Supersymmetric electroweak corrections to $W^{\pm}H^{\mp}$ associated production at the CERN Large Hadron Collider

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The $O(\alpha_{\rm ew}m_{t(b)}^2/m_W^2)$ and $O(\alpha_{\rm ew}m_{t(b)}^4/m_W^4)$ supersymmetric electroweak corrections to the cross section for $W^{\pm}H^{\mp}$ associated production at the CERN LHC are calculated in the minimal supersymmetric standard model. Those corrections arise from the quantum effects which are induced by the Yukawa couplings from the Higgs sector and the genuine supersymmetric electroweak couplings involving supersymmetric particles, i.e., chargino–top(bottom)–bottom-squark-(top-squark) couplings, neutralino–top(bottom)–top-squark (bottom-squark) couplings and charged Higgs-boson–top-squark–bottom-squark couplings. The Yukawa corrections can decrease the total cross sections significantly for low $\tan\beta(<4)$ when $m_{H^+}(<300)$ GeV, which exceed -12%. For high $\tan\beta$ the Yukawa corrections become negligibly small. The genuine supersymmetric electroweak corrections can increase or decrease the total cross sections depending on the supersymmetric parameters, which are at most a few percent, except the region near the threshold. We also show that the genuine supersymmetric electroweak corrections depend strongly on the choice of $\tan\beta$, A_t, $M_{\tilde{Q}}$, and μ. For large values of A_t, or large values of μ and $\tan\beta$, one can get larger corrections. The corrections can become very small, in contrast, for larger values of $M_{\tilde{Q}}$.

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I. INTRODUCTION

One of the most important objectives of the CERN Large Hadron Collider (LHC) is the search for Higgs boson. In various extensions of the Higgs sector of the standard model (SM), for example, in the two-Higgs-doublet models (THDM) [1], particularly the minimal supersymmetric standard model (MSSM) [2], there are physical charged Higgs bosons, which do not belong to the spectrum of the SM and therefore their discovery would be instant evidence of new physics. In much of the parameter space preferred by the MSSM, namely, $m_{H^{\pm}}>m_W$ and $1<\tan\beta<m_t/m_b$ [3,4], the LHC will provide the greatest opportunity for the discovery of charged Higgs boson. Previous studies have shown that for a relatively light charged Higgs boson, $m_{H^{\pm}}<m_t-m_b$, the dominate production processes at the LHC are $gg\to t\bar{t}$ and $q\bar{q}\to t\bar{t}$ followed by the decay sequence $t\to bH^+ \to b\tau^+\nu_\tau$ [5], and for a heavier charged Higgs boson the dominate production process is $gb\to tH^-$ [6,7,8]. In addition to the processes mentioned above, in Ref. [9] Dicus *et al.* also studied the production of a charged Higgs boson in association with a W boson via $b\bar{b}$ annihilation at the tree level and gg fusion at one loop at hadron colliders. Since the leptonic decays of W boson would serve as a spectacular trigger for the charged Higgs boson search, these processes seem attractive. But the authors of Ref. [9] only considered the case where the value of $\tan\beta$ to be in the range 0.3–2.3. Recently Barrientos Bendezu and Kniehl [10] further studied these processes and presented theoretical predictions for the $W^{\pm}H^{\mp}$ production cross section at the LHC and the Fermilab Tevatron run II, where they generalize the analysis of Ref. [9] for arbitrary values of $\tan\beta$ and to update it. They found that the $W^{\pm}H^{\mp}$ production would have a sizeable cross section and its signal should have a significant rate at the LHC unless $m_{H^{\mp}}$ is very large.

As analyzed in Refs. [7,11], the search for heavy charged Higgs bosons with $m_{H^+}>m_t+m_b$ at a hadron collider is seriously complicated by QCD backgrounds. For example, the processes suggested in Ref. [10] suffer from the irreducible background due to top quark pair production $q\bar{q}\to t\bar{t}$ and $gg\to t\bar{t}$ with subsequent decay through the intermediate state $b\bar{b}W^+W^-$, and heavy charged Higgs boson produced in association with $W^{\pm}$ gauge bosons cannot be resolved at the LHC, via semileptonic W^+W^- decays, for charged Higgs boson masses in the range between $2m_t$ and 600 GeV at neither low nor high $\tan\beta$ [11]. However, recent analyses [12,13] have shown that the decay mode $H^+\to\tau^+\nu$, indeed dominant for light charged Higgs bosons below the top threshold for any accessible $\tan\beta$ [14], provides an excellent signature for a heavy charged Higgs boson in searches at the LHC. The discover region for $H^{\pm}$ is far greater than had been thought for a large range of the $(m_{H^{\pm}},\tan\beta)$ parameter space, extending beyond $m_{H^{\pm}}\sim 1$ TeV and down to at least $\tan\beta\sim 3$, and potentially to $\tan\beta\sim 1.5$, assuming the latest results for the SM parameters and parton distribution functions as well as using kinematic selection techniques and the tau polarization analysis [13]. Recently the relative experimental simulation has been performed [15], and confirmed above analyses.

Since the contributions to the $W^{\pm}H^{\mp}$ production cross section due to $b\bar{b}$ annihilation at the tree level are greater than ones due to gg fusion which proceeds at one-loop, it is important to calculate the one-loop radiative corrections to the $W^{\pm}H^{\mp}$ production via $b\bar{b}$ annihilation for more accurate theoretical predictions for the cross sections. In this paper we present the calculations of the $O(\alpha_{\rm ew}m_{t(b)}^2/m_W^2)$ and $O(\alpha_{\rm ew}m_{t(b)}^4/m_W^4)$ supersymmetric (SUSY) electroweak (EW) corrections to this $W^{\pm}H^{\mp}$ associated production process at the LHC in the MSSM. These corrections arise from the quantum effects which are induced by potentially large Yukawa couplings from the Higgs sector and the chargino–

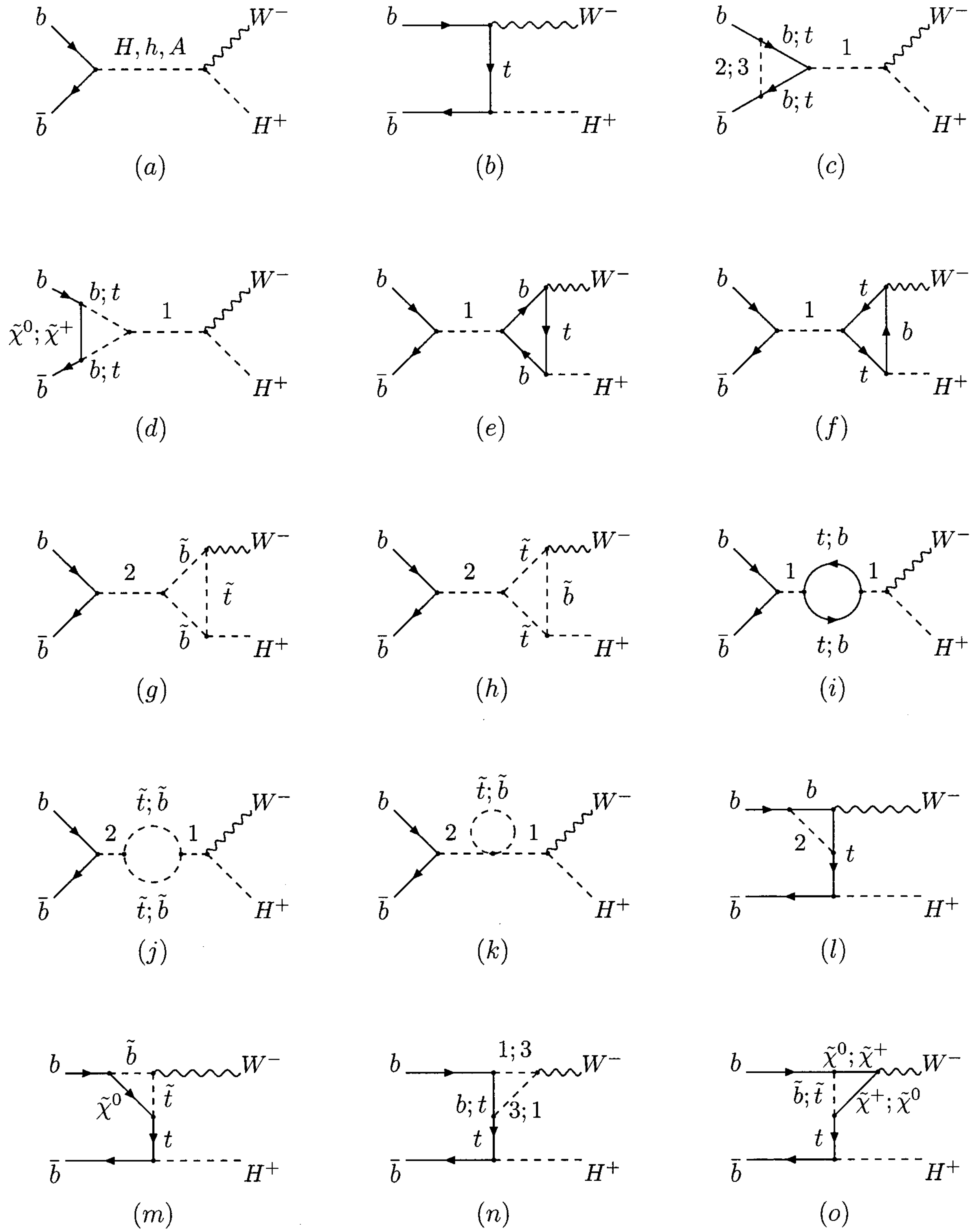

FIG. 1. Feynman diagrams contributing to supersymmetric electroweak corrections to $b\bar{b}\to W^-H^+$: (a) and (b) are tree level diagrams; (c)–(x) are one-loop corrections. The dashed line 1 represents H, h, A; the dashed line 2 represents H, h, A, G^0; the dashed line 3 represents H^+, G^+. For diagram (r), the dashed line in the loop represents H, h, A, G^0, H^+, G^+, $\tilde{t}$, $\tilde{b}$.

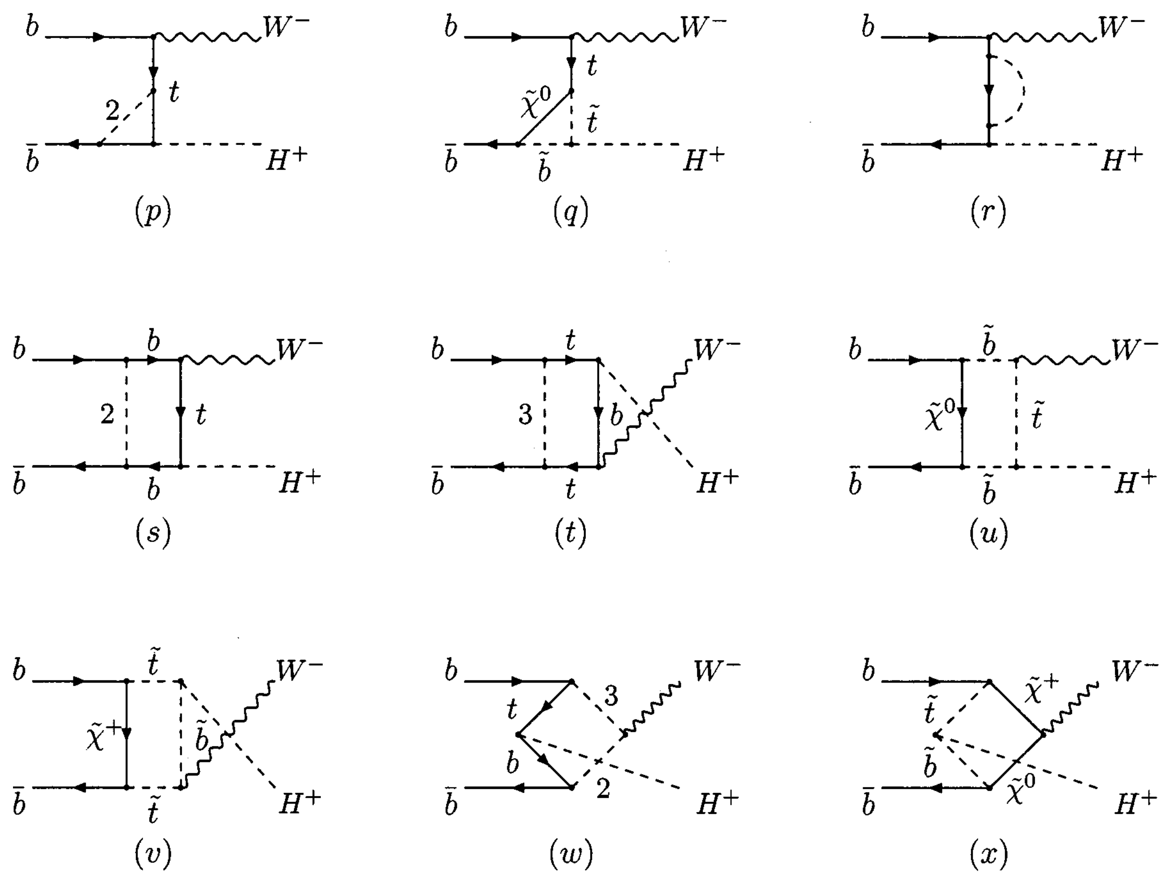

FIG. 1 (*Continued*).

top(bottom)–bottom-squark(top-squark) couplings, neutralino-top(bottom)–top-squark(bottom-squark) couplings and charged Higgs-boson–top-squark–bottom-squark couplings which will contribute at the $O(\alpha_{\rm ew} m_{t(b)}^4/m_W^4)$ to the self-energy of the charged Higgs boson. The relevant QCD corrections are expected to be larger, but not yet available.

The arrangement of this paper is as follows. In Sec. II we give the analytic results. In Sec. III we present some numerical examples and discuss the implications of our results. Some notations used in this paper and the lengthy expressions of the form factors are summarized in Appendixes A and B.

II. CALCULATIONS

The Feynman diagrams for the charged Higgs boson production via $b(p_1)\overline{b}(p_2)\to W^{\pm}(k)H^{\mp}(p_3)$, which include the supersymmetric (SUSY) EW corrections to the process, are shown in Figs. 1 and 2. We carried out the calculation in the 't Hooft–Feynman gauge and used dimensional reduction, which preserves supersymmetry, for regularization of the ultraviolet divergences in the virtual loop corrections using the on-mass-shell renormalization scheme [16], in which the fine-structure constant $\alpha_{\rm ew}$ and physical masses are chosen to be the renormalized parameters, and finite parts of the counterterms are fixed by the renormalization conditions. The coupling constant g is related to the input parameters e, m_W, and m_Z via $g^2=e^2/s_w^2$ and $s_w^2=1-m_W^2/m_Z^2$. As far as the parameters β and α, for the MSSM we are considering, they have to be renormalized, too. In the MSSM they are not independent. Nevertheless, we follow the approach of Mendez and Pomarol [17] in which they consider them as independent renormalized parameters and fixed the corresponding renormalization constants by a renormalization condition that the on-mass-shell $H^+\overline{l}\nu_l$ and $h\overline{l}l$ couplings keep the forms of Eq. (3) of Ref. [17] to all order of perturbation theory.

We define the Mandelstam variables as

$$\hat{s}=(p_1+p_2)^2=(k+p_3)^2,$$
$$\hat{t}=(p_1-k)^2=(p_2-p_3)^2,$$
$$\hat{u}=(p_1-p_3)^2=(p_2-k)^2. \tag{1}$$

The relevant renormalization constants are defined as

$$m_{W_0}^2=m_W^2+\delta m_W^2, \quad m_{Z_0}^2=m_Z^2+\delta m_Z^2,$$
$$\tan\beta_0=(1+\delta Z_\beta)\tan\beta,$$
$$\sin\alpha_0=(1+\delta Z_\alpha)\sin\alpha,$$
$$W_0^{\pm\mu}=(1+\delta Z_W)^{1/2}W^{\pm\mu}+iZ_{H^\pm W^\pm}^{1/2}\partial^\mu H^{\mp},$$

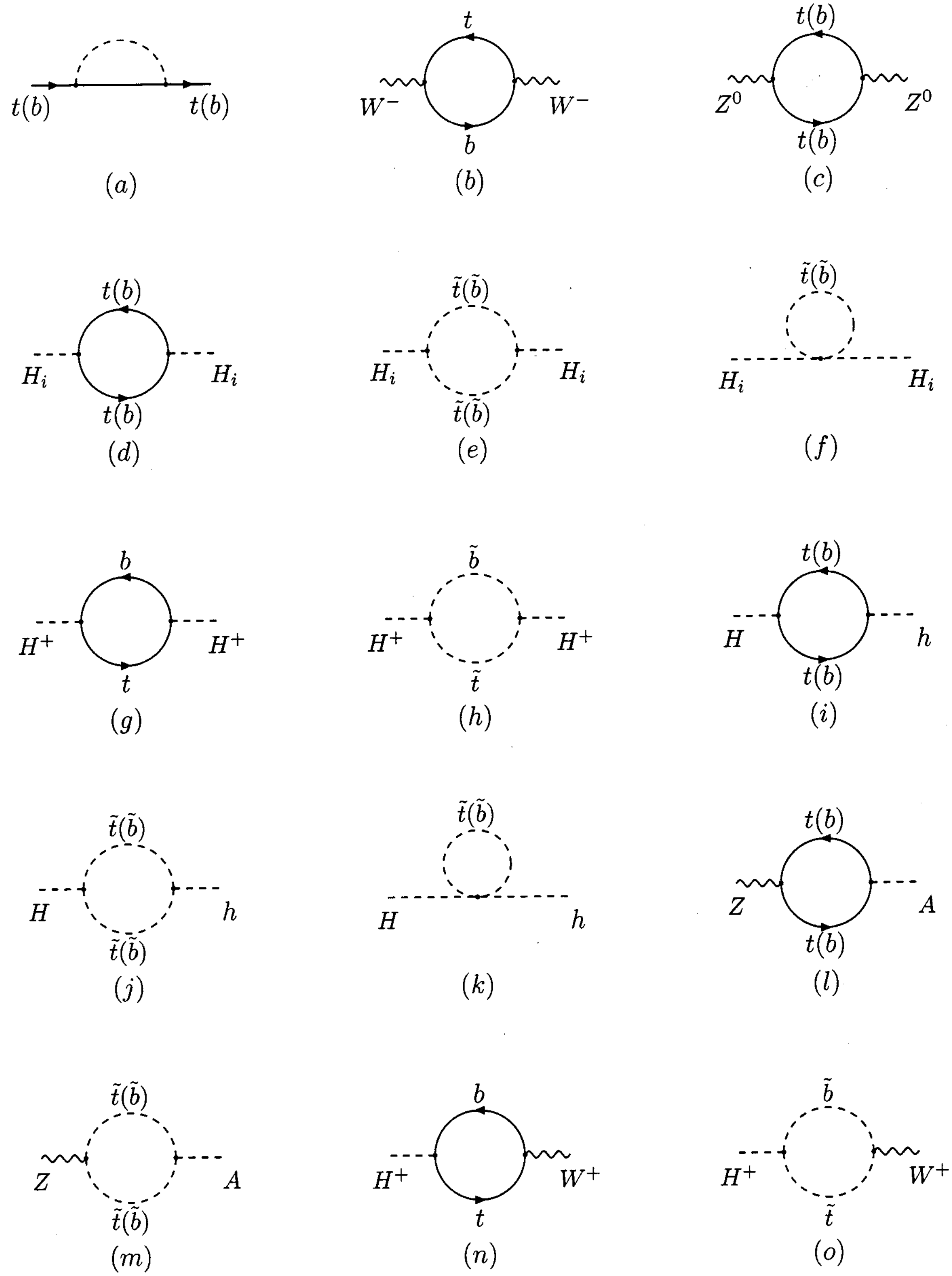

FIG. 2. Feynman diagrams contributing to renormalization constants: The dashed line represents *H, h, A*, G^0, H^+, G^+, $\tilde{t}$, $\tilde{b}$ for diagram (a), and H_i in diagrams (d)–(f) represents *H, h, A*.

$$H_0^{\pm}=(1+\delta Z_{H^{\pm}})^{1/2}H^{\pm},$$

$$Z_0^{\mu}=(1+\delta Z_Z)^{1/2}Z^{\mu}+iZ_{ZA}^{1/2}\partial^{\mu}A,$$

$$A_0=(1+\delta Z_A)^{1/2}A,$$

$$H_0=(1+\delta Z_H)^{1/2}H+Z_{Hh}^{1/2}h,$$

$$h_0=(1+\delta Z_h)^{1/2}h+Z_{hH}^{1/2}H. \qquad (2)$$

Taking into account the $O(\alpha_{\rm ew}m_{t(b)}^2/m_W^2)$ and

$O(\alpha_{ew}m_{t(b)}^4/m_W^4)$ SUSY EW corrections, the renormalized amplitude for $b\bar{b}\to W^- H^+$ can be written as

$$M_{\rm ren}=M_0^{(s)}+M_0^{(t)}+[\delta\hat{M}^{V_1(s)}+\delta\hat{M}^{S(s)}+\delta\hat{M}^{V_2(s)}](H_i)+[\delta\hat{M}^{V_1(s)}+\delta\hat{M}^{S(s)}+\delta\hat{M}^{V_2(s)}](A)+\delta\hat{M}^{V_1(t)}+\delta\hat{M}^{S(t)}+\delta\hat{M}^{V_2(t)}+\delta M^{\rm box}, \tag{3}$$

where $M_0^{(s)}$ and $M_0^{(t)}$ are the tree-level amplitudes arising from Figs. 1(a) and 1(b), respectively, which are given by

$$M_0^{(s)}=-i\sum_i \frac{gh_b\alpha_{2i}\varphi_{11}}{\sqrt{2}(\hat{s}-m_{H_i}^2)}\sum_{j=1}^4 M_j+\frac{igh_b\beta_{12}}{\sqrt{2}(\hat{s}-m_A^2)}(M_1-M_2+M_3-M_4) \tag{4}$$

and

$$M_0^{(t)}=\frac{ig}{\sqrt{2}(\hat{t}-m_t^2)}(2h_b\beta_{12}M_2-h_bm_b\beta_{12}M_5+h_tm_t\beta_{11}M_6-h_b\beta_{12}M_{12}). \tag{5}$$

