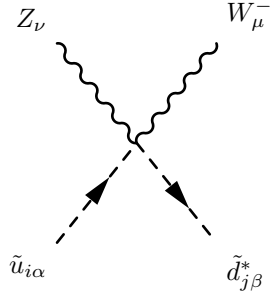
$$\frac{i}{3} \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \delta_{\alpha\beta} \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^D (g_{\mu\nu}) \quad (559)$$


---



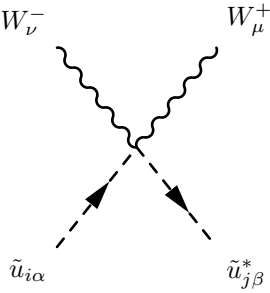
$$\begin{aligned}
& -\frac{i}{36}\delta_{\alpha\beta}\left(\left(-6g_1g_2\cos 2\Theta_W + \left(-9g_2^2 + g_1^2\right)\sin 2\Theta_W\right)\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^U\right. \\
& \left.+ 16g_1^2\sin 2\Theta_W\sum_{a=1}^3Z_{i3+a}^{U,*}Z_{j3+a}^U\right)(g_{\mu\nu})
\end{aligned} \tag{560}$$


---



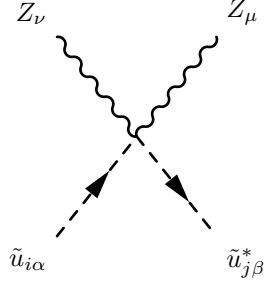
$$-\frac{i}{3}\frac{1}{\sqrt{2}}g_1g_2\delta_{\alpha\beta}\sin\Theta_W\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^D(g_{\mu\nu}) \tag{561}$$


---



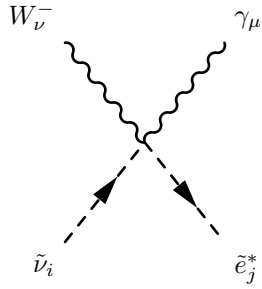
$$\frac{i}{2}g_2^2\delta_{\alpha\beta}\sum_{a=1}^3Z_{ia}^{U,*}Z_{ja}^U(g_{\mu\nu}) \tag{562}$$


---



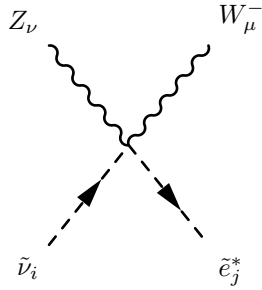
$$\frac{i}{18} \delta_{\alpha\beta} \left( 16g_1^2 \sin^2 \Theta_W \sum_{a=1}^3 Z_{i3+a}^{U,*} Z_{j3+a}^U + \left( -3g_2 \cos \Theta_W + g_1 \sin \Theta_W \right)^2 \sum_{a=1}^3 Z_{ia}^{U,*} Z_{ja}^U \right) (g_{\mu\nu}) \quad (563)$$


---



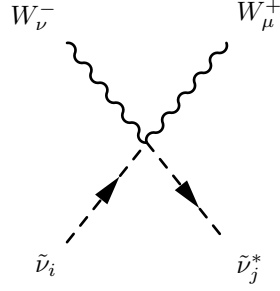
$$-i \frac{1}{\sqrt{2}} g_1 g_2 \cos \Theta_W \left( Z_{i4}^{V,*} Z_{j7}^E - Z_{i5}^{V,*} Z_{j8}^E + \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ja}^E \right) (g_{\mu\nu}) \quad (564)$$


---



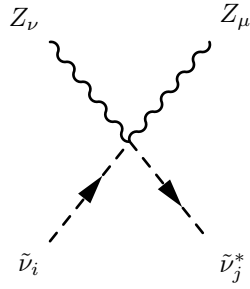
$$i \frac{1}{\sqrt{2}} g_1 g_2 \sin \Theta_W \left( Z_{i4}^{V,*} Z_{j7}^E - Z_{i5}^{V,*} Z_{j8}^E + \sum_{a=1}^3 Z_{ia}^{V,*} Z_{ja}^E \right) (g_{\mu\nu}) \quad (565)$$


---



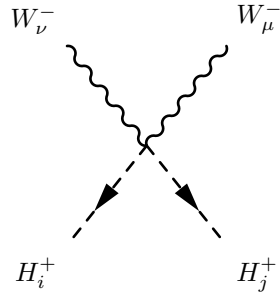
$$\frac{i}{2}g_2^2\left(Z_{i4}^{V,*}Z_{j4}^V+Z_{i5}^{V,*}Z_{j5}^V+\sum_{a=1}^3Z_{ia}^{V,*}Z_{ja}^V\right)(g_{\mu\nu}) \quad (566)$$