Here $h_b\equiv gm_b/\sqrt{2}m_W\cos\beta$ and $h_t\equiv gm_t/\sqrt{2}m_W\sin\beta$ are the Yukawa couplings from the bottom and top quarks, p_1 and p_2 denote the momentum of incoming quarks b and $\bar{b}$, respectively, while k and p_3 are used for the outgoing W^- boson and H^+ boson, respectively. The notation α_{ij}, β_{ij}, and φ_{ij} used in the above expressions is defined in Appendix A, and H_i stands for Higgs bosons h with $i=1$ and H with $i=2$. M_i are the standard matrix elements, which are defined by

$$M_1=\overline{v}(p_2)P_Ru(p_1)p_1\cdot\varepsilon(k),$$

$$M_2=\overline{v}(p_2)P_Lu(p_1)p_1\cdot\varepsilon(k),$$

$$M_3=\overline{v}(p_2)P_Ru(p_1)p_2\cdot\varepsilon(k),$$

$$M_4=\overline{v}(p_2)P_Lu(p_1)p_2\cdot\varepsilon(k),$$

$$M_5=\overline{v}(p_2)\not{\varepsilon}(k)P_Ru(p_1),$$

$$M_6=\overline{v}(p_2)\not{\varepsilon}(k)P_Lu(p_1),$$

$$M_7=\overline{v}(p_2)\not{\varepsilon}(k)P_Ru(p_1)p_1\cdot\varepsilon(k),$$

$$M_8=\overline{v}(p_2)\not{\varepsilon}(k)P_Lu(p_1)p_1\cdot\varepsilon(k),$$

$$M_9=\overline{v}(p_2)\not{\varepsilon}(k)P_Ru(p_1)p_2\cdot\varepsilon(k),$$

$$M_{10}=\overline{v}(p_2)\not{\varepsilon}(k)P_Lu(p_1)p_2\cdot\varepsilon(k),$$

$$M_{11}=\overline{v}(p_2)\not{k}\not{\varepsilon}(k)P_Ru(p_1),$$

$$M_{12}=\overline{v}(p_2)\not{k}\not{\varepsilon}(k)P_Lu(p_1), \tag{6}$$

where $P_{L,R}\equiv(1\mp\gamma_5)/2$. The vertex and self-energy corrections to the tree-level process are included in $\delta\hat{M}^{V,S}$, which are given by

$$\delta\hat{M}^{V_1(s)}(H_i)=-\frac{igh_b}{\sqrt{2}}\left\{\sum_{i=1,2}\frac{\alpha_{2i}\varphi_{i1}}{\hat{s}-m_{H_i}^2}\left[\frac{\delta h_b}{h_b}+\frac{1}{2}\delta Z_L^b+\frac{1}{2}\delta Z_R^b+\frac{1}{2}\delta Z_{H_i}\right]+\frac{\sin(\beta-\alpha)\sin\alpha}{\hat{s}-m_H^2}(\tan\alpha\,\delta Z_\alpha+Z_{hH}^{1/2})-\frac{\cos(\beta-\alpha)}{\hat{s}-m_h^2}(\sin\alpha\,\delta Z_\alpha-\cos\alpha Z_{Hh}^{1/2})\right\}\sum_{j=1}^4 M_j+\delta M^{V_1(s)}(H),$$

$$\delta\hat{M}^{V_1(s)}(A)=-\frac{igh_b\sin\beta}{\sqrt{2}(\hat{s}-m_A^2)}\left[\frac{\delta h_b}{h_b}+\cos^2\beta\,\delta Z_\beta+\frac{1}{2}\delta Z_L^b+\frac{1}{2}\delta Z_R^b+\frac{1}{2}\delta Z_A+\frac{im_W}{\tan\beta\cos\theta_W}Z_{hH}^{1/2}\right](M_1-M_2+M_3-M_4)+\delta M^{V_1(s)}(A),$$

$$\delta\hat{M}^{S(s)}(H_i)=\frac{igh_b}{\sqrt{2}}\sum_{i=1,2}\frac{\alpha_{2i}\varphi_{i1}}{(\hat{s}-m_{H_i}^2)^2}[\delta m_{H_i}^2-(\hat{s}-m_{H_i}^2)\delta Z_{H_i}-(\hat{s}-m_H^2)Z_{Hh}^{1/2}-(\hat{s}-m_h^2)Z_{hH}^{1/2}]\sum_{j=1}^4 M_j+\delta M^{S(s)}(H),$$

$$\delta\hat{M}^{S(s)}(A)=\frac{igh_b\sin\beta}{\sqrt{2}(\hat{s}-m_A^2)}[\delta m_A^2-(\hat{s}-m_A^2)\delta Z_A](M_1-M_2+M_3-M_4)+\delta M^{S(s)}(A),$$

$$\delta\hat{M}^{V_2(s)}(H_i) = -\frac{igh_b}{\sqrt{2}}\left\{\sum_{i=1,2}\frac{\alpha_{2i}\varphi_{i1}}{\hat{s}-m_{H_i}^2}\left(\frac{\delta g}{g}+\frac{1}{2}\delta Z_{W^-}+\frac{1}{2}\delta Z_{H^+}+\frac{1}{2}Z_{H_i}\right)\right.$$
$$-\frac{\cos\alpha\cos(\beta-\alpha)}{\hat{s}-m_H^2}(\sin\beta\cos\beta\,\delta Z_\beta-\tan\alpha\,\delta Z_\alpha-Z_{hH}^{1/2}+m_W Z_{HW}^{1/2})$$
$$\left.+\frac{\sin\alpha\sin(\beta-\alpha)}{\hat{s}-m_h^2}(\sin\beta\cos\beta\,\delta Z_\beta-\tan\alpha\,\delta Z_\alpha+Z_{Hh}^{1/2}+m_W Z_{HW}^{1/2})\right\}\sum_{j=1}^{4}M_j+\delta M^{V_2(s)}(H),$$

$$\delta\hat{M}^{V_2(s)}(A) = -\frac{igh_b\sin\beta}{\sqrt{2}(\hat{s}-m_A^2)}\left[\frac{\delta g}{g}+\frac{1}{2}\delta Z^A+\frac{1}{2}\delta Z_{H^+}+\frac{1}{2}\delta Z_{W^-}\right](M_1-M_2+M_3-M_4)+\delta M^{V_2(s)}(A),$$

$$\delta\hat{M}^{V_1(t)} = \frac{ig}{\sqrt{2}(\hat{t}-m_t^2)}(2h_b\beta_{12}M_2-h_b m_b\beta_{12}M_5+h_t m_t\beta_{11}M_6-h_b\beta_{12}M_{12})\left(\frac{\delta g}{g}+\frac{1}{2}\delta Z_L^t+\frac{1}{2}\delta Z_L^b+\frac{1}{2}\delta Z_{W^-}\right)$$
$$+\delta M^{V_1(t)},$$

$$\delta\hat{M}^{S(t)} = \frac{ig}{\sqrt{2}(\hat{t}-m_t^2)^2}\left[\left(2m_t^2\frac{\delta m_t}{m_t}+m_t^2\delta Z_L^t-\hat{t}\,\delta Z_L^t\right)\left(2h_b\beta_{12}M_2-h_b m_b\beta_{12}M_5-h_t\beta_{12}M_{12}+\frac{1}{2}h_t m_t\beta_{11}M_6\right)\right.$$
$$\left.+\frac{1}{2}\left(2\hat{t}\frac{\delta m_t}{m_t}+m_t^2\delta Z_R^t-\hat{t}\,\delta Z_R^t\right)h_t m_t\beta_{11}M_6\right]+\delta M^{S(t)},$$

$$\delta\hat{M}^{V_2(t)} = \frac{ig^2}{2m_W(\hat{t}-m_t^2)}\left[m_t^2\cot\beta\left(\frac{\delta h_t}{h_t}-\cos^2\beta\,\delta Z_\beta+\frac{1}{2}\delta Z_L^b+\frac{1}{2}\delta Z_R^t+\frac{1}{2}\delta Z_{H^+}+\frac{m_W}{\cot\beta}Z_{HW}^{1/2}\right)M_6\right.$$
$$\left.+m_b\tan\beta\left(\frac{\delta h_b}{h_b}+\sin^2\beta\,\delta Z_\beta+\frac{1}{2}\delta Z_L^t+\frac{1}{2}\delta Z_R^b+\frac{1}{2}\delta Z_{H^+}-\frac{m_W}{\tan\beta}Z_{HW}^{1/2}\right)(2M_2-M_{12}-m_b M_5)\right]+\delta M^{V_2(t)},$$
(7)

with

$$\frac{\delta g}{g}=\frac{\delta e}{e}+\frac{1}{2}\frac{\delta m_Z^2}{m_Z^2}-\frac{1}{2}\frac{\delta m_Z^2-\delta m_W^2}{m_Z^2-m_W^2},$$

$$\frac{\delta h_b}{h_b}=\frac{\delta g}{g}+\frac{\delta m_b}{m_b}-\frac{1}{2}\frac{\delta m_W^2}{m_W^2}+\cos^2\beta\,\delta Z_\beta,$$

$$\frac{\delta h_t}{h_t}=\frac{\delta g}{g}+\frac{\delta m_t}{m_t}-\frac{1}{2}\frac{\delta m_W^2}{m_W^2}-\sin^2\beta\,\delta Z_\beta,$$

$$\delta Z_\beta=-\frac{\delta g}{g}+\frac{1}{2}\frac{\delta m_W^2}{m_W^2}-\frac{1}{2}\delta Z_{H^+}-\frac{m_W}{\tan\beta}Z_{HW}^{1/2},$$

$$\delta Z_\alpha=-\frac{\delta g}{g}+\frac{1}{2}\frac{\delta m_W^2}{m_W^2}-\frac{1}{2}\delta Z_h-\cot\alpha Z_{Hh}^{1/2}-\sin^2\beta\,\delta Z_\beta.$$
(8)

The $\delta e/e$ appearing in Eq. (8) does not contain the $O(\alpha_{\rm ew}m_{t(b)}^2/m_W^2)$ corrections and needs not be considered in our calculations. Also $\delta M^{V_1(s)}(H_i)$, $\delta M^{V_1(s)}(A)$, $\delta M^{S(s)}(H_i)$, $\delta M^{S(s)}(A)$, $\delta M^{V_2(s)}(H_i)$, $\delta M^{V_2(s)}(A)$, $\delta M^{V_1(t)}$, $\delta M^{S(t)}$, $\delta M^{V_2(t)}$, and $\delta M^{\rm box}$ represent the irreducible corrections arising, respectively, from the $b\bar{b}H(h)$ vertex diagrams shown in Figs. 1(c)–1(d), the $b\bar{b}A$ vertex diagrams shown in Figs. 1(c)–1(d), the H and h boson self-energy diagrams in Figs. 1(i)–1(k), the A boson self-energy diagrams shown in Figs. 1(i)–1(k), the $H(h)W^-H^+$ vertex diagrams shown in Figs. 1(f)–1(h), the AW^-H^+ vertex diagrams shown in Figs. 1(f)–1(h), the btW^- vertex diagrams Figs. 1(l)–1(o), the top quark self-energy diagrams Fig. 1(r), the $t\bar{b}H^+$ vertex diagrams Figs. 1(p)–1(q), and the box diagrams Figs. 1(s)–1(x). All above $\delta M^{V,S}$ and $\delta M^{\rm box}$ can be written in the form

$$\delta M^{V,S,\rm box}=i\sum_{i=1}^{12}f_i^{V,S,\rm box}M_i, \tag{9}$$

where the $f_i^{V,S,\rm box}$ are form factors, which are given explicitly in Appendix B.

Calculating the self-energy diagrams in Fig. 2, we can get the explicit expressions of all the renormalization constants as follows:

$$\frac{\delta m_t}{m_t}=\sum_i \frac{-h_t^2}{32\pi^2}[\alpha_{1i}^2(-B_0^{ttH_i}+B_1^{ttH_i})+\beta_{1i}^2(B_0^{ttA_i}+B_1^{ttA_i})]-\sum_i \frac{1}{32\pi^2 m_t}[(h_t^2 m_t\beta_{1i}^2+h_b^2 m_b\beta_{2i}^2)B_1^{tbH_i^+}+2h_b h_t\beta_{1i}\beta_{2i}B_0^{tbH_i^+}]$$
$$+\sum_{i,j}\frac{h_t^2}{32\pi^2 m_t}[m_t|N_{j4}|^2(B_0^{t\tilde{t}_i\tilde{\chi}_j^0}+B_1^{t\tilde{t}_i\tilde{\chi}_j^0})+m_{\tilde{\chi}_j^0}\theta_{i1}^t\theta_{i2}^t(N_{j4}^2+N_{j4}^{*2})B_0^{t\tilde{t}_i\tilde{\chi}_j^0}]$$
$$+\sum_{i,j}\frac{1}{32\pi^2 m_t}\{m_t[h_t^2(\theta_{i1}^b)^2|V_{j1}|^2+h_b^2(\theta_{i2}^b)^2|U_{j2}|^2](B_0^{t\tilde{b}_i\tilde{\chi}_j^+}+B_1^{t\tilde{b}_i\tilde{\chi}_j^+})+h_b h_t m_{\tilde{\chi}_j^+}\theta_{i1}^b\theta_{i2}^b(U_{j2}V_{j2}+U_{j2}^*V_{j2}^*)B_0^{t\tilde{b}_i\tilde{\chi}_j^+}\},$$

$$\delta Z_L^t=\sum_i \frac{h_b^2\beta_{2i}^2}{16\pi^2}B_1^{tbH_i^+}-\sum_{i,j}\frac{h_t^2(\theta_{i2}^t)^2}{16\pi^2}|N_{j4}|^2(B_0^{t\tilde{t}_i\tilde{\chi}_j^0}+B_1^{t\tilde{t}_i\tilde{\chi}_j^0})-\sum_{i,j}\frac{h_b^2(\theta_{i2}^b)^2}{16\pi^2}|U_{j2}|^2(B_0^{t\tilde{b}_i\tilde{\chi}_j^+}+B_1^{t\tilde{b}_i\tilde{\chi}_j^+})+\delta^t,$$

$$\delta Z_R^t=\sum_i \frac{h_t^2\beta_{1i}^2}{16\pi^2}B_1^{tbH_i^+}-\sum_{i,j}\frac{h_t^2(\theta_{i1}^t)^2}{16\pi^2}|N_{j4}|^2(B_0^{t\tilde{t}_i\tilde{\chi}_j^0}+B_1^{t\tilde{t}_i\tilde{\chi}_j^0})-\sum_{i,j}\frac{h_t^2(\theta_{i1}^b)^2}{16\pi^2}|V_{j2}|^2(B_0^{t\tilde{b}_i\tilde{\chi}_j^+}+B_1^{t\tilde{b}_i\tilde{\chi}_j^+})+\delta^t,$$

$$\delta^t=\sum_i \frac{h_t^2}{32\pi^2}\{\alpha_{1i}^2[B_1^{ttH_i}-2m_t^2(B_0^{ttH_i}-B_1^{ttH_i})]+\beta_{1i}^2[B_1^{ttA_i}+2m_t^2(B_0^{ttA_i}+B_1^{ttA_i})]\}+\sum_i \frac{m_t}{16\pi^2}[m_t(h_t^2\beta_{1i}^2+h_b^2\beta_{2i}^2)B_0'^{tbH_i^+}$$
$$+2h_b h_t m_b\beta_{1i}\beta_{2i}B_0'^{tbH_i^+}]-\sum_{i,j}\frac{h_t^2 m_t}{16\pi^2}[m_t|N_{j4}|^2(B_0'^{t\tilde{t}_i\tilde{\chi}_j^0}+B_1'^{t\tilde{t}_i\tilde{\chi}_j^0})+m_{\tilde{\chi}_j^0}\theta_{i1}^t\theta_{i2}^t(N_{j4}^2+N_{j4}^{*2})B_0'^{t\tilde{t}_i\tilde{\chi}_j^0}]$$
$$-\sum_{i,j}\frac{m_t}{16\pi^2}\{m_t[h_t^2(\theta_{i1}^b)^2|V_{j1}|^2+h_b^2(\theta_{i2}^b)^2|U_{j2}|^2](B_0'^{t\tilde{b}_i\tilde{\chi}_j^+}+B_1'^{t\tilde{b}_i\tilde{\chi}_j^+})+h_b h_t m_{\tilde{\chi}_j^+}\theta_{i1}^b\theta_{i2}^b(U_{j2}V_{j2}+U_{j2}^*V_{j2}^*)B_0'^{t\tilde{b}_i\tilde{\chi}_j^+}\},$$

$$\delta m_W^2=\frac{g^2}{16\pi^2}\left\{(m_b^2-m_t^2)\left(1+\frac{m_b^2-m_t^2-2m_W^2}{2m_W^2}B_0^{0bt}\right)-2m_t^2B_0^{0tt}-\frac{1}{2m_W^2}[(m_b^2-m_t^2)^2+(m_b^2+m_t^2)m_W^2]B_0^{Wbt}\right\},$$

$$\delta Z_W=\frac{g^2}{32\pi^2 m_W^2}\left\{\frac{(m_b^2-m_t^2)^2}{m_W^2}(B_0^{0bt}-B_0^{Wbt})+[(m_b^2-m_t^2)^2+(m_b^2+m_t^2)m_W^2]B_0'^{Wbt}\right\},$$

$$\delta m_z^2=\frac{g^2s_W^2}{18c_W^2\pi^2}\left[\frac{m_b^2}{2}(3-2s_W^2)(B_0^{Zbb}+B_0^{0bb})-m_t^2(3-4s_W^2)(B_0^{Ztt}-B_0^{0tt})\right]$$
$$+\frac{g^2}{32c_W^2\pi^2}[m_b^2(B_0^{Zbb}-2B_0^{0bb})-m_t^2(B_0^{Ztt}+2B_0^{0tt})],$$

$$\delta Z_{H^+}=\frac{3}{16\pi^2}\left[2(h_t^2\beta_{11}^2+h_b^2\beta_{21}^2)(B_1^{H^+bt}+m_b^2B_0'^{H^+bt}+m_{H^+}^2B_1'^{H^+bt})-4h_b h_t m_b m_t\beta_{11}\beta_{21}B_0'^{H^+bt}\right.$$
$$\left.+\sum_{i,j,i',j'}(\theta_{ii'}^b)^2(\theta_{jj'}^t)^2(h_b\Theta_{i'j'1}^5+h_t\Theta_{i'j'1}^6)^2B_0'^{H^+\tilde{b}_i\tilde{t}_j}\right],$$

$$\delta m_{H_k}^2=\frac{3}{16\pi^2}\left\{-2h_t^2\alpha_{1k}^2[m_t^2(1+B_0^{0tt}+2B_0^{H_ktt})+m_{H_k}^2B_1^{H_ktt}]-2h_b^2\alpha_{2k}^2[m_b^2(1+B_0^{0bb}+2B_0^{H_kbb})+m_{H_k}^2B_1^{H_kbb}]\right.$$
$$+\sum_{i,j,i',j'}[(h_t\theta_{ii'}^t\theta_{jj'}^t\Theta_{i'j'k}^1)^2B_0^{H_k\tilde{t}_i\tilde{t}_j}+(h_b\theta_{ii'}^b\theta_{jj'}^b\Theta_{i'j'k}^2)^2B_0^{H_k\tilde{b}_i\tilde{b}_j}]+\sum_i h_b^2m_{\tilde{b}_i}^2\alpha_{2k}^2(1+B_0^{0\tilde{b}_i\tilde{b}_i})$$
$$\left.+\sum_i h_t^2m_{\tilde{t}_i}^2\alpha_{1k}^2(1+B_0^{0\tilde{t}_i\tilde{t}_i})\right\},$$

$$\delta Z_{H_k}=\frac{3}{16\pi^2}\Bigg\{2h_t^2\alpha_{1k}^2(B_1^{H_ktt}+2m_t^2B_0'^{H_ktt}+m_{H_k}^2B_1'^{H_ktt})+2h_b^2\alpha_{2k}^2(B_1^{H_kbb}+2m_b^2B_0'^{H_kbb}+m_{H_k}^2B_1'^{H_kbb})$$
$$+\sum_{i,j,i',j'}[(h_t\theta_{ii'}^t\theta_{jj'}^t\Theta_{i'j'k}^1)^2B_0'^{H_k\tilde{t}_i\tilde{t}_j}+(h_b\theta_{ii'}^b\theta_{jj'}^b\Theta_{i'j'k}^2)^2B_0'^{H_k\tilde{b}_i\tilde{b}_j}]\Bigg\},$$

$$\delta m_{A_k}^2=\frac{3}{16\pi^2}\Bigg\{2h_t^2\beta_{1k}^2[m_t^2(1+B_0^{0tt})+m_{A_k}^2B_1^{A_ktt}]+2h_b^2\beta_{2k}^2[m_b^2(1+B_0^{00b})+m_{A_k}^2B_1^{A_kbb}]-\sum_{i,j,i',j'}[(h_t\theta_{ii'}^t\theta_{jj'}^t\Theta_{i'j'k}^3)^2B_0^{A_k\tilde{t}_i\tilde{t}_j}$$
$$+(h_b\theta_{ii'}^b\theta_{jj'}^b\Theta_{i'j'k}^4)^2B_0^{A_k\tilde{b}_i\tilde{b}_j}]+\sum_i h_b^2m_{\tilde{b}_i}^2\beta_{2k}^2(1+B_0^{0\tilde{b}_i\tilde{b}_i})+\sum_i h_t^2m_{\tilde{t}_i}^2\beta_{1k}^2(1+B_0^{0\tilde{t}_i\tilde{t}_i})\Bigg\},$$

$$\delta Z_{A_k}=\frac{3}{16\pi^2}\Bigg\{2h_t^2\beta_{1k}^2(B_1^{A_ktt}+m_{A_k}^2B_1'^{A_ktt})+2h_b^2\beta_{2k}^2(B_1^{A_kbb}+m_{A_k}^2B_1'^{A_kbb})$$
$$-\sum_{i,j,i',j'}[(h_t\theta_{ii'}^t\theta_{jj'}^t\Theta_{i'j'k}^3)^2B_0'^{A_k\tilde{t}_i\tilde{t}_j}+(h_b\theta_{ii'}^b\theta_{jj'}^b\Theta_{i'j'k}^4)^2B_0'^{A_k\tilde{b}_i\tilde{b}_j}]\Bigg\},$$

$$Z_{H^+W}=\frac{-3g}{16\sqrt{2}\pi^2m_{H^+}^2m_W^2}\Bigg[(h_tm_t\beta_{11}+h_bm_b\beta_{12})[(m_b^2-m_t^2)(B_0^{0bt}-B_0^{H^+bt})-m_{H^+}^2B_0^{H^+bt}]$$
$$+\sum_{i,j,i',j'}\theta_{i1}^b\theta_{ii'}^b\theta_{j1}^t\theta_{jj'}^t(h_b\Theta_{i'j'1}^5+h_t\Theta_{i'j'1}^6)(m_{\tilde{t}_j}^2-m_{\tilde{b}_i}^2)(B_0^{0\tilde{b}_i\tilde{t}_j}-B_0^{H^+\tilde{b}_i\tilde{t}_j})\Bigg],$$

$$Z_{AZ}=\frac{-i3gc_W}{16\sqrt{2}\pi^2m_W^2}(h_tm_t\beta_{11}B_0^{Att}-h_bm_b\beta_{12}B_0^{Abb})+\frac{igc_W}{32\pi^2m_A^2m_W^2}\sum_{i,j,i',j'}\{h_b\theta_{ii'}^b\theta_{jj'}^b\Theta_{j'i'1}^4[(3-2s_W^2)\theta_{i1}^b\theta_{j1}^b-2s_W^2\theta_{i2}^b\theta_{j2}^b]$$
$$\times(m_{\tilde{b}s_i}^2-m_{\tilde{b}_j}^2)(B_0^{0\tilde{b}_i\tilde{b}_j}-B_0^{A\tilde{b}_i\tilde{b}_j})-h_t\theta_{ii'}^t\theta_{jj'}^t\Theta_{j't'1}^3[(3-4s_W^2)\theta_{i1}^t\theta_{j1}^t-4s_W^2\theta_{i2}^t\theta_{j2}^t](m_{\tilde{t}_i}^2-m_{\tilde{t}_j}^2)(B_0^{0\tilde{t}_i\tilde{t}_j}-B_0^{A\tilde{t}_i\tilde{t}_j})\},$$

$$Z_{hH}^{1/2}=\frac{3\alpha_{11}\alpha_{12}}{16\pi^2(m_h^2-m_H^2)}[2m_b^2(1+B_0^{0bb}+2B_0^{Hbb})-2m_t^2(1+B_0^{0tt}+2B_0^{Htt})-m_H^2(B_0^{Hbb}-B_0^{Htt})]$$
$$+\frac{3}{16\pi^2(m_h^2-m_H^2)}\sum_{i,j,i',j'}[(h_b\theta_{ii'}^b\theta_{jj'}^b)^2\Theta_{i'j'1}^2\Theta_{i'j'2}^2B_0^{H\tilde{b}_i\tilde{b}_j}+(h_t\theta_{ii'}^t\theta_{jj'}^t)^2\Theta_{i'j'1}^1\Theta_{i'j'2}^1B_0^{H\tilde{t}_i\tilde{t}_j}]$$
$$-\frac{3\alpha_{11}\alpha_{12}}{16\pi^2(m_h^2-m_H^2)}\sum_i[h_b^2m_{\tilde{b}_i}^2(1+B_0^{0\tilde{b}_i\tilde{b}_i})+h_t^2m_{\tilde{t}_i}^2(1+B_0^{0\tilde{t}_i\tilde{t}_i})],$$

$$Z_{Hh}^{1/2}=Z_{hH}^{1/2}|_{h\leftrightarrow H},\tag{10}$$

with

$$B_n^{ijk}=(-1)^n\left\{\frac{\Delta}{n+1}-\int_0^1dy\,y^n\times\ln\left[\frac{m_i^2y(y-1)+m_j^2(1-y)+m_k^2y}{\mu^2}\right]\right\},\tag{11}$$

$$B_n'^{ijk}=(-1)^n\int_0^1dy\frac{y^{n+1}(1-y)}{m_i^2y(y-1)+m_j^2(1-y)+m_k^2y}.\tag{12}$$