---



$$\frac{i}{2}\left(g_1\sin\Theta_W+g_2\cos\Theta_W\right)^2\left(Z_{i4}^{V,*}Z_{j4}^V+Z_{i5}^{V,*}Z_{j5}^V+\sum_{a=1}^3Z_{ia}^{V,*}Z_{ja}^V\right)(g_{\mu\nu}) \quad (567)$$

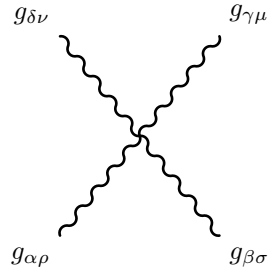

---



$$-2ig_2^2\left(Z_{i3}^+Z_{j4}^++Z_{i4}^+Z_{j3}^+\right)(g_{\mu\nu}) \quad (568)$$


---

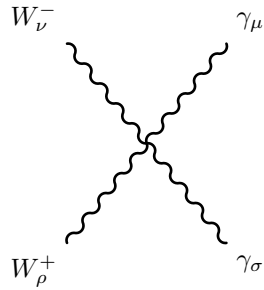
## 9.9 Four Vector Boson-Interaction



$$-ig_3^2 \left( \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} + \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} \right) (g_{\rho\sigma} g_{\mu\nu}) \quad (569)$$

$$+ ig_3^2 \left( - \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} + \sum_{a=1}^8 f_{\alpha,\delta,a} f_{\beta,\gamma,a} \right) (g_{\rho\mu} g_{\sigma\nu}) \quad (570)$$

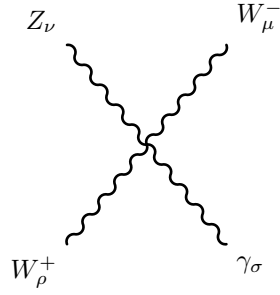
$$+ ig_3^2 \left( \sum_{a=1}^8 f_{\alpha,\gamma,a} f_{\beta,\delta,a} + \sum_{a=1}^8 f_{\alpha,\beta,a} f_{\gamma,\delta,a} \right) (g_{\rho\nu} g_{\sigma\mu}) \quad (571)$$



$$ig_2^2 \sin^2 \Theta_W (g_{\rho\sigma} g_{\mu\nu}) \quad (572)$$

$$+ ig_2^2 \sin^2 \Theta_W (g_{\rho\mu} g_{\sigma\nu}) \quad (573)$$

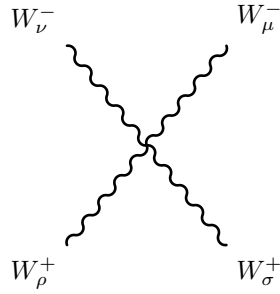
$$+ -2ig_2^2 \sin^2 \Theta_W (g_{\rho\nu} g_{\sigma\mu}) \quad (574)$$



$$ig_2^2 \cos \Theta_W \sin \Theta_W (g_{\rho\sigma} g_{\mu\nu}) \quad (575)$$

$$+ -ig_2^2 \sin 2\Theta_W (g_{\rho\mu} g_{\sigma\nu}) \quad (576)$$

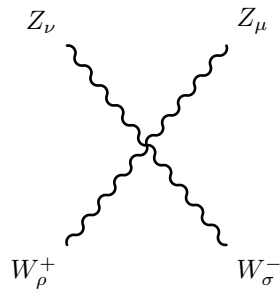
$$+ ig_2^2 \cos \Theta_W \sin \Theta_W (g_{\rho\nu} g_{\sigma\mu}) \quad (577)$$



$$2ig_2^2 (g_{\rho\sigma} g_{\mu\nu}) \quad (578)$$

$$+ -ig_2^2 (g_{\rho\mu} g_{\sigma\nu}) \quad (579)$$

$$+ -ig_2^2 (g_{\rho\nu} g_{\sigma\mu}) \quad (580)$$

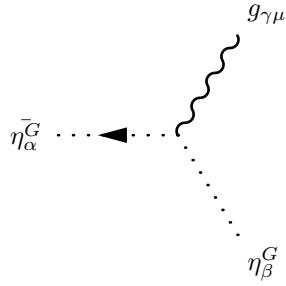


$$- 2ig_2^2 \cos^2 \Theta_W^2 (g_{\rho\sigma} g_{\mu\nu}) \quad (581)$$

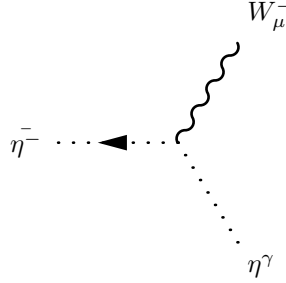
$$+ ig_2^2 \cos^2 \Theta_W^2 (g_{\rho\mu} g_{\sigma\nu}) \quad (582)$$