The notations θ_{ij}^t, θ_{ij}^b, and Θ_{ijk}^n used in above expressions are defined in Appendix A. A_i stands for A with $i=1$ and G^0 with $i=2$. H_i^+ stands for H^+ with $i=1$ and G^+ with $i=2$. $\delta m_b/m_b$, $\delta Z_L^b,\delta Z_R^b$ can be obtained, respectively, from $\delta m_t/m_t,\delta Z_L^t,\delta Z_R^t$ by the transformation

$$h_b\leftrightarrow h_t,m_b\leftrightarrow m_t,m_{\tilde{b}_i}\leftrightarrow m_{\tilde{t}_i},\alpha_{1i}\leftrightarrow\alpha_{2i},\beta_{1i}\leftrightarrow\beta_{2i},$$

$$\theta_{ij}^b\leftrightarrow\theta_{ij}^t,N_{i4}\rightarrow N_{i3},U_{i2}\rightarrow V_{i2}.$$

The corresponding amplitude squared is

$$\overline{\sum} |M_{\rm ren}|^2 = \overline{\sum} |M_0^{(s)} + M_0^{(t)}|^2 + 2\,{\rm Re}\,\overline{\sum}\left[\left(\sum \delta M\right)(M_0^{(s)} + M_0^{(t)})^\dagger\right]. \tag{13}$$

The cross section for the process $b\bar{b} \to W^\pm H^\mp$ is

$$\hat{\sigma} = \int_{\hat{t}_-}^{\hat{t}_+} \frac{1}{16\pi \hat{s}^2} \overline{\sum} |M_{\rm ren}|^2 d\hat{t}. \tag{14}$$

with

$$\hat{t}_\pm = \frac{m_W^2 + m_{H^-}^2 - \hat{s}}{2} \pm \frac{1}{2}\sqrt{[\hat{s} - (m_W + m_{H^-})^2][\hat{s} - (m_W - m_{H^-})^2]}. \tag{15}$$

The total hadronic cross section for $pp \to b\bar{b} \to W^\pm H^\mp$ can be obtained by folding the subprocess cross section $\hat{\sigma}$ with the parton luminosity

$$\sigma(s) = \int_{(m_W + m_{H^-})/\sqrt{s}}^{1} dz \frac{dL}{dz} \hat{\sigma}(b\bar{b} \to W^\pm H^\mp \quad \text{at} \quad \hat{s} = z^2 s). \tag{16}$$

Here $\sqrt{s}$ and $\sqrt{\hat{s}}$ are the c.m. energies of the pp and $b\bar{b}$ states, respectively, and dL/dz is the parton luminosity, defined as

$$\frac{dL}{dz} = 2z \int_{z^2}^{1} \frac{dx}{x} f_{b/P}(x,\mu) f_{\bar{b}/P}(z^2/x,\mu), \tag{17}$$

where $f_{b/P}(x,\mu)$ and $f_{\bar{b}/P}(z^2/x,\mu)$ are the bottom quark and bottom antiquark parton distribution functions, respectively.

III. NUMERICAL RESULTS AND CONCLUSION

We now present some numerical results for the SUSY EW corrections to $W^\pm H^\mp$ associated production at the LHC. The SM input parameters in our calculations were taken to be $\alpha_{\rm ew}(m_Z) = 1/128.8$, $m_W = 80.375$ GeV and $m_Z = 91.1867$ GeV [18], and $m_t = 175.6$ GeV and $m_b = 4.7$ GeV, which were taken according to Ref. [10] for comparison. We used the CTEQ5M parton distributions throughout the calculations [19]. The one-loop relations [20] between the Higgs boson masses $M_{h,H,A,H^\mp}$ and the parameters α and β in the MSSM were used, and m_{H^+} and β were chosen as the two independent input parameters. Other MSSM parameters were determined as follows.

(i) For the parameters M_1, M_2 and μ in the chargino and neutralino matrix, we take M_2 and μ as the input parameters, and then used the relation $M_1 = (5/3)(g'^2/g^2)M_2 \simeq 0.5 M_2$ [2] to determine M_1.

(ii) For the parameters $m^2_{\tilde{Q},\tilde{U},\tilde{D}}$ and $A_{t,b}$ in squark mass matrices

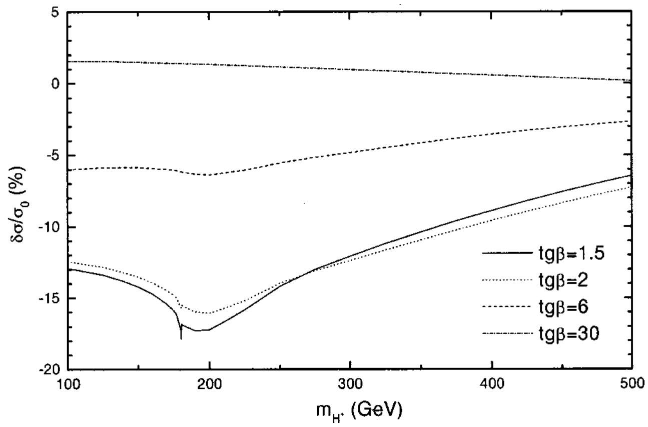

FIG. 3. The Yukawa corrections versus m_{H^+} for $\tan\beta$=1.5, 2, 6, and 30, respectively.

$$M_{\tilde{q}}^2 = \begin{pmatrix} M_{LL}^2 & m_q M_{LR} \\ m_q M_{RL} & M_{RR}^2 \end{pmatrix} \tag{18}$$

with

$$M_{LL}^2 = m_{\tilde{Q}}^2 + m_q^2 + m_Z^2 \cos 2\beta (I_q^{3L} - e_q \sin^2\theta_W),$$

$$M_{RR}^2 = m_{\tilde{U},\tilde{D}}^2 + m_q^2 + m_Z^2 \cos 2\beta e_q \sin^2\theta_W,$$

$$M_{LR} = M_{RL} = \begin{pmatrix} A_t - \mu \cot\beta & (\tilde{q} = \tilde{t}) \\ A_b - \mu \tan\beta & (\tilde{q} = \tilde{b}) \end{pmatrix}, \tag{19}$$

to simplify the calculation we assumed $M_{\tilde{Q}} = M_{\tilde{U}} = M_{\tilde{D}}$ and $A_t = A_b$, and we used $M_{\tilde{Q}}$ and A_t as the input parameters except the numerical calculations as shown in Fig. 6, where we took $m_{\tilde{t}_1}$, $m_{\tilde{b}_1}$ and $A_t = A_b$ as the input parameters. Some typical numerical calculations of the Yukawa corrections and the genuine SUSY EW corrections are given in Figs. 3, 4 and Figs. 5–9, respectively.

In Fig. 3 we present the Yukawa corrections to the total cross sections relative to the tree-level values as a function of m_{H^+} for $\tan\beta$=1.5, 2, 6 and 30. For $\tan\beta$=1.5 and 2 the corrections decrease the total cross sections significantly, which exceed −6% for $m_{H^+} < 50$ GeV and −12% for $m_{H^+} < 300$ GeV, while the lightest Higgs boson mass values have been smaller than 106 GeV and excluded by the CERN e^+e^- collider LEP. For $\tan\beta(=6)$ these corrections also decrease the total cross sections, although relatively smaller, which exceed −2.5% for $m_{H^+} < 500$ GeV and exceed −5% for $m_{H^+} < 250$ GeV. But for high $\tan\beta(=30)$ these corrections become positive, which increase the total cross sections slightly. Note that there are the peaks at $m_{H^+} = 180.3$ GeV, which arise from the singularity of the charged Higgs boson wave function renormalization constant at the threshold point $m_{H^+} = m_t + m_b$.

In Fig. 4 we show the Yukawa corrections as a function of $\tan\beta$ for m_{H^+} = 100, 150, 200, and 300 GeV. For $2 < \tan\beta < 4$ the corrections reduce the total cross sections by more than 12% when $m_{H^+} = 200$ GeV. With $m_{H^+} = 300$ GeV the corrections are only significant for $1 < \tan\beta < 5$. For m_{H^+}

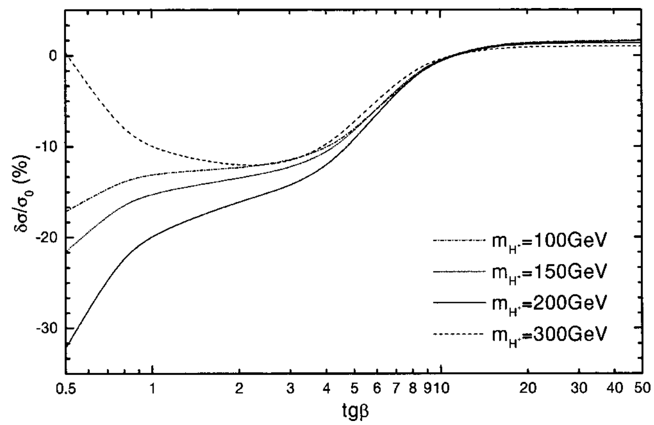

FIG. 4. The Yukawa corrections versus $\tan\beta$ for $m_{H^+}=100$, 150, 200, and 300 GeV, respectively.

$=100\,\mathrm{GeV}$, the lightest Higgs boson mass value has been excluded by the LEP. With $m_{H^+}=150\,\mathrm{GeV}$, the lightest Higgs mass value has not been excluded by the LEP only for $\tan\beta>5$, where the magnitude of the corrections is at most a few percent. For high $\tan\beta(>10)$ the corrections become negligibly small for all above m_{H^+} values.

Figure 5 gives the genuine SUSY EW corrections as a function of m_{H^+} for $\tan\beta=1.5$, 2, 6, and 30, respectively, assuming $M_2=300\,\mathrm{GeV}$, $\mu=-100\,\mathrm{GeV}$, $A_t=A_b=200\,\mathrm{GeV}$, and $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}=500\,\mathrm{GeV}$. From this figure one sees that the corrections are very small and negligible, which is reasonable because the squark masses are now very large and also the couplings of the charged Higgs boson-squarks are small for the values of $A_{t,b}$, $M_{\tilde{Q},\tilde{U},\tilde{D}}$ and μ used in those numerical calculations. In contrast, in Fig. 6 when we take the lighter squarks masses: $m_{\tilde{t}_1}=100\,\mathrm{GeV}$ and $m_{\tilde{b}_1}=150\,\mathrm{GeV}$, and put $A_t=A_b=1\,\mathrm{TeV}$, which are relatively larger, assuming $M_2=200\,\mathrm{GeV}$, $\mu=100\,\mathrm{GeV}$, and $M_{\tilde{Q}}=M_{\tilde{U}}$, the genuine SUSY EW corrections are enhanced significantly, especially for low $\tan\beta(=1.5)$ and m_{H^+} below 250 GeV, which can exceed -30%. But when $m_{H^+}>250\,\mathrm{GeV}$ the corrections increase the cross sections, which

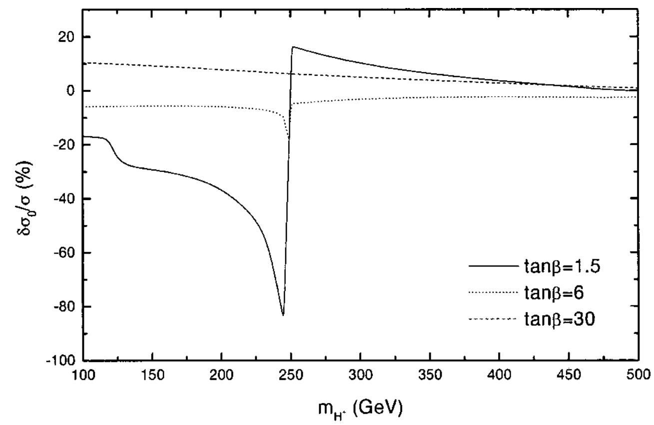

FIG. 6. The genuine SUSY EW corrections versus m_{H^+} for $\tan\beta=1.5$, 6, and 30, respectively, assuming $M_2=200\,\mathrm{GeV}$, $\mu=100\,\mathrm{GeV}$, $A_t=A_b=1\,\mathrm{TeV}$, $M_{\tilde{Q}}=M_{\tilde{U}}$, $m_{\tilde{t}_1}=100\,\mathrm{GeV}$, and $m_{\tilde{b}_1}=150\,\mathrm{GeV}$.

can exceed 10%. However, for $\tan\beta=1.5$, above lightest top-squark mass has been excluded by the Tevatron with some assumption of supersymmetric parameters, because the lightest neutrolino mass becomes now 35.7 GeV, for which the experimental bound on the lightest top-squark mass is greater than 100 GeV [21]. For $\tan\beta=6$ and 30 the corrections are at most 10% and become small with an increase of m_{H^+}. The sharp dips at $m_{H^+}=250\,\mathrm{GeV}$ are again due to the singularity of the charged Higgs boson wave function renormalization constant at the threshold point $m_{H^+}=m_{\tilde{t}_1}+m_{\tilde{b}_1}=250\,\mathrm{GeV}$.

Figures 7, 8, and 9 give the genuine SUSY EW corrections versus $A_t=A_b$, $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}$ and μ, respectively, for $\tan\beta=1.5$ and 30. In each figure we fixed $m_{H^+}=200\,\mathrm{GeV}$ and $M_2=300\,\mathrm{GeV}$, and the top-squark masses are larger than 170 GeV for the most of A_t values, which are still allowed by the experimental bound at the LEP and the Tevatron.

Figure 7 shows that the corrections are negative for $\tan\beta=1.5$ and positive for $\tan\beta=30$, assuming $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}=400\,\mathrm{GeV}$ and $\mu=100\,\mathrm{GeV}$. For both $\tan\beta=1.5$ and

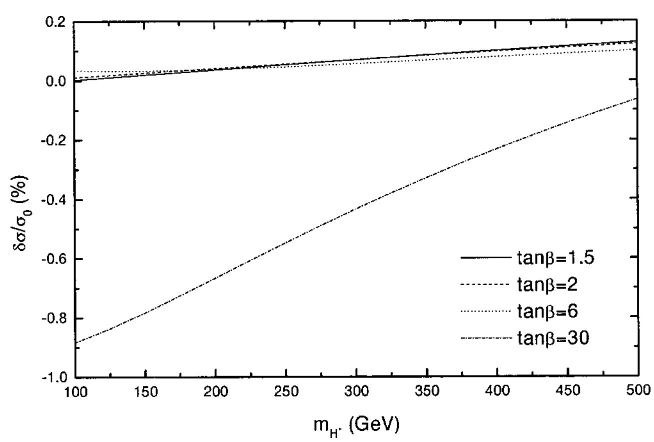

FIG. 5. The genuine SUSY EW corrections versus m_{H^+} for $\tan\beta=1.5$, 2, 6, and 30, respectively, assuming $M_2=300\,\mathrm{GeV}$, $\mu=-100\,\mathrm{GeV}$, $A_t=A_b=200\,\mathrm{GeV}$, and $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}=500\,\mathrm{GeV}$.

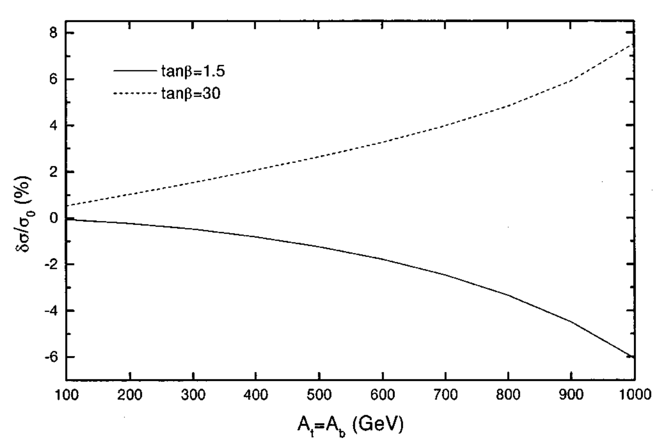

FIG. 7. The genuine SUSY EW corrections versus $A_t=A_b$ for $\tan\beta=1.5$ and 30, respectively, assuming $m_{H^+}=200\,\mathrm{GeV}$, $M_2=300\,\mathrm{GeV}$, $\mu=100\,\mathrm{GeV}$, and $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}=400\,\mathrm{GeV}$.

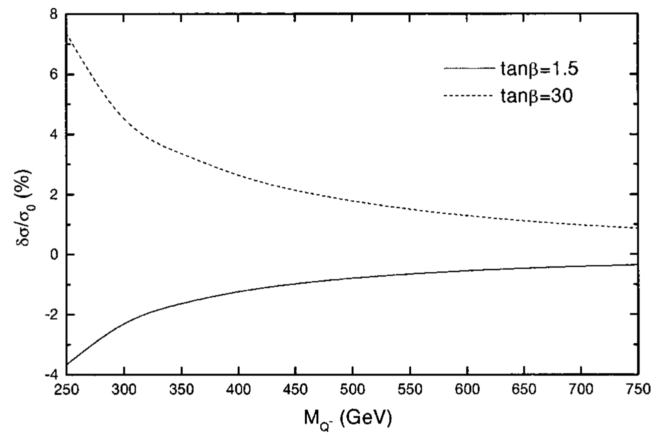

FIG. 8. The genuine SUSY EW corrections versus $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}$ for $\tan\beta=1.5$ and 30, respectively, assuming $m_{H^+}=200\,\text{GeV}$, $M_2=300\,\text{GeV}$, $\mu=100\,\text{GeV}$, and $A_t=A_b=500\,\text{GeV}$.

30 the magnitude of the corrections increases with increasing $A_t=A_b$. When $A_t=A_b=1$ TeV the corrections can reach -6 and 7.5 % for $\tan\beta=1.5$ and 30, respectively. Otherwise, when $A_t=A_b$ decrease to 100 GeV, the corrections become negligibly small. This result is due to the fact that large values of $A_t=A_b$ not only enhance the couplings, but also give a large splitting between the masses of $\tilde{t}_1(\tilde{b}_1)$ and $\tilde{t}_2(\tilde{b}_2)$, and in consequence lighter $\tilde{t}_1$ and $\tilde{b}_1$.

Figure 8 also show that the corrections are negative for $\tan\beta=1.5$ and positive for $\tan\beta=30$, assuming $A_t=A_b=500\,\text{GeV}$ and $\mu=100\,\text{GeV}$. When $M_{\tilde{Q},\tilde{U},\tilde{D}}=250\,\text{GeV}$ the corrections can reach -3.6% for $\tan\beta=1.5$ and 7.3% for $\tan\beta=30$. But the magnitude of the corrections drops below one percent when $M_{\tilde{Q},\tilde{U},\tilde{D}}$ increase to 750 GeV. This is because for larger values of $M_{\tilde{Q},\tilde{U},\tilde{D}}$ the squarks have larger masses and their virtual effects decrease due to the decoupling effects.

In Fig. 9 we present the genuine SUSY EW corrections as a function of μ, assuming $A_t=A_b=500\,\text{GeV}$ and $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}=400\,\text{GeV}$. For $\tan\beta=30$ the magnitude of the corrections increase with an increase of $|\mu|$, which varies from 0 to

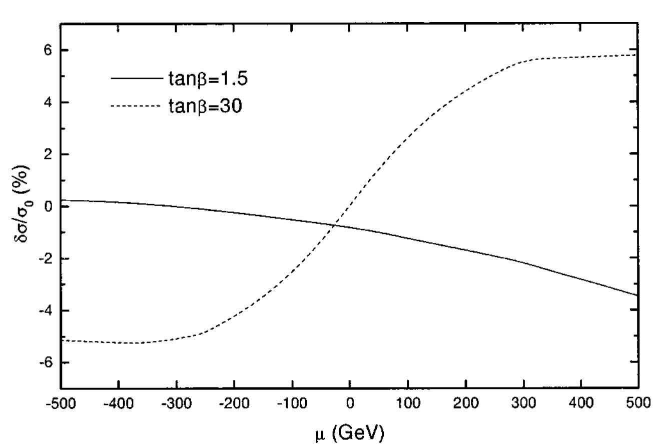

FIG. 9. The genuine SUSY EW corrections versus μ for $\tan\beta=1.5$ and 30, respectively, assuming $m_{H^+}=200\,\text{GeV}$, $M_2=300\,\text{GeV}$, $A_t=A_b=500\,\text{GeV}$, and $M_{\tilde{Q}}=M_{\tilde{U}}=M_{\tilde{D}}=400\,\text{GeV}$.

5 % when $|\mu|$ ranges between 0–500 GeV. For $\tan\beta=1.5$ the corrections are relatively small and increase slowly from about 0 to 3.5 % when μ ranges between -500–500 GeV. This result indicates that large values of μ and $\tan\beta$ can enhance the corrections significantly since the couplings become stronger.

In conclusion, we have calculated the $O(\alpha_{\text{ew}}m_{t(b)}^2/m_W^2)$ and $O(\alpha_{\text{ew}}m_{t(b)}^4/m_W^4)$ SUSY EW corrections to the cross sections for $W^{\pm}H^{\mp}$ associated production at the LHC in the MSSM. The Yukawa corrections arising from the Higgs sector can decrease the total cross sections significantly for low $\tan\beta(<4)$ when $m_{H^+}(<300)\,\text{GeV}$, which exceed -12%. For high $\tan\beta$ the Yukawa corrections become negligibly small. The genuine SUSY EW corrections can increase or decrease the total cross sections depending on the SUSY parameters, which are at most a few percent, except the region near the threshold. We also show that the genuine SUSY EW corrections depend strongly on the choice of $\tan\beta$, A_t, $M_{\tilde{Q}}$, and μ. For large values of A_t, or large values of μ and $\tan\beta$, one can get much larger corrections. The corrections can become very small, in contrast, for larger values of $M_{\tilde{Q}}$.

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APPENDIX A

We present some notations used in this paper here. We introduce an angle $\varphi=\beta-\alpha$, and for each angle α, β, φ, θ^t, or θ^b, we define

$$\alpha_{ij}=\begin{pmatrix}\cos\alpha & \sin\alpha\\ -\sin\alpha & \cos\alpha\end{pmatrix},\quad \beta_{ij}=\begin{pmatrix}\cos\beta & \sin\beta\\ -\sin\beta & \cos\beta\end{pmatrix},$$

$$\varphi_{ij}=\begin{pmatrix}\cos\varphi & \sin\varphi\\ -\sin\varphi & \cos\varphi\end{pmatrix},$$

$$\theta_{ij}^t=\begin{pmatrix}\cos\theta^t & \cos\theta^t\\ -\sin\theta^t & \cos\theta^t\end{pmatrix},\quad \theta_{ij}^b=\begin{pmatrix}\cos\theta^b & \sin\theta^b\\ -\sin\theta^b & \cos\theta^b\end{pmatrix}.$$

We define six matrix Θ_{jkl}^i, $i=1-6$ for the couplings between squarks and Higgs bosons:

$$\Theta_{ij1}^1=\frac{1}{\sqrt{2}}\begin{pmatrix}2m_t\cos\alpha & A_t\cos\alpha+\mu\sin\alpha\\ A_t\cos\alpha+\mu\sin\alpha & 2m_t\cos\alpha\end{pmatrix},$$

$$\Theta_{ij2}^1=\frac{1}{\sqrt{2}}\begin{pmatrix}2m_t\sin\alpha & A_t\sin\alpha-\mu\cos\alpha\\ A_t\sin\alpha-\mu\cos\alpha & 2m_t\sin\alpha\end{pmatrix},$$

$$\Theta^2_{ij1}=\frac{-1}{\sqrt{2}}\begin{pmatrix} 2m_b\sin\alpha & A_b\sin\alpha+\mu\cos\alpha \\ A_b\sin\alpha+\mu\cos\alpha & 2m_b\sin\alpha \end{pmatrix},$$

$$\Theta^2_{ij2}=\frac{1}{\sqrt{2}}\begin{pmatrix} 2m_b\cos\alpha & A_b\cos\alpha-\mu\sin\alpha \\ A_b\cos\alpha-\mu\sin\alpha & 2m_b\cos\alpha \end{pmatrix},$$

$$\Theta^3_{ij1}=\frac{1}{\sqrt{2}}\begin{pmatrix} 0 & A_t\cos\beta+\mu\sin\beta \\ -A_t\cos\beta-\mu\sin\beta & 0 \end{pmatrix},$$

$$\Theta^3_{ij2}=\frac{1}{\sqrt{2}}\begin{pmatrix} 0 & A_t\sin\beta-\mu\cos\beta \\ -A_t\sin\beta+\mu\cos\beta & 0 \end{pmatrix},$$

$$\Theta^4_{ij1}=\frac{1}{\sqrt{2}}\begin{pmatrix} 0 & A_b\sin\beta+\mu\cos\beta \\ -A_b\sin\beta-\mu\cos\beta & 0 \end{pmatrix},$$

$$\Theta^4_{ij2}=\frac{1}{\sqrt{2}}\begin{pmatrix} 0 & -A_b\cos\beta+\mu\sin\beta \\ A_b\cos\beta-\mu\sin\beta & 0 \end{pmatrix},$$

$$\Theta^5_{ij1}=\begin{pmatrix} m_b\sin\beta & 0 \\ A_b\sin\beta+\mu\cos\beta & m_t\sin\beta \end{pmatrix},$$

$$\Theta^5_{ij2}=\begin{pmatrix} -m_b\cos\beta & 0 \\ -A_b\cos\beta+\mu\sin\beta & 0 \end{pmatrix},$$

$$\Theta^6_{ij1}=\begin{pmatrix} m_t\cos\beta & A_t\cos\beta+\mu\sin\beta \\ 0 & m_b\cos\beta \end{pmatrix},$$

$$\Theta^6_{ij2}=\begin{pmatrix} m_t\sin\beta & A_t\sin\beta-\mu\cos\beta \\ 0 & 0 \end{pmatrix}.$$

APPENDIX B

The form factors defined in Eq. (9) are the following:

$$\begin{aligned}
f_1^{V_1(s)}(H)=&\sum_{ij}\frac{gh_b^3\alpha_{2i}^2\alpha_{2j}\varphi_{j1}}{32\sqrt{2}\pi^2(\hat{s}-m_{H_j}^2)}\{B_0^{bbH_i}+[4m_b^2C_0+(4m_b^2+\hat{s})C_1](\hat{s},m_b^2,m_b^2,m_b^2,m_b^2,m_{H_i}^2)\}\\
&+\sum_{i,j}\frac{-gh_b^3\beta_{2i}^2\alpha_{2j}\varphi_{j1}}{32\sqrt{2}\pi^2(\hat{s}-m_{H_j}^2)}[B_0^{bbA_i}-(4m_b^2-\hat{s})C_1(\hat{s},m_b^2,m_b^2,m_b^2,m_b^2,m_{A_i}^2)]\\
&+\sum_{ij}\frac{gh_t\alpha_{1j}\varphi_{j1}}{16\sqrt{2}\pi^2(\hat{s}-m_{H_j}^2)}\{-h_bh_t\beta_{1i}\beta_{2i}B_0^{btH_i^+}+[(h_t^2m_bm_t\beta_{1i}^2+2h_bh_tm_t^2\beta_{1i}\beta_{2i}+h_b^2m_bm_t\beta_{2i}^2)C_0\\
&+(2h_t^2m_bm_t\beta_{1i}^2+h_bh_t\hat{s}\beta_{1i}\beta_{2i}+2h_b^2m_bm_t\beta_{2i}^2)C_1](\hat{s},m_b^2,m_b^2,m_t^2,m_t^2,m_{H_i^+}^2)\}\\
&+\sum_{i,j,k,l}\sum_{i'j'}\frac{gh_t\varphi_{l1}\theta^t_{ii'}\theta^t_{jj'}\Theta^1_{j'i'l}}{16\pi^2(\hat{s}-m_{H_l}^2)}[h_b^2m_b\theta^t_{i1}\theta^t_{j1}\theta|U_{k2}|^2(C_0+C_1+C_2)+m_{\tilde{\chi}_k^+}h_bh_t\theta^t_{i2}\theta^t_{j1}U_{k2}V_{k2}C_0\\
&-h_t^2m_b\theta^t_{i2}\theta^t_{j2}|V_{j2}|^2C_1](\hat{s},m_b^2,m_b^2,m_{\hat{t}_i}^2,m_{\hat{t}_j}^2,m_{\tilde{\chi}_k^+})+\sum_{i,j,k,l}\sum_{j',k'}\frac{gh_b^3\varphi_{i1}\theta^b_{jj'}\theta^b_{kk'}N_{l3}\Theta^2_{j'k'i}}{16\pi^2(\hat{s}-m_{H_i}^2)}\\
&\times[m_b\theta^b_{j1}\theta^b_{k1}N^*_{13}(C_0+C_1+C_2)-m_b\theta^b_{j2}\theta^b_{k2}N^*_{l3}C_1+m_{\tilde{\chi}_l^0}\theta^b_{j1}\theta^b_{k2}N_{l3}C_0](\hat{s},m_b^2,m_b^2,m_{\tilde{b}_j}^2,m_{\hat{b}_k}^2,m_{\tilde{\chi}_l^0}),
\end{aligned}$$

$$f_2^{V_1(s)}(H)=f_1^{V_1(s)}(H)(h_b\theta^t_{n1}\leftrightarrow h_t\theta^t_{n2},\theta^b_{n1}\leftrightarrow\theta^b_{n2}\leftrightarrow\theta^b_{n2},U_{n2}\leftrightarrow V^*_{n2},N_{n3}\leftrightarrow N^*_{n3}),$$

$$f_3^{V_1(s)}(H)=f_1^{V_1(s)}(H),$$

$$f_4^{V_1(s)}(H)=f_2^{V_1(s)}(H);$$

$$f_i^{V_1(s)}(A)=f_i^{V_1(s)}(A)_a+f_i^{V_1(s)}(A)_b,$$

where

$$f_1^{V_1(s)}(A)_a=\sum_{i,j,k}\sum_{i',j'}\frac{gh_t\theta^t_{ii'}\theta^t_{jj'}\Theta^3_{j'i'1}}{16\pi^2(\hat{s}-m_A^2)}[-h_b^2m_b\theta^t_{i1}\theta^t_{j1}|U_{j2}|^2(C_0+C_1+C_2)-m_{\tilde{\chi}_k^+}h_bh_t\theta^t_{i2}\theta^t_{j1}U_{k2}V_{k2}C_0$$

$$+h_t^2m_b\theta^t_{i1}\theta^t_{j2}|V_{j2}|^2C_2](\hat{s},m_b^2,m_b^2,m^2_{\tilde{t}_i},m^2_{\tilde{t}_j},m_{\tilde{\chi}_k^+})+\sum_{i,j,k}\sum_{i',j'}\frac{gh_b^3N_{k3}\theta^b_{ii'}\theta^b_{jj'}\Theta^4_{j'k'i}}{16\pi^2(\hat{s}-m_A^2)}$$

$$\times[-m_b\theta^b_{i1}\theta^b_{j1}N^*_{k3}(C_1+C_2+C_3)+m_b\theta^b_{i2}\theta^b_{j1}N^*_{k3}C_1-m_{\tilde{\chi}_k^0}\theta^b_{j1}\theta^b_{i2}N_{k3}C_0](\hat{s},m_b^2,m_b^2,m^2_{\tilde{b}_i},m^2_{\tilde{b}_j},m_{\tilde{\chi}_k^0}),$$

$$f_2^{V_1(s)}(A)_a=f_1^{V_1(s)}(A)_a(h_b\theta^t_{n1}\leftrightarrow h_t\theta^t_{n2},\theta^b_{n1}\leftrightarrow\theta^b_{n2},U_{n2}\leftrightarrow V^*_{n2},N_{n3}\leftrightarrow N^*_{n3}),$$

$$f_3^{V_1(s)}(A)_a=f_1^{V_1(s)}(A)_a,$$

$$f_4^{V_1(s)}(A)_a=f_2^{V_1(s)}(A)_a,$$

$$f_1^{V_1(s)}(A)_b=\sum_i\frac{gh_b^3\alpha_{2i}^2\beta_{21}}{32\sqrt{2}\pi^2(\hat{s}-m_A^2)}\{B_0^{bbH_i}-[4m_b^2C_0+(4m_b^2-\hat{s})C_1](\hat{s},m_b^2,m_b^2,m_b^2,m_b^2,m^2_{H_i})\}+\sum_i\frac{-gh_b^3\beta_{2i}^2\beta_{21}}{32\sqrt{2}\pi^2(\hat{s}-m_A^2)}$$

$$\times[B_0^{bbA_i}-(4m_b^2-\hat{s})C_1(\hat{s},m_b^2,m_b^2,m_b^2,m_b^2,m^2_{A_i})]+\sum_i\frac{gh_t\beta_{11}}{16\sqrt{2}\pi^2(\hat{s}-m_A^2}\{h_bh_t\beta_{1i}\beta_{2i}B_0^{btH_i^+}$$

$$+[(h_t^2m_bm_t\beta_{1i}^2-2h_bh_tm_b^2\beta_{1i}\beta_{2i}+h_b^2m_bm_t\beta_{2i}^2)C_0-h_bh_t(4m_b^2-\hat{s})\beta_{1i}\beta_{2i}C_1](\hat{s},m_b^2,m_b^2,m_t^2,m_t^2,m^2_{H_i^+})\},$$

$$f_2^{V_1(s)}(A)_b=-f_3^{V_1(s)}(A)_b=f_4^{V_1(s)}(A)_b=-f_1^{V_1(s)}(A)_b;$$

$$f_1^{s(s)}(H)=\sum_{i,j}\frac{-gh_b^3\alpha_{2i}^2\alpha_{2j}\varphi_{j1}}{8\sqrt{2}\pi^2(\hat{s}-m^2_{H_i})(\hat{s}-m^2_{H_j})}[m_b^2(1+B_0^{0bb})+(2m_b^2B_0^{\hat{s}bb}+\hat{s}B_1^{\hat{s}bb})]+\sum_{i,j}\frac{-gh_bh_t^2\alpha_{1j}\alpha_{1j}\alpha_{2i}\varphi_{j1}}{8\sqrt{2}\pi^2(\hat{s}-m^2_{H_i})(\hat{s}-m^2_{H_j})}$$

$$\times[m_t^2(1+B_0^{0tt})+(2m_t^2B_0^{\hat{s}tt}+\hat{s}B_1^{\hat{s}tt})]+\sum_{i,j,k,l}\sum_{i',j'}\frac{gh_b^3\alpha_{2k}\varphi_{l1}(\theta^b_{jj'})^2(\theta^b_{ii'})^2\Theta^2_{i'j'k}\Theta^2_{j'i'l}}{16\sqrt{2}\pi^2(\hat{s}-m^2_{H_l})(\hat{s}-m^2_{H_k})}B_0^{\hat{s}\tilde{b}_i\tilde{b}_j}$$

$$+\sum_{i,j,k,l}\sum_{i',j'}\frac{gh_bh_t^2\alpha_{2l}\varphi_{k1}(\theta^t_{jj'})^2(\theta^t_{ii'})^2\Theta^1_{i'j'l}\Theta^1_{j'i'k}}{16\sqrt{2}\pi^2(\hat{s}-m^2_{H_l})(\hat{s}-m^2_{H_k})}B_0^{\hat{s}\tilde{t}_i\tilde{t}_j}+\sum_{i,j,k}\frac{3gh_b\alpha_{2i}\varphi_{j1}}{16\sqrt{2}\pi^2(\hat{s}-m^2_{H_i})(\hat{s}-m^2_{H_j})}$$

$$\times[h_b^2\alpha_{2i}\alpha_{2j}A_0(m^2_{\tilde{b}_k})+h_t^2\alpha_{1i}\alpha_{1j}A_0(m^2_{\tilde{t}_k})],$$

$$f_2^{s(s)}(H)=f_3^{s(s)}(H)=f_4^{s(s)}(H)=f_1^{s(s)}(H);$$

$$f_1^{s(s)}(A)=\frac{gh_b^3\beta_{2l}^3}{8\sqrt{2}\pi^2(\hat{s}-m_A^2)^2}[m_b^2(1+B_0^{0bb})+\hat{s}B_1^{\tilde{s}bb}]+\frac{gh_b\beta_{11}^2\beta_{21}}{8\sqrt{2}\pi^2(\hat{s}-m_A^2)^2}[m_t^2(1+B_0^{0tt})+\hat{s}B_1^{\tilde{s}tt}]$$

$$-\sum_{i,j}\sum_{i',j'}\frac{gh_b^3\beta_{21}(\theta^b_{jj'})^2(\theta^b_{ii'})^2(\Theta^4_{i'j'1})^2}{16\sqrt{2}\pi^2(\hat{s}-m_A^2)^2}B_0^{\hat{s}\tilde{b}_i\tilde{b}_j}-\sum_{i,j}\sum_{i',j'}\frac{-gh_bh_t^2\beta_{21}(\theta^t_{jj'})^2(\theta^t_{ii'})^2(\Theta^3_{i'j'l})^2}{16\sqrt{2}\pi^2(\hat{s}-m_A^2)^2}B_0^{\hat{s}\tilde{t}_i\tilde{t}_j}$$

$$-\sum_k\frac{3gh_b\beta_{21}}{16\sqrt{2}\pi^2(\hat{s}-m_A^2)^2}[h_b^2\beta_{21}^2A_0(m^2_{\tilde{b}_k})+h_t^2\beta_{11}^2A_0(m^2_{\tilde{t}_k})],$$

$$f_2^{s(s)}(A)=-f_3^{s(s)}(A)=f_4^{s(s)}(A)=-f_1^{s(s)}(A);$$

$$
\begin{aligned}
f_1^{V_2(s)}(H)=&\sum_i \frac{-gh_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2(\hat{s}-m_{H_i}^2)}\Bigg\{\frac{3}{2}h_b\beta_{21}B_0^{\hat{s}bb}+[(h_t m_b m_t\beta_{11}+h_b m_t^2\beta_{21})C_0+h_b m_W^2\beta_{21}C_1-(h_b m_b^2\beta_{21}+h_b m_t^2\beta_{21}\\
&-2h_t m_b m_t\beta_{11})C_2-2h_b\beta_{21}C_{00}-h_b\beta_{21}(\hat{t}+\hat{u}-2m_b^2)C_{12}-2h_b m_H^2+\beta_{21}C_{22}](\hat{s},m_{H^+}^2,m_W^2,m_b^2,m_t^2)\Bigg\}\\
&+\sum_i \frac{gh_b h_t\alpha_{1i}\alpha_{2i}}{16\sqrt{2}\pi^2(\hat{s}-m_{H_i}^2)}\Bigg\{\frac{3}{2}h_t\beta_{11}B_0^{\hat{s}tt}+[(h_t m_b^2\beta_{11}-h_b m_b m_t\beta_{21})C_0+h_t m_W^2\beta_{11}C_1-(h_t m_b^2\beta_{11}+h_t m_t^2\beta_{11}\\
&-2h_b m_b m_t\beta_{21})C_2-2h_t\beta_{11}C_{00}-h_t\beta_{11}(\hat{t}+\hat{u}-2m_b^2)C_{12}-2h_t m_H^2+\beta_{11}C_{22}](\hat{s},m_{H^+}^2,m_W^2,m_t^2,m_t^2,m_b^2)\Bigg\}\\
&+\sum_{i,j,k,l}\sum_{i',j',k'}\frac{gh_b^2}{16\pi^2(\hat{s}-m_{H_l}^2)}\alpha_{2l}(\theta_{ii'}^b)^2\theta_{j1}^b\theta_{jj'}^b\theta_{k1}^t\theta_{kk'}^t\Theta_{i'j'l}^2(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)\\
&\times C_2(\hat{s},m_{H^+}^2,m_W^2,m_{\tilde{b}_j}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2)+\sum_{i,j,k,l}\sum_{i',j',k'}\frac{gh_b h_t}{16\pi^2(\hat{s}-m_{H_l}^2)}\alpha_{2l}(\theta_{ii'}^t)^2\theta_{j1}^t\theta_{jj'}^t\theta_{k1}^b\theta_{kk'}^b\Theta_{j'i'l}^1\\
&\times(h_b\Theta_{k'i'1}^5+h_t\Theta_{k'i'1}^6)C_2(\hat{s},m_{H^+}^2,m_W^2,m_{\tilde{t}_j}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_k}^2),
\end{aligned}
$$

$$f_2^{V_2(s)}(H)=f_3^{V_2(s)}(H)=f_4^{V_2(s)}(H)=f_1^{V_2(s)}(H);$$

$$
\begin{aligned}
f_1^{V_2(s)}(A)=&\frac{-gh_b^2\beta_{21}^2}{16\sqrt{2}\pi^2(\hat{s}-m_A^2)}\Bigg\{\frac{3}{2}h_b\beta_{21}B_0^{\hat{s}bb}-[(h_t m_b m_t\beta_{11}-h_b m_t^2\beta_{21})C_0+h_b m_W^2\beta_{21}C_1+h_b\beta_{21}(m_b^2-m_t^2)C_2\\
&-2h_b\beta_{21}C_{00}-h_b\beta_{21}(\hat{t}+\hat{u}-2m_b^2)C_{12}-2h_b m_{H^+}^2\beta_{21}C_{22}](\hat{s},m_{H^+}^2,m_W^2,m_b^2,m_b^2,m_t^2)\Bigg\}+\frac{-gh_b h_t\beta_{11}\beta_{21}}{16\sqrt{2}\pi^2(\hat{s}-m_A^2)}\\
&\times\Bigg\{\frac{3}{2}h_t\beta_{11}B_0^{\hat{s}tt}+[(h_t m_b^2\beta_{11}-h_b m_b m_t\beta_{21})C_0+h_t m_W^2\beta_{11}C_1-h_t\beta_{11}(m_b^2-m_t^2)C_2-2h_t\beta_{11}C_{00}\\
&-h_t\beta_{11}(\hat{t}+\hat{u}-2m_b^2)C_{12}-2h_t m_{H^+}^2\beta_{11}C_{22}](\hat{s},m_{H^+}^2,m_W^2,m_t^2,m_t^2,m_b^2)\Bigg\}\\
&+\sum_{i,j,k}\sum_{i',j',k'}\frac{-gh_b^2}{16\pi^2(\hat{s}-m_A^2)}\beta_{21}(\theta_{ii'}^b)^2\theta_{j1}^b\theta_{jj'}^b\theta_{k1}^t\theta_{kk'}^t\Theta_{i'j'1}^4(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)\\
&\times C_2(\hat{s},m_{H^+}^2,m_W^2,m_{\tilde{b}_j}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2)+\sum_{i,j,k}\sum_{i',j',k'}\frac{gh_b h_t}{16\pi^2(\hat{s}-m_{A_l}^2)}\beta_{21}(\theta_{ii'}^t)^2\theta_{j1}^t\theta_{jj'}^t\theta_{k1}^b\theta_{kk'}^b\Theta_{j'i'1}^3\\
&\times(h_b\Theta_{k'i'1}^5+h_t\Theta_{k'i'1}^6)C_2(\hat{s},m_{H^+}^2,m_W^2,m_{\tilde{t}_j}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_k}^2),
\end{aligned}
$$

$$f_2^{V_2(s)}(A)=-f_3^{V_2(s)}(A)=f_4^{V_2(s)}(A)=-f_1^{V_2(s)}(A);$$

$$
\begin{aligned}
f_1^{V_1(t)}=&\sum_i \frac{-gh_b h_t^2\alpha_{1i}\alpha_{2i}\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{-B_0^{Wbt}+[-m_{H_i}^2C_0+2C_{00}+m_b^2C_{11}+(m_b^2+\hat{t})C_{12}+\hat{t}C_{22}](m_b^2,m_W^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)\}\\
&+\sum_i \frac{-gh_b h_t^2\beta_{1i}\beta_{2i}\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{-B_0^{Wbt}+[-m_{A_i}^2C_0+2C_{00}+m_b^2C_{11}+(m_b^2+\hat{t})C_{12}+\hat{t}C_{22}](m_b^2,m_W^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)\}\\
&+\sum_{i,j}\frac{-gh_t^2\alpha_{1i}\beta_{11}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[(h_t m_b m_t\beta_{1j}-h_b m_t^2\beta_{2j})C_0+h_b\beta_{2j}(m_b^2-m_t^2)C_1+h_b\beta_{2j}(\hat{t}-m_t^2)C_2+2h_b\beta_{2j}C_{00}
\end{aligned}
$$