$$+ ig_2^2 \cos^2 \Theta_W^2 (g_{\rho\nu} g_{\sigma\mu}) \quad (583)$$

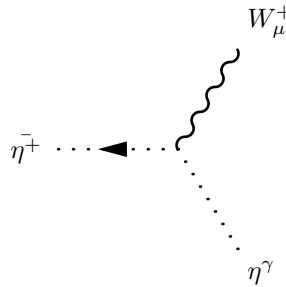
### 9.10 Two Ghosts-One Vector Boson-Interaction



$$g_3 f_{\alpha,\beta,\gamma} (p_\mu^{\eta_\beta^G}) \quad (584)$$

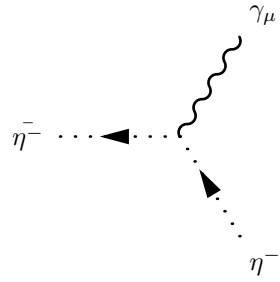


$$ig_2 \sin \Theta_W (p_\mu^{\eta^\gamma}) \quad (585)$$



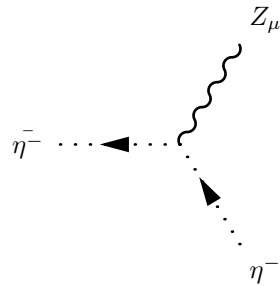
$$-ig_2 \sin \Theta_W (p_\mu^{\eta^\gamma}) \quad (586)$$


---



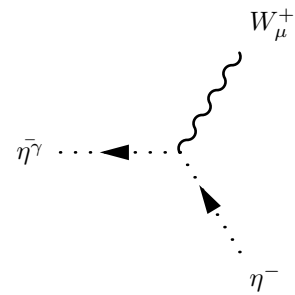
$$-ig_2 \sin \Theta_W (p_\mu^{\eta^-}) \quad (587)$$


---



$$-ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \quad (588)$$

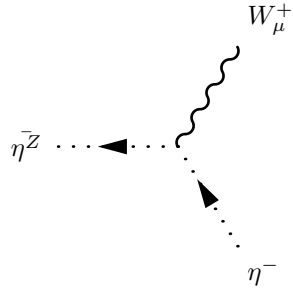

---



$$ig_2 \sin \Theta_W (p_\mu^{\eta^-}) \quad (589)$$

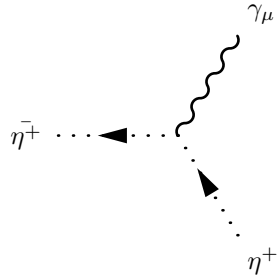

---





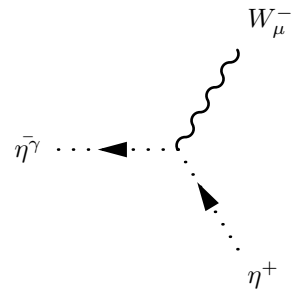
---


$$ig_2 \cos \Theta_W (p_\mu^{\eta^-}) \tag{590}$$



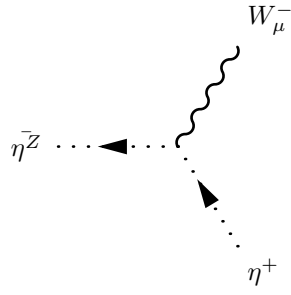
---


$$ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \tag{591}$$



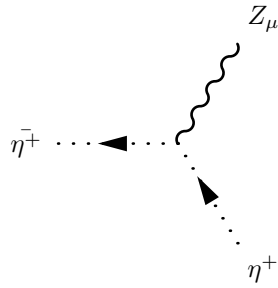
---


$$-ig_2 \sin \Theta_W (p_\mu^{\eta^+}) \tag{592}$$



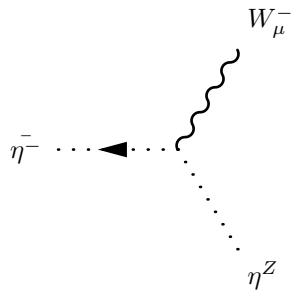
$$-ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (593)$$