$$+(-h_t m_b m_t \beta_{1j}+h_b m_b^2 \beta_{2j}+h_b \hat{t}\beta_{2j})C_{12}+(h_b\hat{t}\beta_{2j}-h_t m_b m_t \beta_{1j})C_{22}](m_b^2,m_W^2,\hat{t},m_t^2,m_{H_j^+}^2,m_{H_i}^2)$$

$$+\sum_i \frac{g h_t^2 \beta_{11}\beta_{1i}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_t m_b m_t \beta_{1i}(C_0+2C_1+2C_2+C_{11}+2C_{12}+C_{22})+2h_b\beta_{2i}C_{00}+h_b m_t^2\beta_{2i}(C_0+C_1+C_2)$$

$$+h_b m_b^2 \beta_{2i}(C_1+C_{11}+C_{12})+h_b\beta_{2i}\hat{t}(C_2+C_{12}+C_{22})](m_b^2,m_W^2,\hat{t},m_t^2,m_{H_i^+}^2,m_{A_i}^2)$$

$$+\sum_{i,j}\frac{g h_b h_t \alpha_{2j}\beta_{11}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_t m_b^2\beta_{1i}(C_0+C_2-C_{11}-C_{12})-2h_t\beta_{1i}C_{00}+h_b m_b m_t\beta_{2i}(-C_0+C_{11}+2C_{12}+C_{22})$$

$$-h_t\beta_{1i}\hat{t}(C_2+C_{12}+C_{22})](m_b^2,m_W^2,\hat{t},m_b^2,m_{H_j}^2,m_{H_i^+}^2)+\sum_{i,j,k}\frac{-g h_b h_t^2\beta_{11}\theta_{j1}^b\theta_{i1}^t}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{N_{k3}N_{k4}^*\theta_{j1}^b\theta_{i1}^t[m_b^2(C_1+C_{11}+C_{12})$$

$$+\hat{t}(C_2+C_{12}+C_{22})+2C_{00}]-(N_{k3}^*N_{k4}^*\theta_{j2}^b\theta_{i1}^t m_b m_{\tilde{\chi}_k^0}+N_{k3}N_{k4}\theta_{j1}^b\theta_{i2}^t m_t m_{\tilde{\chi}_k^0})(C_0+C_1+C_2)$$

$$+N_{k3}^*N_{k4}m_b m_t\theta_{j1}^b\theta_{i2}^t(C_1+C_2+C_{11}+2C_{12}+C_{22})\}(m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)+\sum_{i,j,k}\frac{g h_t^2\beta_{11}N_{i4}^*\theta_{k1}^t}{8\pi^2(\hat{t}-m_t^2)}$$

$$\times(-h_b\theta_{k1}^t O_{ji}^{R*}U_{j2}B_0^{W\tilde{\chi}_j^+\tilde{\chi}_i^0}+\{h_b\theta_{k1}^t U_{j2}[m_{\tilde{\chi}_j^+}m_{\tilde{\chi}_i^0}O_{ji}^{L*}C_0+O_{ji}^{R*}(2C_{00}+m_b^2C_{11}+m_b^2C_{12}+\hat{t}C_{12}+\hat{t}C_{22}$$

$$-m_{\tilde{t}_k}^2C_0)]+h_t m_b O_{ji}^{L*}V_{j2}\theta_{k2}^t(C_0+C_1+C_2)\}(m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2))$$

$$+\sum_{i,j,k}\frac{g h_t^2 m_t\beta_{11}\theta_{k2}^t O_{ji}^{L*}N_{i4}}{8\pi^2(\hat{t}-m_t^2)}[h_b m_{\tilde{\chi}_j^+}\theta_{k1}^t(C_0+C_1+C_2)+h_t m_b\theta_{k2}^t V_{j2}(C_0+2C_1+C_{11}+2C_{12}+2C_2+C_{22})]$$

$$\times(m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)+\sum_{i,j,k}\frac{g h_b h_t\beta_{11}}{8\pi^2(\hat{t}-m_t^2)}\{h_t(\theta_{k1}^b)^2N_{j3}V_{i2}O_{ij}^{L*}B_0^{W\tilde{\chi}_i^+\tilde{\chi}_j^0}-[h_t(\theta_{kl}^b)^2N_{j3}V_{i2}(O_{ij}^{L*}(2C_{00}$$

$$+m_b^2(C_{11}+C_{12})-m_{\tilde{b}_k}^2C_0+\hat{t}(C_{12}+C_{12}))+m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{R*}C_0)+\theta_{k1}^b\theta_{k2}^b O_{ij}^{R*}(h_b m_t m_{\tilde{\chi}_j^0}N_{j3}U_{i2}+h_t m_b m_{\tilde{\chi}_i^+}N_{j3}^*V_{i2})$$

$$\times(C_0+C_1+C_2)+h_b m_b m_t(\theta_{k2}^b)^2N_{j3}^*U_{i2}O_{ij}^{R*}(C_0+2C_1+C_{11}+2C_{12}+2C_2+C_{22})](m_b^2,m_W^2,\hat{t},m_{\tilde{b}_k}^2,m_{\tilde{\chi}_j^0}^2,m_{\tilde{\chi}_i^+}^2)\}$$

$$f_2^{V_1(t)}=\sum_i\frac{-g h_b^2 h_t m_b m_t\alpha_{1i}\alpha_{2i}\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(4C_0+4C_1+4C_2+C_{11}+2C_{12}+C_{22})(m_b^2,m_W^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)$$

$$+\sum_i\frac{g h_b^2 h_t m_b m_t\beta_{1i}\beta_{2i}\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(C_{11}+2C_{12}+C_{22})(m_b^2,m_W^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)$$

$$+\sum_{i,j}\frac{-g h_b h_t\alpha_{1i}\beta_{21}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[(h_b m_b m_t\beta_{2j}-h_t m_t^2\beta_{1j})+h_t\beta_{1j}(m_b^2-m_t^2)C_1+h_t\beta_{1j}(\hat{t}-m_t^2)C_2+2h_t\beta_{1j}C_{00}$$

$$+(-h_b m_b m_t\beta_{2j}+h_t m_b^2\beta_{1j}+h_t\hat{t}\beta_{1j})C_{12}+(h_t\hat{t}\beta_{1j}-h_b m_b m_t\beta_{2j})C_{22}](m_b^2,m_W^2,\hat{t},m_t^2,m_{H_j^+}^2,m_{H_i}^2)$$

$$+\sum_i\frac{-g h_b h_t\beta_{1i}\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_b m_b m_t\beta_{2i}(C_0+2C_1+2C_2+C_{11}+2C_{12}+C_{22})+2h_t\beta_{1i}C_{00}$$

$$+h_t m_t^2\beta_{1i}(C_0+C_1+C_2)+h_t m_b^2\beta_{1i}(C_1+C_{11}+C_{12})+h_t\beta_{1i}\hat{t}(C_2+C_{12}+C_{22})](m_b^2,m_W^2,\hat{t},m_t^2,m_{H_i^+}^2,m_{A_i}^2)$$

$$+\sum_{i,j}\frac{gh_b^2\alpha_{2j}\beta_{21}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_b m_b^2\beta_{2i}(C_0+C_2-C_{11}-C_{12})-2h_b\beta_{2i}C_{00}$$

$$+h_t m_b m_t\beta_{1i}(-C_0+C_{11}+2C_{12}+C_{22})-h_b\beta_{2i}\hat{t}(C_2+C_{12}+C_{22})](m_b^2,m_W^2,\hat{t},m_b^2,m_{H_j}^2,m_{H_i^+}^2)$$

$$+\sum_{i,j,k}\frac{gh_b^2h_t\beta_{21}\theta_{j1}^b\theta_{i1}^t}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{N_{k3}N_{k4}^*\theta_{j1}^b\theta_{i1}^t m_b m_t(C_1+C_2+C_{11}+2C_{12}+C_{22})-(N_{k3}^*N_{k4}^*\theta_{j2}^b\theta_{i1}^t m_t m_{\tilde{\chi}_k^0}$$

$$+N_{k3}N_{k4}\theta_{j1}^b\theta_{i2}^t m_b m_{\tilde{\chi}_k^0})(C_0+C_1+C_2)+N_{k3}^*N_{k4}\theta_{j2}^b\theta_{i2}^t[m_b^2(C_1+C_{11}+C_{12})+\hat{t}(C_2+C_{12}+C_{22})+2C_{00}]\}$$

$$\times(m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)+\sum_{i,j,k}\frac{gh_bh_t\beta_{12}\theta_{k2}^tN_{i4}}{8\pi^2(\hat{t}-m_t^2)}\{-h_t\theta_{k2}^tO_{ji}^{L*}V_{j2}B_0^{W\tilde{\chi}_j^+\tilde{\chi}_i^0}+[h_b m_b m_{\tilde{\chi}_i^0}\theta_{k1}^tO_{ji}^{R*}U_{j2}(C_0+C_1$$

$$+C_2)+h_t\theta_{k2}^tO_{ji}^{L*}V_{j2}(2C_{00}+m_b^2C_{11}+m_b^2C_{12}+\hat{t}C_{12}+\hat{t}C_{22}-m_{\tilde{t}_k}^2C_0+m_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}C_0)]$$

$$\times(m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{t}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}+\sum_{i,j,k}\frac{gh_bh_tm_t\beta_{12}\theta_{k1}^tO_{ji}^{R*}N_{i4}^*}{8\pi^2(\tilde{t}-m_t^2)}[h_b m_b\theta_{k1}^tU_{j2}(C_0+2C_1+C_{11}+2C_{12}+2C_2$$

$$+C_{22})+h_t m_{\tilde{\chi}_j^+}\theta_{k2}^tV_{j2}(C_0+C_1+C_2)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)$$

$$-\sum_{i,j,k}\frac{gh_b^2\beta_{21}}{8\pi^2(\hat{t}-m_t^2)}\{h_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}O_{ij}^{R*}B_0^{W\tilde{\chi}_i^+\tilde{\chi}_j^0}-[h_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}(O_{ij}^{R*}(2C_{00}+m_b^2(C_{11}+C_{12})-m_{\tilde{b}_k}^2C_0$$

$$+\hat{t}(C_{12}+C_{22}))+m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{L*}C_0)+\theta_{k1}^b\theta_{k2}^bO_{ij}^{L*}(h_tm_tm_{\tilde{\chi}_j^0}N_{j3}^*V_{i2}+h_bm_bm_{\tilde{\chi}_i^+}N_{j3}U_{i2})(C_0+C_1+C_2)$$

$$+h_tm_bm_t(\theta_{k1}^b)^2N_{j3}V_{i2}O_{ij}^{L*}(C_0+2C_1+C_{11}+2C_{12}+2C_2+C_{22})](m_b^2,m_W^2,\hat{t},m_{\tilde{b}_k}^2,m_{\tilde{\chi}_j^0}^2,m_{\tilde{\chi}_i^+}^2)\},$$

$$f_5^{V_1(t)}=\sum_i\frac{gh_b^2h_tm_t\alpha_{1i}\alpha_{2i}\beta_{21}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{B_0^{Wbt}+[(4m_b^2+m_{H_i}^2)C_0+4m_b^2C_1+2(m_b^2+\hat{t})C_2-2C_{00}](m_b^2,m_W^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)\}$$

$$+\sum_i\frac{-gh_b^2h_tm_t\beta_{1i}\beta_{2i}\beta_{21}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}[B_0^{Wbt}+(m_{A_i}^2C_0-2C_{00})(m_b^2,m_W^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)]+\sum_{ij}\frac{gh_bh_t\alpha_{1i}\beta_{21}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}$$

$$\times(h_tm_b\beta_{1j}+h_bm_t\beta_{2j})C_{00}(m_b^2,m_W^2,\hat{t},m_{H_j^+}^2,m_{H_i}^2)+\sum_i\frac{gh_bh_t\beta_{1i}\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}$$

$$\times(h_tm_b\beta_{1i}-h_bm_t\beta_{2i})C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_i^+}^2,m_{A_i}^2)+\sum_{i,j}\frac{gh_b^2\alpha_{2j}\beta_{21}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(h_tm_t\beta_{1i}$$

$$+h_bm_b\beta_{2i})C_{00}(m_b^2,m_W^2,\hat{t},m_b^2,m_{H_j}^2,m_{H_i^+}^2)+\sum_{i,j,k}\frac{-gh_b^2h_t\beta_{21}\theta_{j1}^b\theta_{i1}^t}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}(m_bN_{k3}^*N_{k4}\theta_{j2}^b\theta_{i2}^t$$

$$-m_tN_{k3}N_{k4}^*\theta_{j1}^b\theta_{i1}^t)C_{00}(m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)+\sum_{i,j,k}\frac{gh_bh_t\beta_{12}\theta_{k2}^tN_{i4}}{16\pi^2(\hat{t}-m_t^2)}\{-h_tm_b\theta_{k2}^tO_{ji}^{L*}V_{j2}B_0^{W\tilde{\chi}_j^+\tilde{\chi}_i^0}$$

$$+[-h_bm_{\tilde{\chi}_j^+}\theta_{k1}^tO_{ji}^{L*}U_{j2}(m_b^2C_1+\hat{t}C_0+\hat{t}C_2)+h_bm_{\tilde{\chi}_i^0}O_{ji}^{R*}U_{j2}(m_b^2C_0+m_b^2C_1+\hat{t}C_2)$$

$$-h_tm_b\theta_{k2}^tO_{ji}^{L*}V_{j2}(-2C_{00}-m_b^2C_1+\hat{t}(C_0+C_1+2C_2)+m_{\tilde{t}_k}^2C_0-m_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}C_0)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}$$

$$+\sum_{i,j,k}\frac{gh_bh_tm_t\beta_{12}\theta_{k1}^tN_{i4}^*}{16\pi^2(\hat{t}-m_t^2)}\{h_b\theta_{k1}^tO_{ji}^{R*}U_{j2}B_0^{W\tilde{\chi}_j^+\tilde{\chi}_i^0}+[-h_bm_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}\theta_{k1}^tO_{ji}^{L*}U_{j2}C_0+h_b\theta_{k1}^tO_{ji}^{R*}U_{j2}(-2C_{00}$$

$$+m_b^2C_0+2m_b^2C_1+m_b^2C_2+\hat{t}C_2+m_{\tilde{t}_k}^2C_0)$$

$$+h_tm_b\theta_{k2}^tV_{j2}(m_{\tilde{\chi}_j^+}O_{ji}^{R*}-m_{\tilde{\chi}_i^0}O_{ji}^{L*})(C_0+C_1+C_2)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}+\sum_{i,j,k}\frac{gh_b^2\beta_{21}}{16\pi^2(\hat{t}-m_t^2)}$$

$$\times\{(-h_t(\theta_{k1}^b)^2N_{j3}V_{i2}O_{ij}^{L*}+h_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}O_{ij}^{R*})B_0^{W\tilde{\chi}_i^+\tilde{\chi}_j^0}-[h_tm_t(\theta_{k1}^b)^2N_{j3}V_{i2}[O_{ij}^{L*}(-2C_{00}+m_b^2$$

$$\times(C_0+2C_1+C_2)+m_{\tilde{b}_k}^2C_0+\hat{t}C_2)-m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{R*}C_0]+\theta_{k1}^b\theta_{k2}^b[h_bN_{j3}U_{i2}(m_{\tilde{\chi}_i^+}O_{ij}^{L*}(m_b^2C_0+m_b^2C_1+\hat{t}C_2)$$

$$-m_{\tilde{\chi}_j^0}O_{ij}^{R*}(m_b^2C_1+\hat{t}C_0+\hat{t}C_2))+h_tm_bm_tN_{j3}^*V_{i2}(m_{\tilde{\chi}_j^0}O_{ij}^{L*}(m_bm_tC_0+m_bm_tC_1+m_bm_tC_2)-m_{\tilde{\chi}_i^+}O_{ij}^{R*}$$

$$\times(C_0+C_1+C_2))]+h_bm_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}(m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{L*}C_0+O_{ij}^{R*}(2C_{00}-m_b^2C_1-m_{\tilde{b}_k}^2C_0-\hat{t}(C_0+C_1$$

$$+C_2)))](m_b^2,m_W^2,\hat{t},m_{\tilde{b}_k}^2,m_{\tilde{\chi}_j^0}^2,m_{\tilde{\chi}_i^+}^2)\},$$

$$f_6^{V_1(t)}=\sum_i\frac{gh_bh_t^2m_b\alpha_{1i}\alpha_{2i}\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{B_0^{Wbt}+[2(m_t^2+\hat{t}+m_{H_i}^2)C_0+(2m_b^2+m_t^2+\hat{t})C_1+(m_t^2+3t)C_2-2C_{00}]$$

$$\times(m_b^2,m_W^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)\}+\sum_i\frac{-gh_bh_t^2m_b\beta_{1i}\beta_{2i}\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{B_0^{Wbt}+[m_{A_i}^2C_0-(m_t^2-\hat{t})(C_1+C_2)-2C_{00}]$$

$$\times(m_b^2,m_W^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)\}+\sum_{i,j}\frac{gh_t^2\alpha_{1i}\beta_{11}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(h_tm_t\beta_{1j}+h_bm_b\beta_{2j})C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_j^+}^2,m_{H_i}^2)$$

$$+\sum_i\frac{-gh_t^2\beta_{1i}\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(h_bm_b\beta_{2i}-h_tm_t\beta_{1i})C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_i^+}^2,m_{A_i}^2)+\sum_{i,j}\frac{gh_bh_t\alpha_{2j}\beta_{11}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(h_tm_b\beta_{1i}$$

$$+h_bm_t\beta_{2i})C_{00}(m_b^2,m_W^2,\hat{t},m_b^2,m_{H_j}^2,m_{H_i^+}^2)+\sum_{i,j,k}\frac{-gh_b^2h_t\beta_{11}\theta_{j1}^b\theta_{i1}^t}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}(m_tN_{k3}^*N_{k4}\theta_{j2}^b\theta_{i2}^t$$

$$-m_bN_{k3}N_{k4}^*\theta_{j1}^b\theta_{i1}^t)C_{00}(m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)+\sum_{i,j,k}\frac{gh_t^2\beta_{11}\theta_{k1}^tN_{i4}^*}{16\pi^2(\hat{t}-m_t^2)}\{h_bm_b\theta_{k1}^tO_{ji}^{R*}U_{j2}B_0^{W\tilde{\chi}_j^+\tilde{\chi}_i^0}$$

$$+[-h_bm_bm_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}\theta_{k1}^tO_{ji}^{L*}U_{j2}C_0+h_bm_b\theta_{k1}^tO_{ji}^{R*}U_{j2}(-2C_{00}+m_b^2C_1+\hat{t}C_0+\hat{t}C_1+2\hat{t}C_2+m_{\tilde{t}_{k1}}^2C_0)$$

$$-h_tm_{\tilde{\chi}_i^0}\theta_{k2}^tO_{ji}^{L*}V_{j2}(m_b^2C_0+m_b^2C_1+\hat{t}C_2)+h_tm_{\tilde{\chi}_j^+}\theta_{k2}^tO_{ji}^{R*}V_{j2}(m_b^2C_1+\hat{t}C_0+\hat{t}C_2)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}$$

$$+\sum_{i,j,k}\frac{gh_t^2m_t\beta_{11}\theta_{k2}^tN_{j4}}{16\pi^2(\hat{t}-m_t^2)}\{-h_t\theta_{k2}^tO_{ji}^{L*}V_{j2}B_0^{W\tilde{\chi}_j^+\tilde{\chi}_i^0}+[h_bm_b\theta_{k1}^tU_{j2}(m_{\tilde{\chi}_i^0}O_{ji}^{R*}-m_{\tilde{\chi}_j^+}O_{ji}^{L*})(C_0+C_1+C_2)$$

$$-h_t\theta_{k2}^tO_{ji}^{L*}V_{j2}(2C_{00}-m_b^2C_0-2m_b^2C_1-m_b^2C_2-\hat{t}C_2-m_{\tilde{t}_k}^2C_0+m_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}C_0)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}$$

$$-\sum_{i,j,k}\frac{gh_bh_t\beta_{11}}{16\pi^2(\hat{t}-m_t^2)}\{[-h_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}O_{ij}^{R*}+h_t(\theta_{k1}^b)^2N_{j3}V_{i2}O_{ij}^{L*}]B_0^{W\tilde{\chi}_i^+\tilde{\chi}_j^0}$$

$$-[h_bm_t(\theta_{k2}^b)^2N_{j3}^*U_{i2}[O_{ij}^{R*}(-2C_{00}+m_b^2(C_0+2C_1+C_2)+m_{\tilde{b}_k}^2C_0+\hat{t}C_2)-m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{L*}C_0]$$

$$+\theta_{k1}^b\theta_{k2}^b[h_tN_{j3}^*V_{i2}(m_{\tilde{\chi}_i^+}O_{ij}^{R*}(m_b^2C_0+m_b^2C_1+\hat{t}C_2)-m_{\tilde{\chi}_j^0}O_{ij}^{L*}(m_b^2C_1+\hat{t}C_0+\hat{t}C_2))$$

$$+h_bm_bm_tN_{j3}U_{i2}(m_{\tilde{\chi}_j^0}O_{ij}^{R*}(m_bm_tC_0+m_bm_tC_1+m_bm_tC_2)-m_{\tilde{\chi}_i^+}O_{ij}^{R*}(C_0+C_1+C_2))]$$

$$+h_t m_b(\theta^b_{k1})^2 N_{j3}V_{i2}(m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O^{R*}_{ij}C_0+O^{L*}_{ij}(2C_{00}-m_b^2C_1-m^2_{\tilde{b}_k}C_0-\hat{t}(C_0+C_1+C_2)))](m_b^2,m_W^2,\hat{t},m^2_{\tilde{b}_k},m^2_{\tilde{\chi}_j^0},m^2_{\tilde{\chi}_i^+})\},$$