---



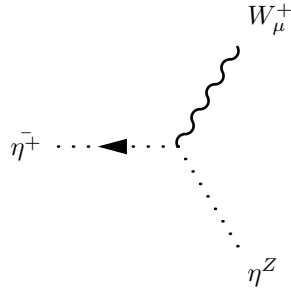
$$ig_2 \cos \Theta_W (p_\mu^{\eta^+}) \quad (594)$$


---



$$ig_2 \cos \Theta_W (p_\mu^{\eta^Z}) \quad (595)$$

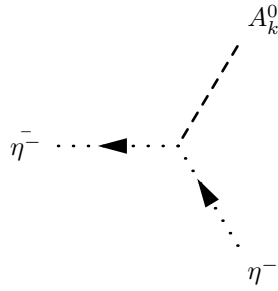

---



$$-ig_2 \cos \Theta_W (p_\mu^{\eta^0}) \quad (596)$$

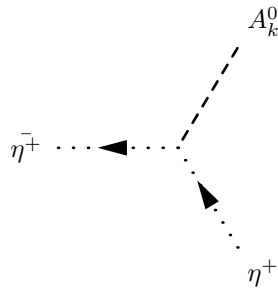

---

### 9.11 Two Ghosts-One Scalar-Interaction



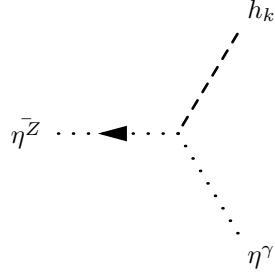
$$\frac{1}{4} g_2^2 \xi_{W^-} (v_d Z_{k1}^A - v_u Z_{k2}^A) \quad (597)$$


---



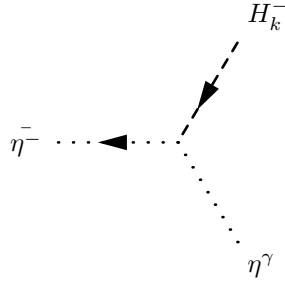
$$\frac{1}{4} g_2^2 \xi_{W^-} (-v_d Z_{k1}^A + v_u Z_{k2}^A) \quad (598)$$


---



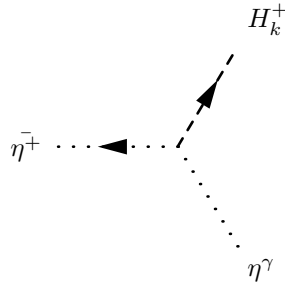
$$\frac{i}{8}\xi_Z \left( 2g_1g_2 \cos 2\Theta_W + (-g_2^2 + g_1^2) \sin 2\Theta_W \right) (v_d Z_{k1}^H + v_u Z_{k2}^H) \quad (599)$$


---



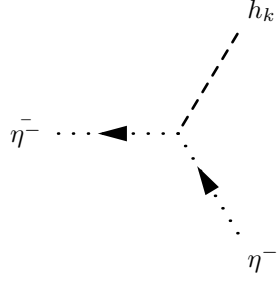
$$\begin{aligned} & \frac{i}{4}g_2\xi_{W^-} \left( v_d (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{k1}^+ - v_u (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{k2}^+ \right. \\ & \left. + 2\sqrt{2}g_2v_T \sin \Theta_W (Z_{k3}^+ + Z_{k4}^+) \right) \quad (600) \end{aligned}$$


---



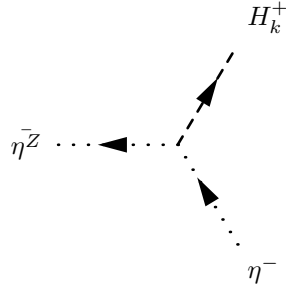
$$\begin{aligned} & \frac{i}{4}g_2\xi_{W^-} \left( v_d (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{k1}^+ - v_u (g_1 \cos \Theta_W + g_2 \sin \Theta_W) Z_{k2}^+ \right. \\ & \left. + 2\sqrt{2}g_2v_T \sin \Theta_W (Z_{k3}^+ + Z_{k4}^+) \right) \quad (601) \end{aligned}$$


---



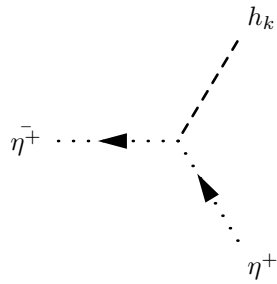
$$-\frac{i}{4}g_2^2\xi_{W^-}\left(4v_T Z_{k4}^H + v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (602)$$


---



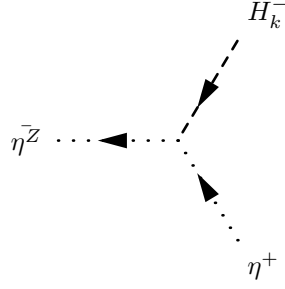
$$-\frac{i}{4}g_2\xi_Z\left(g_1\sin\Theta_W + g_2\cos\Theta_W\right)\left(v_d Z_{k1}^+ - v_u Z_{k2}^+\right) \quad (603)$$


---



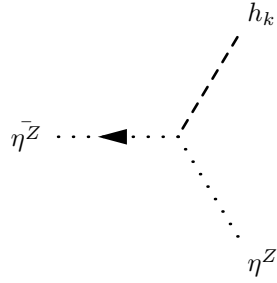
$$-\frac{i}{4}g_2^2\xi_{W^-}\left(4v_T Z_{k4}^H + v_d Z_{k1}^H + v_u Z_{k2}^H\right) \quad (604)$$


---



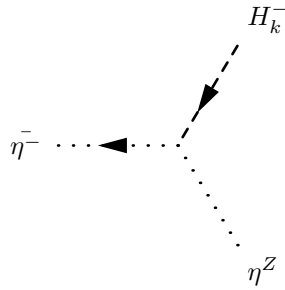
$$-\frac{i}{4}g_2\xi_Z(g_1\sin\Theta_W+g_2\cos\Theta_W)(v_dZ_{k1}^+-v_uZ_{k2}^+) \quad (605)$$


---



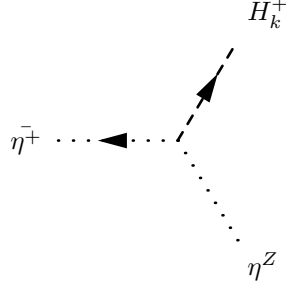
$$-\frac{i}{4}\xi_Z(g_1\sin\Theta_W+g_2\cos\Theta_W)^2(v_dZ_{k1}^H+v_uZ_{k2}^H) \quad (606)$$


---



$$\begin{aligned} &\frac{i}{4}g_2\xi_{W^-}\left(v_d\left(-g_1\sin\Theta_W+g_2\cos\Theta_W\right)Z_{k1}^++\left(g_1v_u\sin\Theta_W-g_2v_u\cos\Theta_W\right)Z_{k2}^+\right. \\ &\left.+2\sqrt{2}g_2v_T\cos\Theta_W\left(Z_{k3}^++Z_{k4}^+\right)\right) \quad (607) \end{aligned}$$


---



$$\begin{aligned}
& \frac{i}{4} g_2 \xi_{W^-} \left( v_d \left( -g_1 \sin \Theta_W + g_2 \cos \Theta_W \right) Z_{k1}^+ + \left( g_1 v_u \sin \Theta_W - g_2 v_u \cos \Theta_W \right) Z_{k2}^+ \right. \\
& \left. + 2\sqrt{2} g_2 v_T \cos \Theta_W \left( Z_{k3}^+ + Z_{k4}^+ \right) \right)
\end{aligned} \tag{608}$$

## 10 Clebsch-Gordan Coefficients

- : Gauge group:SU[2], Dynkin labels: (-2),(2)

$$K_{a,b}^{SU[2],-1 \times 3} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}_{ab} \tag{609}$$

- : Gauge group:SU[2], Dynkin labels: (2),(2)

$$K_{a,b}^{SU[2],3 \times 3} = \begin{pmatrix} 0 & 0 & 1 \\ 0 & -1 & 0 \\ 1 & 0 & 0 \end{pmatrix}_{ab} \tag{610}$$

- : Gauge group:SU[2], Dynkin labels: (1),(2),(1)

$$K_{1,a,b}^{SU[2],2 \times 3 \times 2} = \begin{pmatrix} 0 & 0 \\ 0 & \frac{1}{\sqrt{2}} \\ -1 & 0 \end{pmatrix}_{ab} \tag{611}$$

$$K_{2,a,b}^{SU[2],2 \times 3 \times 2} = \begin{pmatrix} 0 & -1 \\ \frac{1}{\sqrt{2}} & 0 \\ 0 & 0 \end{pmatrix}_{ab} \tag{612}$$

$$\tag{613}$$