$$f_7^{V_1(t)}=\sum_i \frac{-gh_b^2h_tm_t\alpha_{1i}\alpha_{2i}\beta_{21}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}(2C_2+C_{12}+C_{22})(m_b^2,m_W^2,\hat{t},m^2_{H_i},m_b^2,m_t^2)+\sum_i \frac{-gh_b^2h_tm_t\beta_{1i}\beta_{2i}\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(C_{12}+C_{22})$$
$$\times(m_b^2,m_W^2,\hat{t},m^2_{A_i},m_b^2,m_t^2)+\sum_{i,j}\frac{gh_bh_t\alpha_{1i}\beta_{21}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_tm_b\beta_{1j}(C_1+C_{11}+C_{12})+h_bm_t\beta_{2j}(C_0+C_1-C_{12}-C_{22})]$$
$$\times(m_b^2,m_W^2,\hat{t},m_t^2,m^2_{H_j^+},m^2_{H_i})+\sum_i \frac{gh_bh_t\beta_{1i}\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_tm_b\beta_{1i}(C_1+C_{11}+C_{12})+h_bm_t\beta_{2i}(C_0+C_1+2C_2+C_{12}$$
$$+C_{22})](m_b^2,m_W^2,\hat{t},m_t^2,m^2_{H_i^+},m^2_{A_i})+\sum_{i,j}\frac{-gh_b^2\alpha_{2j}\beta_{21}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_tm_t\beta_{1i}(C_2+C_{12}+C_{22})+h_bm_b\beta_{2i}(C_0+C_2-C_{11}$$
$$-C_{12})](m_b^2,m_W^2,\hat{t},m_b^2,m^2_{H_j},m^2_{H_i^+})+\sum_{i,j,k}\frac{-gh_b^2h_t\beta_{21}\theta^b_{j1}\theta^t_{i1}}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}[m_bN^*_{k3}N_{k4}\theta^b_{j2}\theta^t_{i2}(C_2+C_{11}+C_{12})$$
$$-N_{k3}N_{k4}\theta^b_{j1}\theta^t_{i2}m_{\tilde{\chi}_k^0}(C_0+C_1+C_2)+m_tN_{k3}N^*_{k4}\theta^b_{j1}\theta^t_{i1}(C_2+C_{12}+C_{22})](m_b^2,m_W^2,\hat{t},m^2_{\tilde{\chi}_k^0},m^2_{\tilde{b}_j},m^2_{\tilde{t}_i})$$
$$-\sum_{i,j,k}\frac{gh_bh_t\beta_{12}\theta^t_{k2}N_{i4}}{8\pi^2(\hat{t}-m_t^2)}[h_bm_{\tilde{\chi}_j^+}\theta^t_{k1}O^{L*}_{ji}U_{j2}C_1+h_bm_{\tilde{\chi}_i^0}\theta^t_{k1}O^{R*}_{ji}U_{j2}C_2+h_tm_b\theta^t_{k2}O^{L*}_{ji}V_{j2}(C_1+C_{11}+C_{12})]$$
$$\times(m_b^2,m_W^2,\hat{t},m^2_{\tilde{t}_k},m^2_{\tilde{\chi}_j^+},m^2_{\tilde{\chi}_i^0})-\sum_{i,j,k}\frac{gh_b^2h_tm_t\beta_{12}(\theta^t_{k1})^2}{8\pi^2(\hat{t}-m_t^2)}O^{R*}_{ji}U_{j2}N^*_{i4}(C_{12}+C_2+C_{22})(m_b^2,m_W^2,\hat{t},m^2_{\tilde{t}_k},m^2_{\tilde{\chi}_j^+},m^2_{\tilde{\chi}_i^0})$$
$$-\sum_{i,j,k}\frac{gh_b^2\beta_{21}}{8\pi^2(\hat{t}-m_t^2)}[h_tm_t(\theta^b_{k1})^2N_{j3}V_{i2}O^{L*}_{ij}(C_{12}+C_2+C_{22})+h_b\theta^b_{k1}\theta^b_{k2}N_{j3}U_{i2}(m_{\tilde{\chi}_i^+}O^{L*}_{ij}C_2+m_{\tilde{\chi}_j^0}O^{R*}_{ij}C_1)$$
$$+h_bm_b(\theta^b_{k2})^2N^*_{j3}U_{i2}O^{R*}_{ij}(C_{11}+C_1+C_{12})](m_b^2,m_W^2,\hat{t},m^2_{\tilde{b}_k},m^2_{\tilde{\chi}_j^0},m^2_{\tilde{\chi}_i^+}),$$

$$f_8^{V_1(t)}=\sum_i \frac{-gh_bh_t^2m_b\alpha_{1i}\alpha_{2i}\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}(2C_1+C_{11}+C_{12})(m_b^2,m_W^2,\hat{t},m^2_{H_i},m_b^2,m_t^2)+\sum_i \frac{gh_bh_t^2m_b\beta_{1i}\beta_{2i}\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(C_{11}+C_{12})$$
$$\times(m_b^2,m_W^2,\hat{t},m^2_{A_i},m_b^2,m_t^2)+\sum_{i,j}\frac{gh_t^2\alpha_{1i}\beta_{11}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_bm_b\beta_{2j}(C_1+C_{11}+C_{12})$$
$$+h_tm_t\beta_{1j}(C_0+C_1-C_{12}-C_{22})](m_b^2,m_W^2,\hat{t},m_t^2,m^2_{H_j^+},m^2_{H_i})$$
$$+\sum_i \frac{-gh_t^2\beta_{1i}\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_bm_b\beta_{2i}(C_1+C_{11}+C_{12})+h_tm_t\beta_{1i}(C_0+C_1+2C_2+C_{12}+C_{22})]$$
$$\times(m_b^2,m_W^2,\hat{t},m_t^2,m^2_{H_i^+},m^2_{A_i})+\sum_{i,j}\frac{-gh_bh_t\alpha_{2j}\beta_{11}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}[h_bm_t\beta_{2i}(C_2+C_{11}+C_{22})$$
$$+h_tm_b\beta_{1i}(C_0+C_2-C_{11}-C_{12})]$$
$$\times(m_b^2,m_W^2,\hat{t},m_b^2,m^2_{H_j},m^2_{H_i^+})+\sum_{i,j,k}\frac{gh_bh_t^2\beta_{11}\theta^b_{j1}\theta^t_{i1}}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}[m_tN^*_{k3}N_{k4}\theta^b_{j2}\theta^t_{i2}(C_2+C_{12}+C_{22})$$

$$-N_{k3}^{*}N_{k4}^{*}\theta_{j2}^{b}\theta_{i1}^{t}m_{\tilde{\chi}_k^0}(C_0+C_1+C_2)+m_bN_{k3}N_{k4}^{*}\theta_{j1}^{b}\theta_{i1}^{t}(C_1+C_{11}+C_{12})](m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)$$

$$-\sum_{i,j,k}\frac{gh_t^2\beta_{11}\theta_{k1}^{t}N_{i4}^{*}}{8\pi^2(\hat{t}-m_t^2)}[h_tm_{\tilde{\chi}_j^+}\theta_{kw}^{t}O_{ji}^{R*}V_{j2}C_1+h_tm_{\tilde{\chi}_i^0}\theta_{k2}^{t}O_{ji}^{L*}V_{j2}C_2+h_bm_b\theta_{k1}^{t}O_{ji}^{R*}U_{j2}(C_1+C_{11}+C_{12})]$$

$$\times(m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)-\sum_{i,j,k}\frac{gh_t^3m_t\beta_{11}(\theta_{k2}^{t})^2}{8\pi^2(\hat{t}-m_t^2)}O_{ji}^{L*}V_{j2}N_{i4}^{*}(C_2+C_{12}+C_{22})(m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)$$

$$+\sum_{i,j,k}\frac{gh_bh_t\beta_{11}}{8\pi^2(\hat{t}-m_t^2)}[h_bm_t(\theta_{k2}^{b})^2N_{j3}^{*}U_{i2}O_{ij}^{R*}(C_{12}+C_2+C_{22})+h_t\theta_{k1}^{b}\theta_{k2}^{b}N_{j3}^{*}V_{i2}(m_{\tilde{\chi}_i^+}O_{ij}^{R*}C_2+m_{\tilde{\chi}_j^0}O_{ij}^{L*}C_1)$$

$$+h_tm_b(\theta_{k1}^{b})^2N_{j3}V_{i2}O_{ij}^{L*}(C_{11}+C_1+C_{12})](m_b^2,m_W^2,\hat{t},m_{\tilde{b}_k}^2,m_{\tilde{\chi}_j^0}^2,m_{\tilde{\chi}_i^+}^2),$$

$$f_{11}^{V_1(t)}=\sum_{i}\frac{gh_bh_t^2\alpha_{1i}\alpha_{2i}\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{B_0^{Wbt}+[m_{H_i}^2C_0+2m_b^2C_1+(m_t^2+\hat{t})C_2-2C_{00}](m_b^2,m_W^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)\}$$

$$+\sum_{i}\frac{-gh_bh_t^2m_b\beta_{1i}\beta_{2i}\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{B_0^{Wbt}+[m_{A_i}^2C_0-(m_t^2-\hat{t})C_2-2C_{00}](m_b^2,m_W^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)\}$$

$$+\sum_{i,j}\frac{gh_bh_t^2\alpha_{1i}\beta_{11}\beta_{2j}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_j^+}^2,m_{H_i}^2)$$

$$+\sum_{i}\frac{-gh_bh_t^2\beta_{1i}\beta_{2i}\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_i^+}^2,m_{A_i}^2)$$

$$+\sum_{i,j}\frac{gh_bh_t^2\alpha_{2j}\beta_{11}\beta_{1i}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}C_{00}(m_b^2,m_W^2,\hat{t},m_b^2,m_{H_j}^2,m_{H_i^+}^2)$$

$$+\sum_{i,j,k}\frac{gh_bh_t^2\beta_{11}(\theta_{j1}^{b})^2(\theta_{i1}^{t})^2}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}N_{k3}N_{k4}^{*}C_{00}(m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)+\sum_{i,j,k}\frac{gh_t^2\beta_{11}\theta_{k1}^{t}N_{i4}^{*}}{16\pi^2(\hat{t}-m_t^2)}\{h_b\theta_{k1}^{t}O_{ji}^{R*}U_{j2}B_0^{Wbt}$$

$$+[-h_bm_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}\theta_{k1}^{t}O_{ji}^{L*}U_{j2}C_0+h_b\theta_{k1}^{t}O_{ji}^{R*}U_{j2}(-2C_{00}+m_b^2C_1+\hat{t}C_2+m_{\tilde{t}_k}^2C_0)$$

$$+h_tm_b\theta_{k2}^{t}V_{j2}(m_{\tilde{\chi}_j^+}O_{ji}^{L*}-m_{\tilde{\chi}_i^0}O_{ji}^{R*})C_1](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}$$

$$-\sum_{i,j,k}\frac{gh_t^2\beta_{11}\theta_{k2}^{t}N_{i4}}{16\pi^2(\hat{t}-m_t^2)}[h_bm_{\tilde{\chi}_j^+}\theta_{k1}^{t}O_{ji}^{L*}U_{j2}(C_0+C_2)-h_bm_{\tilde{\chi}_i^0}\theta_{k1}^{t}O_{ji}^{R*}U_{j2}C_2+h_tm_b\theta_{k2}^{t}O_{ji}^{L*}V_{j2}$$

$$\times(C_0+C_1+C_2)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)+\sum_{i,j,k}\frac{gh_bh_t\beta_{11}}{16\pi^2(\hat{t}-m_t^2)}\{-h_t(\theta_{k1}^{b})^2N_{j3}V_{i2}O_{ij}^{L*}B_0^{W\tilde{\chi}_i^+\tilde{\chi}_j^0}$$

$$+(-h_t(\theta_{k1}^{b})^2N_{j3}V_{i2}[m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{R*}C_0+O_{ij}^{L*}(-2C_{00}+m_b^2C_1+m_{\tilde{b}_k}^2C_0+\hat{t}C_2)]$$

$$-\theta_{k1}^{b}\theta_{k2}^{b}[h_bm_tN_{j3}U_{i2}(m_{\tilde{\chi}_i^+}O_{ij}^{L*}C_2-O_{ij}^{R*}(m_{\tilde{\chi}_j^0}C_0+m_{\tilde{\chi}_i^+}C_2))+h_tm_bN_{j3}^{*}V_{i2}[m_{\tilde{\chi}_j^0}O_{ij}^{L*}C_1-O_{ij}^{R*}$$

$$\times(m_{\tilde{\chi}_i^+}C_0+m_{\tilde{\chi}_j^0}C_1)]]+h_bm_bm_t(\theta_{k2}^{b})^2N_{j3}^{*}U_{i2}O_{ij}^{R*}(C_0+C_1+C_2))(m_b^2,m_W^2,\hat{t},m_{\tilde{b}_k}^2,m_{\tilde{\chi}_j^0}^2,m_{\tilde{\chi}_i^+}^2)\},$$

$$f_{12}^{V_1(t)}=\sum_i \frac{-gh_b^2h_t\alpha_{1i}\alpha_{2i}\beta_{21}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}m_bm_t(2C_0+C_1+C_2)(m_b^2,m_W^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)$$

$$+\sum_{i,j}\frac{gh_bh_t^2\alpha_{1i}\beta_{21}\beta_{1j}\varphi_{ij}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_j^+}^2,m_{H_i}^2)+\sum_i\frac{-gh_bh_t^2\alpha_{1i}^2\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}C_{00}(m_b^2,m_W^2,\hat{t},m_t^2,m_{H_i^+}^2,m_{A_i}^2)$$

$$+\sum_{i,j}\frac{gh_b^3\alpha_{2j}\beta_{21}\beta_{2i}\varphi_{ji}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}C_{00}(m_b^2,m_W^2,\hat{t},m_b^2,m_{H_j}^2,m_{H_i^+}^2)$$

$$+\sum_{i,j,k}\frac{-gh_b^2h_t\beta_{21}\theta_{j1}^b\theta_{j2}^b\theta_{i1}^t\theta_{i2}^t}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}N_{k3}^*N_{k4}C_{00}(m_b^2,m_W^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2)$$

$$+\sum_{i,j,k}\frac{gh_t^2\beta_{11}\theta_{k1}^tN_{i4}^*}{16\pi^2(\hat{t}-m_t^2)}\{h_b\theta_{k1}^tO_{ji}^{R*}U_{j2}B_0^{Wbt}+[-h_bm_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}\theta_{k1}^tO_{ji}^{L*}U_{j2}C_0+h_b\theta_{k1}^tO_{ji}^{R*}U_{j2}(-2C_{00}+m_b^2C_1$$

$$+\hat{t}C_2+m_{\tilde{t}_k}^2C_0)+h_tm_b\theta_{k2}^tV_{j2}(m_{\tilde{\chi}_j^+}O_{ji}^{L*}-m_{\tilde{\chi}_i^0}O_{ji}^{R*})C_1](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)\}$$

$$-\sum_{i,j,k}\frac{gh_bh_t\beta_{12}\theta_{k1}^tN_{14}^*}{16\pi^2(\hat{t}-m_t^2)}[h_tm_{\tilde{\chi}_j^+}\theta_{k2}^tO_{ji}^{R*}V_{j2}(C_0+C_2)-h_tm_{\tilde{\chi}_i^0}\theta_{k2}^tO_{ji}^{L*}V_{j2}C_2+h_bm_b\theta_{k1}^tO_{ji}^{R*}U_{j2}$$

$$\times(C_0+C_1+C_2)](m_b^2,m_W^2,\hat{t},m_{\tilde{t}_k}^2,m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2)-\sum_{i,j,k}\frac{gh_b^2\beta_{21}}{16\pi^2(\hat{t}-m_t^2)}\{-h_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}O_{ij}^{R*}B_0^{W\tilde{\chi}_i^+\tilde{\chi}_j^0}$$

$$+[-h_b(\theta_{k2}^b)^2N_{j3}^*U_{i2}(m_{\tilde{\chi}_i^+}m_{\tilde{\chi}_j^0}O_{ij}^{L*}C_0+O_{ij}^{R*}(-2C_{00}+m_b^2C_1+m_{\tilde{b}_k}^2C_0+\hat{t}C_2))$$

$$-\theta_{k1}^b\theta_{k2}^b(h_tm_tN_{j3}^*V_{i2}(m_{\tilde{\chi}_i^+}O_{ij}^{R*}C_2-O_{ij}^{L*}(m_{\tilde{\chi}_j^0}C_0+m_{\tilde{\chi}_i^+}C_2))+h_bm_bN_{j3}U_{i2}(m_{\tilde{\chi}_j^0}O_{ij}^{R*}C_1-O_{ij}^{L*}(m_{\tilde{\chi}_i^+}C_0$$

$$+m_{\tilde{\chi}_j^0}C_1)))+h_tm_bm_t(\theta_{k1}^b)^2N_{j3}V_{i2}O_{ij}^{L*}(C_0+C_1+C_2)](m_b^2,m_W^2,\hat{t},m_{\tilde{b}_k}^2,m_{\tilde{\chi}_j^0}^2,m_{\tilde{\chi}_i^+}^2)\};$$

$$f_2^{s(t)}=\sum_i\frac{-gh_bh_t^2\alpha_{1i}^2\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[2m_t^2B_0^{\hat{t}tH_i}-(m_t^2+\hat{t})B_i^{\hat{t}tH_i}]+\sum_i\frac{gh_bh_t^2\beta_{1i}^2\beta_{21}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[2m_t^2B_0^{\hat{t}tA_i}+(m_t^2+\hat{t})B_1^{\hat{t}tA_i}]$$

$$+\sum_i\frac{gh_b\beta_{21}}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[2h_bh_tm_bm_t\beta_{1i}\beta_{2i}\beta_0^{\hat{t}bH_i^+}+(h_t^2m_t^2\beta_{1i}+h_b^2\hat{t}\beta_{2i})^2B_1^{\hat{t}bH_i^+}]$$

$$+\sum_{i,j}\frac{-gh_bh_t^2\beta_{21}}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}\{m_t\theta_{i1}^t\theta_{i2}^t(N_{j4}^2+N_{j4}^{*2})B_0^{\hat{t}\tilde{\chi}_j^0\hat{t}_i}-[m_t^2(\theta_{i1}^t)^2+\hat{t}(\theta_{i2}^t)^2]|N_{j4}|^2B_1^{\hat{t}\tilde{\chi}_j^0\tilde{t}_i}\}$$

$$+\sum_{i,j}\frac{-gh_b\beta_{21}}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[-h_b^2m_t^2(\theta_{i2}^b)^2|U_{j2}|^2B_1^{\hat{t}\tilde{\chi}_j^+\tilde{b}_i}+h_bh_tm_t\theta_{i1}^b\theta_{i2}^b(U_{j2}V_{j2}+U_{j2}^*V_{j2}^*)B_0^{\hat{t}\tilde{\chi}_j^+\tilde{b}_i}$$

$$-h_t^2\hat{t}(\theta_{i1}^b)^2|V_{j2}|^2B_1^{i\tilde{\chi}_j^+\tilde{b}_i}],$$

$$f_5^{s(t)}=-\frac{1}{2}m_bf_2^{s(t)},$$

$$f_6^{s(t)}=\sum_i \frac{-gh_t^3 m_t\alpha_{1i}^2\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[-(m_t^2-\hat{t})B_0^{\hat{t}tH_i}+2\hat{t}B_1^{\hat{t}tH_i}]+\sum_i \frac{-gh_t^3 m_t\beta_{1i}^2\beta_{11}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[(m_t^2+\hat{t})B_0^{\hat{t}tA_i}+2\hat{t}B_1^{\hat{t}tA_i}]$$

$$+\sum_i \frac{-gh_t\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}[h_bh_tm_b\beta_{1i}\beta_{2i}(m_t^2+\hat{t})B_0^{\hat{t}bH_i^+}+(h_t^2\beta_{1i}^2+h_b^2\beta_{2i}^2)m_t\hat{t}B_1^{\hat{t}bH_i^+}]+\sum_{i,j}\frac{-gh_t^3\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}$$

$$\times[-\theta_{i1}^t\theta_{i2}^t(m_t^2N_{j4}^2+\hat{t}N_{j4}^{*2})B_0^{\hat{t}\tilde{\chi}_j^0\tilde{t}_i}+m_t\hat{t}|N_{j4}|^2B_1^{\hat{t}\tilde{\chi}_j^0\tilde{t}_i}]+\sum_{i,j}\frac{-gh_t\beta_{11}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)^2}$$

$$\times[h_b^2m_t\hat{t}(\theta_{i2}^b)^2|U_{j2}|^2B_1^{\hat{t}\tilde{\chi}_j^+\tilde{b}_i}-h_bh_t\theta_{i1}^b\theta_{i2}^b(m_t^2U_{j2}V_{j2}+\hat{t}U_{j2}^*V_{j2}^*)B_0^{\hat{t}\tilde{\chi}_j^+\tilde{b}_i}+h_t^2m_t\hat{t}(\theta_{i1}^b)^2|V_{j2}|^2B_1^{\hat{t}\tilde{\chi}_j^+\tilde{b}_i}],$$

$$f_{12}^{s(t)}=-\frac{1}{2}f_2^{s(t)};$$

$$f_2^{V_2(t)}=\sum_i \frac{gh_bh_t\alpha_{1i}\alpha_{2i}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{h_t\beta_{11}B_0^{H^+bt}+[h_t\beta_{11}(m_{H_i}^2C_0+2m_b^2C_1+m_t^2C_2+\hat{t}C_2)-h_bm_bm_t\beta_{21}(4C_0+2C_1$$

$$+2C_2)](m_b^2,m_{H^+}^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)\}+\sum_i \frac{gh_bh_t^2\beta_{1i}\beta_{11}\beta_{2i}}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{B_0^{H^+bt}+[m_{A_i}^2C_0+(\hat{t}-m_t^2)C_2]$$

$$\times(m_b^2,m_{H^+}^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)\}+\sum_{i,j,k}\sum_{i',j'}\frac{-gh_bh_t\theta_{jj'}^b\theta_{ii'}^t}{8\sqrt{2}\pi^2(\hat{t}-m_t^2)}(h_b\Theta_{j'i'1}^5+h_t\Theta_{j'i'2}^6)(m_tN_{k3}^*N_{k4}\theta_{j1}^b\theta_{i1}^tC_2$$

$$-m_{\tilde{\chi}_k^0}N_{k3}^*N_{k4}^*\theta_{j1}^b\theta_{j2}^tC_0+m_bN_{k3}N_{k4}^*\theta_{j2}^b\theta_{i2}^tC_1)(m_b^2,m_{H^+}^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2),$$

$$f_5^{V_2(t)}=-\frac{m_b}{2}f_2^{V_2(t)},$$

$$f_6^{V_2(t)}=\sum_i \frac{-gh_bh_t\alpha_{1i}\alpha_{2i}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{h_bm_t\beta_{21}B_0^{H^+bt}+[h_bm_t\beta_{21}(m_{H_i}^2C_0+2\hat{t}C_2+2m_b^2C_1)-h_tm_b\beta_{11}((m_t^2+\hat{t})(2C_0+C_1)$$

$$+2\hat{t}C_2)](m_b^2,m_{H^+}^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)\}+\sum_i \frac{-gh_bh_t\beta_{1i}\beta_{2i}}{32\sqrt{2}\pi^2(\hat{t}-m_t^2)}\{h_bm_t\beta_{21}B_0^{H^+bt}+[h_bm_tm_{A_i}^2\beta_{21}C_0$$

$$+h_tm_b\beta_{11}(m_t^2-\hat{t})C_1](m_b^2,m_{H^+}^2,\hat{t},m_{A_i}^2,m_b^2,m_t^2)\}+\sum_{i,j,k}\sum_{i',j'}\frac{-gh_bh_t\theta_{jj'}^b\theta_{ii'}^t}{16\sqrt{2}\pi^2(\hat{t}-m_t^2)}(h_b\Theta_{j'i'1}^5+h_t\Theta_{j'i'2}^6)$$

$$\times(m_bm_tN_{k3}^*N_{k4}\theta_{j1}^b\theta_{i1}^tC_1-m_tm_{\tilde{\chi}_k^0}N_{k3}N_{k4}\theta_{j2}^b\theta_{j1}^tC_0+\hat{t}N_{k3}N_{k4}^*\theta_{j2}^b\theta_{i2}^tC_2)(m_b^2,m_{H^+}^2,\hat{t},m_{\tilde{\chi}_k^0}^2,m_{\tilde{b}_j}^2,m_{\tilde{t}_i}^2),$$

$$f_{12}^{V_2(t)}=-\frac{1}{2}f_2^{V_2(t)};$$

$$f_1^{(b)}=\sum_i \frac{gh_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}\{h_b\beta_{21}C_0(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[-h_tm_bm_t\beta_{11}(D_{13}+D_{23})-h_b\beta_{21}2D_{00}+h_bm_b^2\beta_{21}$$

$$\times(2D_3-D_{11}-D_{12}+D_{13}+D_{23})+h_bm_{H^+}^2\beta_{21}(D_{13}+D_{23})-h_b\hat{t}\beta_{21}(D_{12}+D_{13}+D_{22}+D_{23})+h_bm_{H_i}^2\beta_{21}D_0]$$

$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)\}+\sum_i \frac{gh_b^2\beta_{2i}^2}{16\sqrt{2}\pi^2}\{-h_b\beta_{21}C_0(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)$$

$$+[-h_t m_b m_t \beta_{11}(D_{13}+D_{23})+2h_b\beta_{21}D_{00}+h_b m_b^2\beta_{21}(D_{11}+D_{12}+D_{13}+D_{23})-h_b m_{H^+}^2\beta_{21}(D_{13}+D_{23})$$
$$+h_b\hat{t}\beta_{21}(D_{12}+D_{13}+D_{22}+D_{23})-h_b m_{A_i}^2\beta_{21}D_0](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)\}$$
$$+\sum_i \frac{g h_b m_b \beta_{2i}}{8\sqrt{2}\pi^2}[h_t^2 m_b\beta_{11}\beta_{1i}(D_1+D_{11}+D_{12}+D_{13})-h_b h_t m_t\beta_{11}\beta_{2i}(D_1+D_{12}+D_{13})+h_b^2 m_b\beta_{21}\beta_{2i}(D_{12}$$
$$+D_{13})](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}g h_b^2}{16\pi^2}N_{l3}\theta_{ii'}^b\theta_{j1}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)$$
$$\times[m_b\theta_{i1}^b\theta_{j1}^b N_{l3}^*(D_3+D_{13}+D_{23})-m_{\tilde{\chi}_l^0}N_{l3}\theta_{i2}^b\theta_{j1}^b(D_0+D_1+D_2)+m_b\theta_{i2}^b\theta_{j2}^b N_{l3}^*(D_1+D_2+D_{11}+2D_{12}$$
$$+D_{22})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)+\sum_{i,j,k,l}\sum_{j',l'}\frac{g\theta_{l1}^b\theta_{ll'}^b\theta_{i1}^t\theta_{jj'}^t}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)$$
$$\times[h_b^2 m_b\theta_{i1}^t\theta_{j1}^t U_{k2}^2(D_{12}+D_{23})-h_b h_t m_{\tilde{\chi}_k^+}\theta_{i2}^t\theta_{j1}^t U_{k2}V_{k2}D_3+h_t^2 m_b\theta_{i2}^t\theta_{j2}^t V_{k2}^2(D_3+D_{33})]$$
$$\times(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)+\sum_{i,j}\frac{g h_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}\{-h_b^2\beta_{12}\beta_{2j}C_2(m_b^2,m_{H^+}^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)$$
$$+[h_t^2 m_b^2\beta_{11}\beta_{1j}(D_{23}+2D_3+2D_{33})-h_b h_t m_b m_t\beta_{11}\beta_{2j}(D_{23}+2D_3)+h_b h_t m_b m_t\beta_{12}\beta_{1j}D_{33}$$
$$-h_b^2\beta_{12}\beta_{2j}(m_b^2(D_{23}+D_{33})+m_W^2 D_{13}+\hat{u}D_{23}+m_{H_j^+}^2 D_3)](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2 m_b^2,m_t^2)\}$$
$$+\sum_i\frac{g h_b\beta_{2i}}{16\sqrt{2}\pi^2}\{h_b^2\beta_{21}\beta_{2i}(C_0+C_1+C_2)(m_{H^+}^2,m_b^2,\hat{t},m_t^2,m_b^2,m_{A_i}^2)+[h_b^2\beta_{21}\beta_{2i}(m_b^2(D_{12}-D_{11})+m_W^2 D_{13}$$
$$-\hat{u}D_{12}-m_{H_i^+}^2 D_1)+h_b h_t m_b m_t(\beta_{21}\beta_{1i}D_{11}-\beta_{11}\beta_{2i}D_{12})+h_t^2 m_b^2\beta_{11}\beta_{1i}D_{12}]$$
$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)\}+\sum_{i,j,k,l}\sum_{k',l'}\frac{g h_b\theta_{kk'}^b\theta_{ll'}^t}{8\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)$$
$$\times[h_b\theta_{k1}^b\theta_{l1}^t U_{j2}(m_b N_{i3}^* O_{ij}^{R*}D_{23}+m_{\tilde{\chi}_j^+}N_{i3}O_{ij}^{L*}D_3)+h_t m_b\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}O_{ij}^{L*}D_{33}]$$
$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_2^{(b)}=\sum_i\frac{g h_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}[-h_t m_b m_t\beta_{11}(2D_1+2D_2+D_{11}+2D_{12}+D_{22})+h_b m_b^2\beta_{21}(4D_0+6D_1+2D_{11}+4D_{12}+D_{13}$$
$$+6D_2+2D_{22}+D_{23}+2D_3)](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$
$$+\sum_i\frac{-g h_b^2\beta_{2i}^2}{16\sqrt{2}\pi^2}[h_t m_b m_t\beta_{11}(D_{11}+2D_{12}+D_{22})+h_b m_b^2\beta_{21}(D_{13}+D_{23})]$$
$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)$$
$$+\sum_i\frac{g h_b\beta_{2i}}{8\sqrt{2}\pi^2}\{h_t^2\beta_{11}\beta_{1i}(C_0+C_1+C_2)(m_W^2,m_{H^+}^2,\hat{s},m_t^2,m_b^2,m_t^2)$$
$$+[-h_b h_t m_b m_t(\beta_{1i}\beta_{21}D_1+\beta_{11}\beta_{2i}D_{11})+h_b^2 m_b^2\beta_{21}\beta_{2i}^2(D_1+D_{11})+h_t^2\beta_{11}\beta_{1i}(-m_b^2 D_{11}+m_W^2 D_{13}-\hat{u}D_{12}$$
$$-\hat{u}D_{13}-m_{H_i^+}^2 D_1)](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)\}+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}g h_b^2}{16\pi^2}N_{l3}^*\theta_{ii'}^b\theta_{j1}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5$$
$$+h_t\Theta_{i'k'1}^6)[m_b\theta_{i1}^b\theta_{j1}^b N_{l3}(D_1+D_2+D_{11}+2D_{12}+D_{22})-m_{\tilde{\chi}_l^0}N_{l3}^*\theta_{i1}^b\theta_{j2}^b(D_0+D_1+D_2)+m_b\theta_{i2}^b\theta_{j2}^b N_{l3}(D_{13}$$

$$+D_{23}+D_3)](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)+\sum_{i,j,k,l}\sum_{j',l'}\frac{g\theta_{l1}^b\theta_{ll'}^b\theta_{i1}^t\theta_{jj'}^t}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)$$

$$\times[h_b^2m_b\theta_{i1}^t\theta_{j1}^tU_{k2}^2D_{33}-h_bh_tm_{\tilde{\chi}_k^+}\theta_{i1}^t\theta_{j2}^tU_{k2}V_{k2}D_3+h_t^2m_b\theta_{i2}^t\theta_{j2}^tV_{k2}^2(D_{13}+D_{23})]$$

$$\times(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}\{h_t^2\beta_{11}\beta_{1j}C_2(m_b^2,m_{H^+}^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)$$

$$+[-h_b^2m_b^2\beta_{12}\beta_{2j}(D_{23}+2D_3+2D_{33})-h_bh_tm_bm_t\beta_{11}\beta_{2j}D_{33}+h_bh_tm_bm_t\beta_{12}\beta_{1j}(D_{23}+2D_3)$$

$$+h_t^2\beta_{11}\beta_{1j}(m_b^2(D_{23}+D_{33})+m_W^2D_{13}+\hat{u}D_{23}+m_{H_j^+}^2D_3)](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2,m_b^2,m_t^2)\}$$

$$-\sum_i\frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}\{h_t^2\beta_{11}\beta_{1i}(C_0+C_1+C_2)(m_{H^+}^2,m_b^2,\hat{t},m_t^2,m_b^2,m_{A_i}^2)+[h_t^2\beta_{11}\beta_{1i}(m_b^2(D_{12}-D_{11})+m_W^2D_{13}$$

$$-\hat{u}D_{12}-m_{H_i^+}^2D_1)+h_bh_tm_bm_t(\beta_{11}\beta_{2i}D_{11}-\beta_{21}\beta_{1i}D_{12})+h_b^2\beta_{21}\beta_{2i}D_{12}]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)\}+\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_b\theta_{kk'}^b\theta_{ll'}^t}{8\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)$$

$$\times[h_t\theta_{k2}^b\theta_{l2}^tV_{j2}(m_bN_{i3}O_{ij}^{L*}D_{23}+m_{\tilde{\chi}_j^+}N_{i3}^*O_{ij}^{R*}D_3)+h_bm_b\theta_{k1}^b\theta_{l1}^tN_{i3}^*U_{j2}O_{ij}^{R*}D_{33}]$$

$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_3^{(b)}=\sum_i\frac{gh_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}\{-h_bm_b^2\beta_{21}C_2(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[h_tm_bm_t\beta_{11}(2D_3+D_{33})-2h_bm_b^2\beta_{21}D_{33}+h_bm_W^2\beta_{21}D_{13}$$

$$-h_b\hat{t}\beta_{21}(D_{13}+D_{23})-h_bm_{H_i}^2\beta_{21}D_3](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)\}$$

$$+\sum_i\frac{gh_b^2\beta_{2i}^2}{16\sqrt{2}\pi^2}\{h_b\beta_{21}C_2(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[h_tm_bm_t\beta_{11}D_{33}-h_bm_W^2\beta_{21}D_{13}+h_b\hat{t}\beta_{21}(D_{13}+D_{23})+h_bm_{A_i}^2\beta_{21}D_3]$$

$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)\}+\sum_i\frac{g\beta_{2i}}{8\sqrt{2}\pi^2}[h_t^3m_bm_t\beta_{11}\beta_{1i}(D_0+D_1+D_2+D_3)-h_bh_t^2m_b^2\beta_{11}\beta_{1i}(D_0+D_1$$

$$+D_{12}+D_{13}+2D_2+D_{22}+2D_{23}+2D_3+D_{33})-h_bh_t^2m_t^2\beta_{11}\beta_{1i}(D_0+D_2+D_3)+h_b^2h_tm_bm_t\beta_{1i}\beta_{21}(D_2+D_3)$$

$$+h_b^2h_tm_bm_t\beta_{11}\beta_{2i}(D_1+2D_2+D_{22}+2D_{23}+2D_3+D_{33})-h_b^3m_b^2\beta_{21}\beta_{2i}(D_2+D_{22}+2D_{23}+D_3+D_{33})]$$

$$\times(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)+\sum_{i,j,k,l}\sum_{i',k'}\frac{-\sqrt{2}gh_b^2}{16\pi^2}N_{l3}\theta_{ii'}^b\theta_{j1}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)$$

$$\times[m_b\theta_{i1}^b\theta_{j1}^bN_{l3}^*D_{33}-m_{\tilde{\chi}_l^0}N_{l3}\theta_{i2}^b\theta_{j1}^bD_3+m_b\theta_{i2}^b\theta_{j2}^bN_{l3}^*(D_{13}+D_{23})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)$$

$$+\sum_{i,j,k,l}\sum_{j',l'}\frac{g\theta_{l1}^b\theta_{ll'}^b,\theta_{i1}^t\theta_{jj'}^t}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)[h_bh_tm_{\tilde{\chi}_k^+}\theta_{i2}^t\theta_{j1}^tU_{k2}V_{k2}(D_0+D_1+D_2)-h_t^2m_b\theta_{i2}^t\theta_{j2}^tV_{k2}^2(D_{13}+D_{33}$$

$$+D_3)-h_b^2m_b\theta_{i1}^t\theta_{j1}^tU_{k2}^2(D_1+D_{11}+2D_{12}+D_2+D_{22})](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)$$

$$+\sum_{ij}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}\{h_b^2\beta_{12}\beta_{2j}C_1(m_b^2,m_{H^+}^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)+[-h_t^2m_b^2\beta_{11}\beta_{1j}(2D_2+D_{22}+2D_{23})+h_bh_tm_bm_t\beta_{11}\beta_{2j}(D_{22}$$

$$+2D_2)-h_bh_tm_bm_t\beta_{12}\beta_{1j}D_{23}+h_b^2\beta_{12}\beta_{2j}(m_b^2(D_{22}+D_{23})+m_W^2D_{12}+\hat{u}D_{22}+m_{H_j^+}^2D_2)]$$

$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2 m_b^2,m_t^2)\}+\sum_i \frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}\{h_b^2\beta_{21}\beta_{2i}C_1(m_{H^+}^2,m_b^2,\hat{t},m_t^2,m_b^2,m_{A_i}^2)$$

$$+[h_b^2\beta_{21}\beta_{2i}(m_b^2(D_{12}-D_{22})+m_W^2 D_{23}+\hat{u}D_{22}+m_{H_i^+}^2 D_2)-h_b h_t m_b m_t(\beta_{11}\beta_{2i}D_{12}-\beta_{21}\beta_{1i}D_{22})-h_t^2 m_b^2\beta_{11}\beta_{1i}D_{22}]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)\}+\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_b\theta_{kk'}^b\theta_{ll'}^t}{8\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)[h_b\theta_{k1}^b\theta_{l1}^t U_{j2}O_{ij}^{R*}$$

$$(-m_b N_{13}^* D_{22}+m_{\tilde{\chi}_i^0}N_{i3}D_2)-h_t m_b\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}O_{ij}^{L*}D_{23}](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_4^{(b)}=\sum_i \frac{gh_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}[h_t m_b m_t\beta_{11}(D_{13}+D_{23})-h_b m_b^2\beta_{21}(2D_{13}+2D_{23}+2D_3+D_{33})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{gh_b^2\beta_{2i}^2}{16\sqrt{2}\pi^2}[h_t m_b m_t\beta_{11}(D_{13}+D_{23})+h_b m_b^2\beta_{21}D_{33}](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{gh_b\beta_{2i}}{8\sqrt{2}\pi^2}\{-h_t^2\beta_{11}\beta_{1i}C_0(m_W^2,m_{H^+}^2,\hat{s},m_t^2,m_b^2,m_t^2)+[h_b h_t m_b m_t\beta_{11}\beta_{2i}(D_1+D_{12}+D_{13})$$

$$-h_b^2 m_b^2\beta_{21}\beta_{2i}(D_{12}+D_{13})-h_t^2\beta_{11}\beta_{1i}(-2D_{00}+m_b^2(D_1-D_{23}-D_{33})+m_{H^+}^2(D_{12}+D_{13})-\hat{u}(D_{12}+D_{13}+D_{22}+D_{23})$$

$$+m_{H_i^+}^2 D_0)](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)\}+\sum_{i,j,k,l}\sum_{i',k'}\frac{-\sqrt{2}gh_b^2}{16\pi^2}N_{l3}^*\theta_{ii'}^b\theta_{j1}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)$$

$$\times[m_b\theta_{i2}^b\theta_{j2}^b N_{l3}D_{33}-m_{\tilde{\chi}_l^0}N_{l3}^*\theta_{i1}^b\theta_{j2}^b D_3+m_b\theta_{i1}^b\theta_{j1}^b N_{l3}(D_{13}+D_{23})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)$$

$$+\sum_{i,j,k,l}\sum_{j',l'}\frac{g\theta_{l1}^b\theta_{ll'}^b\theta_{i1}^t\theta_{jj'}^t}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)[-h_b^2 m_b\theta_{i1}^t\theta_{j1}^t U_{k2}^2(D_{13}+D_{23}+D_3)+h_b h_t m_{\tilde{\chi}_k^+}\theta_{i1}^t\theta_{j2}^t U_{k2}V_{k2}(D_0+D_1$$

$$+D_2)-h_t^2 m_b\theta_{i2}^t\theta_{j2}^t V_{k2}^2(D_1+D_2+D_{11}+2D_{12}+D_{22})](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)$$

$$+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}\{-h_t^2\beta_{11}\beta_{1j}C_1(m_b^2,m_{H^+}^2,\hat{t},m_{H_i}^2,m_b^2,m_t^2)+[h_b^2 m_b^2\beta_{12}\beta_{2j}(2D_2+D_{22}+2D_{23})$$

$$+h_b h_t m_b m_t(\beta_{11}\beta_{2j}D_{23}+\beta_{12}\beta_{1j}(D_{22}+2D_2))-h_t^2\beta_{11}\beta_{1j}(m_b^2(D_{22}+D_{23})+m_W^2 D_{12}+\hat{u}D_{22}+m_{H_j^+}^2 D_2)]$$

$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2 m_b^2,m_t^2)\}-\sum_i \frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}\{h_t^2\beta_{11}\beta_{1i}C_1(m_{H^+}^2,m_b^2,\hat{t},m_t^2,m_b^2,m_{A_i}^2)$$

$$+[h_t^2\beta_{11}\beta_{1i}(m_b^2(D_{12}-D_{22})+m_W^2 D_{23}+\hat{u}D_{22}+m_{H_i^+}^2 D_2)-h_b h_t m_b m_t(\beta_{21}\beta_{1i}D_{12}-\beta_{11}\beta_{2i}D_{22})-h_b^2 m_b^2\beta_{21}\beta_{2i}D_{22}]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)\}+\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_b\theta_{kk'}^b\theta_{ll'}^t}{8\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)[h_t\theta_{k2}^b\theta_{l2}^t V_{j2}O_{ij}^{L*}$$

$$(-m_b N_{i3}D_{22}+m_{\tilde{\chi}_i^0}N_{i3}^* D_2)-h_b m_b\theta_{k1}^b\theta_{l1}^t N_{i3}^* U_{j2}O_{ij}^{R*}D_{23}](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_5^{(b)}=\sum_i \frac{gh_b^2\alpha_{2i}^2}{32\sqrt{2}\pi^2}\{[h_t m_t\beta_{11}C_0-h_b m_b\beta_{21}(2C_0+C_2)](m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[2h_t m_b^2 m_t\beta_{11}(D_1+D_2+D_3)$$

$$+4h_b m_b\beta_{21}D_{00}-2h_t m_t\beta_{11}D_{00}-h_b m_b^3\beta_{21}(4D_0+6D_1+D_{13}+4D_2+4D_3+D_{33})$$

$$+h_b m_b m_{H^+}^2\beta_{21}(2D_3+D_{33})+h_b m_b m_W^2\beta_{21}D_{13}-h_b m_b\hat{t}\beta_{21}(D_{13}+2D_2+2D_{23}+2D_3+D_{33})+h_t m_t m_{H_i}^2\beta_{11}D_0$$

$$-h_b m_b m_{H_i}^2 \beta_{21}(2D_0+D_3)](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)\}$$

$$+\sum_i \frac{g h_b^2 \beta_{2i}^2}{32\sqrt{2}\pi^2}\{(h_t m_t \beta_{11} C_0 + h_b m_b \beta_{21} C_2)(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[h_b m_b^3 \beta_{21}(D_{13}+D_{33})-2h_t m_t \beta_{11} D_{00} - h_b m_b m_{H^+}^2$$

$$+\beta_{21} D_{33} - h_b m_b m_W^2 \beta_{21} D_{13} + h_b m_b \hat{t} \beta_{21}(D_{13}+2D_{23}+D_{33}) + h_t m_t m_{A_i}^2 \beta_{11} D_0 + h_b m_b m_{A_i}^2 \beta_{21} D_3]$$

$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)\}+\sum_i \frac{g}{16\sqrt{2}\pi^2}\{h_b \beta_{2i}[-h_b^2 m_b \beta_{21}\beta_{2i} C_0 + h_b h_t m_t \beta_{11}\beta_{2i} C_0 + h_t^2 m_b \beta_{11}\beta_{1i}(C_1$$

$$+C_2)](m_W^2,m_{H^+}^2,\hat{s},m_t^2,m_b^2,m_t^2)+[h_t^3 m_b^2 m_t \beta_{11}\beta_{1i}^2(D_0+D_1+D_2+D_3)+h_b^2 h_t m_b^2 m_t \beta_{1i}\beta_{21}\beta_{2i}(D_1+D_2+D_3)$$

$$-h_b^3 m_b \beta_{21}\beta_{2i}^2(-2D_{00}+m_b^2(D_1+D_2+D_3)+m_{H_i^+}^2 D_0)+h_b^2 h_t m_t \beta_{11}\beta_{2i}^2(-2D_{00}+m_b^2(D_0+D_2+2D_3)-m_{H^+}^2 D_1+\hat{u}(D_1$$

$$+D_2)+m_{H_i^+}^2 D_0)+h_b h_t^2 m_b \beta_{11}\beta_{1i}\beta_{2i}(2D_{00}+m_{H^+}^2(D_1+D_{11})-m_t^2(D_0+D_2+D_3)+m_W^2 D_{13}-m_{H_i^+}^2(D_0+D_1)$$

$$-m_b^2(2D_1+D_{11}+D_2+2D_3)-\hat{u}(D_1+D_{11}+2D_{12}+D_{13}+D_2))](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)\}$$

$$+\sum_{i,j,k}\sum_{i',k'}\frac{\sqrt{2} g h_b^2}{16\pi^2}|N_{l3}|^2 \theta_{ii'}^b \theta_{i1}^b (\theta_{j1}^b)^2 \theta_{k1}^t \theta_{kk'}^t (h_b \Theta_{i'k'1}^5 + h_t \Theta_{i'k'1}^6) D_{00}(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)$$

$$+\sum_{i,j,k,l}\sum_{j',l'}\frac{g h_b^2 \theta_{l1}^b \theta_{ll'}^b (\theta_{i1}^t)^2 \theta_{j1}^t \theta_{jj'}^t U_{k2}^2}{8\sqrt{2}\pi^2}(h_b \Theta_{l'j'1}^5 + h_t \Theta_{l'j'1}^6) D_{00}(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)$$

$$+\sum_{i,j}\frac{g h_b \alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}(h_t^2 m_b \beta_{11}\beta_{1j} - h_b h_t \beta_{11}\beta_{2j} - 2h_b^2 m_b \beta_{12}\beta_{2j}) D_{00}(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\tilde{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2 m_b^2,m_t^2)$$

$$+\sum_i \frac{g h_b h_t \beta_{11}\beta_{2i}}{16\sqrt{2}\pi^2}(h_t m_b \beta_{1i} - h_b m_t \beta_{2i}) D_{00}(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)$$

$$+\sum_{i,j,k,l}\sum_{k',l'}\frac{g h_b \theta_{kk'}^b \theta_{ll'}^b}{16\pi^2}(h_b \Theta_{k'l'1}^5 + h_t \Theta_{k'l'1}^6)\{-h_b \theta_{k1}^b \theta_{l1}^t N_{i3}^* U_{j2} O_{ij}^{R*} C_0(m_b^2,m_{H^+}^2,\hat{t},m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2)$$

$$+[h_b m_{\tilde{\chi}_i^0} m_{\tilde{\chi}_i^+} \theta_{k1}^b \theta_{l1}^t N_{i3}^* U_{j2} O_{ij}^{L*} D_0 + h_b \theta_{k1}^b \theta_{l1}^t N_{i3}^* U_{j2} O_{ij}^{R*}(2D_{00}+m_b^2 D_2 - m_W^2 D_1 - \hat{u} D_2 - m_{\tilde{\chi}_j^+}^2 D_0) + h_b m_b$$

$$+\theta_{k2}^b \theta_{l1}^t N_{i3} U_{j2}(-m_{\tilde{\chi}_j^+} + O_{ij}^{L*} + m_{\tilde{\chi}_i^0} + O_{ij}^{R*}) D_2 + h_t m_b \theta_{k1}^b \theta_{l2}^t N_{i3}^* V_{j2}(m_{\tilde{\chi}_j^+} O_{ij}^{R*} - m_{\tilde{\chi}_i^0} O_{ij}^{L*}) D_3]$$

$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2)\},$$

$$f_6^{(b)}=\sum_i \frac{g h_b^2 \alpha_{2i}^2}{32\sqrt{2}\pi^2}\{-h_b m_b \beta_{21} C_2(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[-2h_t m_b^2 m_t \beta_{11}(2D_0+D_1+D_2+D_3)+4h_b m_b \beta_{21} D_{00}$$

$$+h_b m_b^3 \beta_{21}(D_{11}+D_{12}+D_{13}+D_{23}+2D_3)-h_b m_{bH^+}^2 \beta_{21}(D_{13}+D_{23})-h_b m_b m_W^2 \beta_{21}(2D_1+D_{11}D_{12})+h_b m_b \hat{t} \beta_{21}(2D_1$$

$$+D_{11}+3D_{12}+D_{13}+2D_2+2D_{22}+D_{33})+h_b m_b m_{H_i}^2 \beta_{21}(D_0+D_1+D_2)](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)\}$$

$$+\sum_i \frac{g h_b^3 m_b \beta_{21}\beta_{2i}^2}{32\sqrt{2}\pi^2}\{(2C_0+C_2)(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)$$

$$+[-4D_{00}-m_b^2(D_{11}+D_{12}+D_{13}+D_{23})+m_{H^+}^2(D_{13}+D_{23})+m_W^2(D_{11}+D_{12})-\hat{t}(D_{11}+3D_{12}+D_{13}+2D_{22}+D_{23})$$

$$+m_{A_i}^2(D_0-D_1-D_2)](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)\}$$

$$+\sum_i \frac{g}{16\sqrt{2}\pi^2}\{h_t^2\beta_{11}\beta_{1i}[h_b m_b\beta_{2i}(C_1+C_2)-h_t m_t\beta_{1i}C_0](m_W^2,m_{H^+}^2,\hat{s},m_t^2,m_b^2,m_t^2)$$
$$+[h_b h_t^2 m_b m_t^2\beta_{1i}^2\beta_{21}D_0-h_b^2 h_t m_b^2 m_t\beta_{1i}\beta_{21}\beta_{2i}(2D_0+D_1+D_2+D_3)+h_b^3 m_b^3\beta_{21}\beta_{2i}^2(D_0+D_1+D_2+D_3)$$
$$-h_t^3 m_t\beta_{11}\beta_{1i}^2(m_b^2 D_1-m_W^2 D_3+\hat{u}(D_2+D_3)+m_{H_i^+}^2 D_0)$$
$$+h_b h_t^2 m_b\beta_{11}\beta_{1i}\beta_{2i}(4D_{00}+m_b^2(D_{12}+D_{13}+D_{23}+D_{33})-m_{H^+}^2 D_{13}+m_t^2 D_1-m_W^2(D_{23}+D_3-D_{33})+\hat{u}(D_{12}+D_{13}+D_2$$
$$+2D_{22}+3D_{23}+D_3+D_{33})+m_{H_i^+}^2(D_2+D_3))](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)\}$$
$$+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}gh_b^2}{16\pi^2}|N_{l3}|^2\theta_{ii'}^b\theta_{i2}^b\theta_{j1}^b\theta_{j2}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)D_{00}(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)$$
$$+\sum_{i,j,k,l}\sum_{j',l'}\frac{gh_t^2\theta_{l1}^b\theta_{ll'}^b(\theta_{i2}^t)^2\theta_{j1}^t\theta_{jj'}^t V_{k2}^2}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)$$
$$D_{00}(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}(2h_t^2 m_b\beta_{11}\beta_{1j}+h_b h_t\beta_{12}\beta_{1j}$$
$$-h_b^2 m_b\beta_{12}\beta_{2j})D_{00}(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2,m_b^2,m_t^2)-\sum_i\frac{gh_b h_t\beta_{21}\beta_{2i}}{16\sqrt{2}\pi^2}(h_b m_b\beta_{2i}$$
$$-h_t m_t\beta_{1i})D_{00}(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)+\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_b\theta_{kk'}^b\theta_{ll'}^t}{16\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)$$
$$\times\{-h_t\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}O_{ij}^{L*}C_0(m_b^2,m_{H^+}^2,\hat{t},m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2)+[h_t m_{\tilde{\chi}_i^0}m_{\tilde{\chi}_j^+}\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}O_{ij}^{R*}D_0+h_t\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}O_{ij}^{L*}(2D_{00}$$
$$+m_b^2 D_2-m_W^2 D_1-\hat{u}D_2-m_{\tilde{\chi}_j^+}^2 D_0)+h_t m_b\theta_{k1}^b\theta_{l2}^t N_{i3}^* V_{j2}(-m_{\tilde{\chi}_j^+}O_{ij}^{R*}+m_{\tilde{\chi}_i^0}O_{ij}^{L*})D_2+h_b m_b\theta_{k2}^b\theta_{l1}^t N_{i3}U_{j2}(m_{\tilde{\chi}_j^+}O_{ij}^{L*}$$
$$-m_{\tilde{\chi}_i^0}O_{ij}^{R*})D_3](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2)\},$$

$$f_7^{(b)}=\sum_i\frac{gh_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}[h_t m_t\beta_{11}(D_{12}+D_{22})-h_b m_b\beta_{21}(2D_{12}+D_{13}+2D_2+2D_{22}+D_{23})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$
$$+\sum_i\frac{gh_b^2\beta_{2i}^2}{16\sqrt{2}\pi^2}[h_t m_t\beta_{11}(D_{12}+D_{22})+h_b m_b\beta_{21}(D_{13}+D_{23})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s}m_{A_i}^2,m_b^2,m_t^2,m_b^2)$$
$$+\sum_i\frac{gh_b\beta_{2i}^2}{8\sqrt{2}\pi^2}[h_t^2 m_b\beta_{11}\beta_{1i}(D_1+D_{11}+D_{12})$$
$$-h_b h_t m_t\beta_{11}\beta_{2i}(D_1+D_{12})+h_b^2 m_b\beta_{21}\beta_{2i}D_{12}](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)$$
$$+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}gh_b^2}{16\pi^2}|N_{l3}|^2\theta_{ii'}^b\theta_{i1}^b(\theta_{j1}^b)^2\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)(D_{12}+D_2+D_{22})$$
$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)+\sum_{i,j,k,l}\sum_{j',l'}\frac{gh_b^2\theta_{l1}^b\theta_{ll'}^b(\theta_{i1}^t)^2\theta_{j1}^t\theta_{jj'}^t U_{k2}^2}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5$$
$$+h_t\Theta_{l'j'1}^6)D_{23}(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}[h_t^2 m_b\beta_{11}\beta_{1j}(D_{13}+D_{23}+D_3+D_{33})$$
$$-h_b h_t m_t\beta_{11}\beta_{2j}(D_{13}+D_{23}+D_3)-h_b^2 m_b\beta_{12}\beta_{2j}(2D_{13}+D_{23})](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2,m_b^2,m_t^2)$$

$$+\sum_i \frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}[h_b^2 m_b\beta_{21}\beta_{2i}D_{12}-h_bh_tm_t(\beta_{11}\beta_{2i}D_1+\beta_{21}\beta_{1i}D_{12})+h_t^2m_b\beta_{11}\beta_{1i}(D_1+D_{11}+D_{12}+D_{13})]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)+\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_b^2}{8\pi^2}\theta_{k1}^b\theta_{kk'}^b\theta_{l1}^t\theta_{ll'}^t(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)N_{i3}^*U_{j2}O_{ij}^{R*}(D_{13}+D_{23})$$

$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_8^{(b)}=\sum_i \frac{gh_b^3m_b\alpha_{2i}^2\beta_{21}}{16\sqrt{2}\pi^2}(2D_1+D_{11}+D_{12})(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{-gh_b^3m_b\beta_{2i}^2\beta_{21}}{16\sqrt{2}\pi^2}(D_{11}+D_{12})(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{-gh_bh_t^2m_b}{8\sqrt{2}\pi^2}\beta_{11}\beta_{1i}\beta_{2i}D_{13}(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)$$

$$+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}gh_b^2}{16\pi^2}|N_{l3}|^2\theta_{ii'}^b\theta_{i2}^b\theta_{j1}^b\theta_{j2}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)(D_{12}+D_2+D_{22})$$

$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)+\sum_{i,j,k,l}\sum_{j',l'}\frac{gh_t^2\theta_{l1}^b\theta_{ll'}^b(\theta_{i2}^t)^2\theta_{j1}^t\theta_{jj'}^tV_{k2}}{8\sqrt{2}\pi^2}(h_b\Theta_{l'j'1}^5$$

$$+h_t\Theta_{l'j'1}^6)D_{23}(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}[h_t^2m_b\beta_{11}\beta_{1j}(2D_{13}+D_{23})$$

$$+h_bh_tm_t\beta_{11}\beta_{2j}(D_{13}+D_{23}+D_3)-h_b^2m_b\beta_{12}\beta_{2j}(D_{13}+D_{23}+D_{33})](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2m_b^2,m_t^2)$$

$$-\sum_i \frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}[h_t^2m_b\beta_{11}\beta_{1i}D_{12}-h_bh_tm_t(\beta_{21}\beta_{1i}D_1+\beta_{11}\beta_{2i}D_{12})+h_b^2m_b\beta_{21}\beta_{2i}(D_1+D_{11}+D_{12}+D_{13})]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)+\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_bh_t}{8\pi^2}\theta_{k2}^b\theta_{kk'}^b\theta_{l2}^t\theta_{ll'}^t(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)N_{i3}V_{j2}O_{ij}^{L*}(D_{13}$$

$$+D_{23})(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_9^{(b)}=\sum_i \frac{gh_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}[-h_tm_t\beta_{11}D_{23}+h_bm_b\beta_{21}(2D_{23}+2D_3+D_{33})](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{-gh_b^2\beta_{2i}^2}{16\sqrt{2}\pi^2}(h_tm_t\beta_{11}D_{23}+h_bm_b\beta_{21}D_{33})(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{gh_b\beta_{2i}}{8\sqrt{2}\pi^2}[-h_t^2m_b\beta_{11}\beta_{1i}(D_{12}+D_{13}+D_2+D_{22}+D_{23})+h_bh_tm_t\beta_{11}\beta_{2i}(D_2+D_{22}+D_{23})$$

$$-h_b^2m_b\beta_{11}\beta_{2i}(D_{22}+D_{23})](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)$$

$$+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}gh_b^2}{16\pi^2}|N_{l3}|^2\theta_{ii'}^b\theta_{i1}^b(\theta_{j1}^b)^2\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)D_{23}(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)$$

$$-\sum_{i,j,k,l}\sum_{j',l'}\frac{gh_b^2}{8\sqrt{2}\pi^2}\theta_{l1}^b\theta_{ll'}^b(\theta_{i1}^t)^2\theta_{j1}^t\theta_{jj'}^t,U_{k2}^2(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)(D_2+D_{12}+D_{22})$$

$$\times(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_t}^2,m_{\tilde{t}_j}^2)+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}[-h_t^2m_b\beta_{11}\beta_{1j}(D_{12}+D_2+D_{22}+D_{23})$$

$$+h_bh_tm_t\beta_{11}\beta_{2j}(D_{12}+D_2+D_{22})+h_b^2m_b\beta_{12}\beta_{2j}(2D_{12}+D_{22})](m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2m_b^2,m_t^2)+\sum_i\frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}$$

$$\times[-h_b^2m_b\beta_{21}\beta_{2i}D_{22}+h_bh_tm_t\beta_{11}\beta_{2i}(D_2+D_{22}+D_{23})-h_t^2m_b\beta_{11}\beta_{1i}(D_{12}+D_2+D_{22}+D_{23})]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)-\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_b^2}{8\pi^2}\theta_{k1}^b\theta_{kk'}^b\theta_{l1}^t\theta_{ll'}^t(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)N_{i3}^*U_{j2}O_{ij}^{R*}(D_{12}+D_2$$

$$+D_{22})(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_{10}^{(b)}=\sum_i\frac{-gh_b^3m_b\alpha_{2i}^2\beta_{21}}{16\sqrt{2}\pi^2}D_{13}(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i\frac{gh_b^3m_b\beta_{2i}^2\beta_{21}}{16\sqrt{2}\pi^2}D_{13}(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i\frac{gh_t^2\beta_{11}\beta_{1i}}{8\sqrt{2}\pi^2}[h_tm_t\beta_{1i}D_3+h_bm_b\beta_{2i}(D_{23}+D_3+D_{33})](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)$$

$$+\sum_{i,j,k,l}\sum_{i',k'}\frac{\sqrt{2}gh_b^2}{16\pi^2}|N_{l3}|^2\theta_{ii'}^b\theta_{i2}^b\theta_{j1}^b\theta_{j2}^b\theta_{k1}^t\theta_{kk'}^t(h_b\Theta_{i'k'1}^5+h_t\Theta_{i'k'1}^6)$$

$$\times D_{23}(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{\tilde{\chi}_l^0}^2,m_{\tilde{b}_i}^2,m_{\tilde{t}_k}^2,m_{\tilde{b}_j}^2)-\sum_{i,j,k,l}\sum_{j',l'}\frac{gh_t^2}{8\sqrt{2}\pi^2}\theta_{l1}^b\theta_{ll'}^b(\theta_{i2}^t)^2\theta_{j1}^t\theta_{jj'}^tV_{k2}^2(h_b\Theta_{l'j'1}^5+h_t\Theta_{l'j'1}^6)(D_2$$

$$+D_{12}+D_{22})(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{\tilde{\chi}_k^+}^2,m_{\tilde{t}_i}^2,m_{\tilde{b}_l}^2,m_{\tilde{t}_j}^2)$$

$$+\sum_{i,j}\frac{gh_b\alpha_{2i}\varphi_{ij}}{16\sqrt{2}\pi^2}[-h_t^2m_b\beta_{11}\beta_{1j}(D_{12}+D_{22})-h_bh_tm_t\beta_{12}\beta_{1j}(D_{12}+D_2+D_{22})+h_b^2m_b\beta_{12}\beta_{2j}(2D_{12}+D_{22})]$$

$$\times(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2m_b^2,m_t^2)$$

$$-\sum_i\frac{gh_b\beta_{2i}}{16\sqrt{2}\pi^2}[-h_t^2m_b\beta_{11}\beta_{1i}D_{22}+h_bh_tm_t\beta_{21}\beta_{1i}(D_2+D_{22}+D_{23})-h_b^2m_b\beta_{21}\beta_{2i}(D_{12}+D_2+D_{22}+D_{23})]$$

$$\times(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)-\sum_{i,j,k,l}\sum_{k',l'}\frac{gh_bh_t}{8\pi^2}\theta_{k2}^b\theta_{kk'}^b\theta_{l2}^t\theta_{ll'}^t(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)N_{i3}V_{j2}O_{ij}^{L*}(D_{12}+D_2$$

$$+D_{22})(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_{11}^{(b)}=\sum_i\frac{gh_b^2\alpha_{2i}^2}{32\sqrt{2}\pi^2}\{-h_b\beta_{21}(C_0-C_1)(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)+[h_b\beta_{21}D_{00}-2h_tm_bm_t\beta_{11}D_2-h_bm_b^2\beta_{21}(2D_1-D_{12}-D_{23}$$

$$+2D_3)-h_bm_{H^+}^2\beta_{21}D_{23}-h_bm_W^2\beta_{21}D_{12}+h_b\hat{t}\beta_{21}(D_{12}+2D_{22}+D_{23})-h_bm_{H_i}^2(D_0-D_2)]$$

$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)\}+\sum_i\frac{gh_b^3\beta_{21}\beta_{2i}^2}{32\sqrt{2}\pi^2}\{(C_0-C_1)(m_{H^+}^2,m_W^2,\hat{s},m_b^2,m_t^2,m_b^2)$$

$$+[-4D_{00}-m_b^2(D_{12}+D_{23})+m_{H^+}^2D_{23}+m_W^2D_{12}-\hat{t}(D_{12}+2D_{22}+D_{23})+m_{A_i}^2(D_0-D_2)]$$

$$\times(m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{A_i}^2,m_b^2,m_t^2,m_b^2)\}+\sum_i \frac{g}{16\sqrt{2}\pi^2}\{h_t^3 m_b m_t \beta_{11}\beta_{1i}^2(D_0+D_1+D_2)-h_b h_t^2\beta_{11}\beta_{1i}\beta_{2i}[m_b^2(D_0+D_1$$

$$+D_2+D_3)+m_t^2(D_0+D_2)]+h_b^2 h_t m_b m_t\beta_{2i}[\beta_{1i}\beta_{21}D_2+\beta_{11}\beta_{2i}(D_0+D_2+D_3)]-h_b^3 m_b^2\beta_{21}\beta_{2i}^2 D_2\}$$

$$\times(m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)-\sum_{i,j}\frac{g h_b^3\alpha_{2i}\beta_{12}\beta_{2j}\varphi_{ij}}{16\sqrt{2}\pi^2}D_{00}(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2 m_b^2,m_t^2)$$

$$-\sum_i \frac{g h_b^3\beta_{21}\beta_{2i}^2}{16\sqrt{2}\pi^2}D_{00}(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)+\sum_{i,j,k,l}\sum_{k',l'}\frac{g h_b\theta_{kk'}^b\theta_{ll'}^t}{16\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)$$

$$\times\{h_b m_b\theta_{k1}^b\theta_{l1}^t N_{i3}^* U_{j2}D_2+h_b\theta_{k2}^b\theta_{l1}^t N_{i3}U_{j2}[-m_{\tilde{\chi}_j^+}O_{ij}^{L*}(D_0+D_1+D_2)+m_{\tilde{\chi}_i^0}O_{ij}^{R*}(D_1+D_2)]$$

$$+h_t m_b\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}O_{ij}^{L*}D_3\}(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2),$$

$$f_{12}^{(b)}=\sum_i \frac{g h_b^2\alpha_{2i}^2}{16\sqrt{2}\pi^2}[h_t m_b m_t\beta_{11}D_2-h_b m_b^2\beta_{21}(2D_0-D_1-2D_2-D_3)](m_b^2,m_{H^+}^2,m_W^2,m_b^2,\hat{t},\hat{s},m_{H_i}^2,m_b^2,m_t^2,m_b^2)$$

$$+\sum_i \frac{g}{16\sqrt{2}\pi^2}\{-h_b h_t^2\beta_{11}\beta_{1i}\beta_{2i}(C_0-C_1)(m_W^2,m_{H^+}^2,\hat{s},m_t^2,m_b^2,m_t^2)+[h_t^3 m_b m_t\beta_{11}\beta_{1i}^2 D_3-h_b^2 h_t m_b m_t\beta_{2i}(\beta_{1i}\beta_{21}D_2$$

$$-\beta_{11}\beta_{2i}D_1)+h_b^3 m_b^2\beta_{21}\beta_{2i}^2 D_2-h_b h_t^2\beta_{11}\beta_{1i}\beta_{2i}(-4D_{00}+m_b^2(D_1-D_{12}-D_{23}+D_3)+m_{H^+}^2 D_{12}+m_W^2 D_{23}-\hat{u}(D_{12}+D_{22}$$

$$+D_{23})+m_{H_i^+}^2(D_0-D_2))](m_b^2,m_W^2,m_{H^+}^2,m_b^2,\hat{u},\hat{s},m_{H_i^+}^2,m_t^2,m_b^2,m_t^2)\}$$

$$+\sum_{i,j}\frac{g h_b^3\alpha_{2i}\beta_{11}\beta_{1j}\varphi_{ij}}{16\sqrt{2}\pi^2}D_{00}(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{H_j^+}^2,m_{H_i}^2 m_b^2,m_t^2)$$

$$+\sum_i \frac{g h_b h_t^2\beta_{11}\beta_{1i}\beta_{2i}}{16\sqrt{2}\pi^2}D_{00}(m_b^2,m_{H^+}^2,m_b^2,m_W^2,\hat{u},\hat{t},m_{H_i^+}^2,m_t^2,m_b^2,m_{A_i}^2)+\sum_{i,j,k,l}\sum_{k',l'}\frac{g h_b\theta_{kk'}^b\theta_{ll'}^t}{16\pi^2}(h_b\Theta_{k'l'1}^5+h_t\Theta_{k'l'1}^6)$$

$$\times\{h_t m_b\theta_{k2}^b\theta_{l2}^t N_{i3}V_{j2}D_2+h_t\theta_{k1}^b\theta_{l2}^t N_{i3}^* V_{j2}[-m_{\tilde{\chi}_j^+}O_{ij}^{R*}(D_0+D_1+D_2)+m_{\tilde{\chi}_i^0}O_{ij}^{L*}(D_1+D_2)]$$

$$+h_b m_b\theta_{k1}^b\theta_{l1}^t N_{i3}^* U_{j2}O_{ij}^{R*}D_3\}(m_W^2,m_b^2,m_{H^+}^2,m_b^2,\hat{u},\hat{t},m_{\tilde{\chi}_j^+}^2,m_{\tilde{\chi}_i^0}^2,m_{\tilde{b}_k}^2,m_{\tilde{t}_l}^2).$$

All other form factors f_i not listed above vanish. Here A_0, C_i, D_i, and D_{ij} are the one-, three-, and four-point Feynman integrals [22]. The definitions of U_{ij}, V_{ij}, N_{ij}, O_{ij}^L, and O_{ij}^R can be found in Ref. [2].

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