SMEFTatNLO UFO model

Operator definition & normalisation

The table below defines the list of SMEFT operators from the Warsaw basis [1] consistent with a $U(2)^5$ flavor symmetry in the fermion sector. Coefficient names in the model are given in the `UFO` column.
Grey cells denote operators not consistent with the restricted, $U(3)^3 \times U(2)^2$ flavor symmetry assumed in basic implementation, `SMEFTatNLO_U2_2_U3_3_cG_4F_LO_UFO`. Their Wilson coefficients are set to the corresponding, universal light fermion flavor component, *e.g.*, `cpb`→`cpd` if present, otherwise they are set to zero.
See [2] for more details on conventions and the flavor symmetry implementation. The model contains a general cutoff parameter, Λ (`Lambda`), which normalises all operators in the Lagrangian as $\frac{c_i}{\Lambda^2}\mathcal{O}_i$.

Bosonic			SLHA Block: DIM6		
$\mathcal{O}_i$	UFO	Definition	$\mathcal{O}_i$	UFO	Definition
$\mathcal{O}_G$	cG	$g_S f_{ABC}\, G^A_{\mu\nu}\, G^{B,\nu\rho}\, G^{C,\mu}_{\rho}$	$\mathcal{O}_W$	cWWW	$\varepsilon_{IJK}\, W^I_{\mu\nu}\, W^{J,\nu\rho}\, W^{K,\mu}_{\rho}$
$\mathcal{O}_{\varphi G}$	cpG	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right) G^{\mu\nu}_A\, G^A_{\mu\nu}$	$\mathcal{O}_{\varphi W}$	cpW	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right) W^{\mu\nu}_I\, W^I_{\mu\nu}$
$\mathcal{O}_{\varphi B}$	cpBB	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right) B^{\mu\nu}\, B_{\mu\nu}$	$\mathcal{O}_{\varphi WB}$	cpWB	$(\varphi^\dagger\tau_I\varphi)\, B^{\mu\nu} W^I_{\mu\nu}$
$\mathcal{O}_{\varphi}$	cp	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right)^3$	$\mathcal{O}_{\varphi d}$	cdp	$\partial_\mu(\varphi^\dagger\varphi)\partial^\mu(\varphi^\dagger\varphi)$
$\mathcal{O}_{\varphi D}$	cpDC	$(\varphi^\dagger D^\mu\varphi)^\dagger(\varphi^\dagger D_\mu\varphi)$			

2 fermion (chiral flip)			SLHA Block: DIM62F		
$\mathcal{O}_i$	UFO	Definition	$\mathcal{O}_i$	UFO	Definition
$\mathcal{O}_{t\varphi}$	ctp	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right) \bar{Q}\, t\, \tilde{\varphi} + \text{h.c.}$	$\mathcal{O}_{tW}$	ctW	$i\big(\bar{Q}\tau^{\mu\nu}\, \tau_I\, t\big)\, \tilde{\varphi}\, W^I_{\mu\nu} + \text{h.c.}$
$\mathcal{O}_{tG}$	ctG	$ig_S\left(\bar{Q}\tau^{\mu\nu}\, T_A\, t\right) \tilde{\varphi}\, G^A_{\mu\nu} + \text{h.c.}$	$\mathcal{O}_{tB}$	-	$i\big(\bar{Q}\tau^{\mu\nu}\, t\big)\, \tilde{\varphi}\, B_{\mu\nu} + \text{h.c.}$
			$\mathcal{O}_{tZ}$	ctZ	$-\sin\theta_W \mathcal{O}_{tB} + \cos\theta_W \mathcal{O}_{tW}$
$\mathcal{O}_{b\varphi}$	cbp	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right) \bar{Q}\, b\, \varphi + \text{h.c.}$	$\mathcal{O}_{bW}$	cbW	$i\big(\bar{Q}\tau^{\mu\nu}\, \tau_I\, b\big)\, \varphi\, W^I_{\mu\nu} + \text{h.c.}$
$\mathcal{O}_{bG}$	cbG	$ig_S\left(\bar{Q}\tau^{\mu\nu}\, T_A\, b\right) \varphi\, G^A_{\mu\nu} + \text{h.c.}$	$\mathcal{O}_{bB}$	cbB	$i\big(\bar{Q}\tau^{\mu\nu}\, b\big)\, \varphi\, B_{\mu\nu} + \text{h.c.}$
$\mathcal{O}_{\tau\varphi}$	ctap	$\left(\varphi^\dagger\varphi - \frac{v^2}{2}\right) \bar{Q}\, \tau\, \tilde{\varphi} + \text{h.c.}$	$\mathcal{O}_{\tau W}$	ctaW	$i\big(\bar{Q}\tau^{\mu\nu}\, \tau_I\, \tau\big)\, \tilde{\varphi}\, W^I_{\mu\nu} + \text{h.c.}$
			$\mathcal{O}_{\tau B}$	ctaB	$i\big(\bar{Q}\tau^{\mu\nu}\, \tau\big)\, \tilde{\varphi}\, B_{\mu\nu} + \text{h.c.}$

2 fermion (current)			SLHA Block: DIM62F		
$\mathcal{O}_i$	UFO	Definition	$\mathcal{O}_i$	UFO	Definition
$\mathcal{O}^{(1)}_{\varphi l_1}$	cpl1	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{l}_1 \gamma^\mu l_1\big)$	$\mathcal{O}^{(3)}_{\varphi l_1}$	c3pl1	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \tau_I \varphi\big)\big(\bar{l}_1 \gamma^\mu \tau^I l_1\big)$
$\mathcal{O}^{(1)}_{\varphi l_2}$	cpl2	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{l}_2 \gamma^\mu l_2\big)$	$\mathcal{O}^{(3)}_{\varphi l_2}$	c3pl2	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \tau_I \varphi\big)\big(\bar{l}_2 \gamma^\mu \tau^I l_1\big)$
$\mathcal{O}^{(1)}_{\varphi l_3}$	cpl3	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{l}_3 \gamma^\mu l_3\big)$	$\mathcal{O}^{(3)}_{\varphi l_3}$	c3pl3	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \tau_I \varphi\big)\big(\bar{l}_3 \gamma^\mu \tau^I l_3\big)$
$\mathcal{O}_{\varphi e}$	cpe	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{e} \gamma^\mu e\big)$	$\mathcal{O}_{\varphi \mu}$	cpmu	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{\mu} \gamma^\mu \mu\big)$
$\mathcal{O}_{\varphi \tau}$	cpta	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{\tau} \gamma^\mu \tau\big)$	$\mathcal{O}_{\varphi tb}$	cptb	$i\big(\tilde{\varphi}\, D_\mu \varphi\big)\big(\bar{t} \gamma^\mu b\big) + \text{h.c.}$
$\mathcal{O}^{(1)}_{\varphi q_i}$	-	$\sum_{i=1,2} i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{q}_i \gamma^\mu q_i\big)$	$\mathcal{O}^{(1)}_{\varphi Q}$	-	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{Q} \gamma^\mu Q\big)$
$\mathcal{O}^{(3)}_{\varphi q_i}$	cpq3i	$\sum_{i=1,2} i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \tau_I \varphi\big)\big(\bar{q}_i \gamma^\mu \tau^I q_i\big)$	$\mathcal{O}^{(3)}_{\varphi Q}$	cpQ3	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \tau_I \varphi\big)\big(\bar{Q} \gamma^\mu \tau^I Q\big)$
$\mathcal{O}^{(-)}_{\varphi q_i}$	cpqMi	$\mathcal{O}^{(1)}_{\varphi q_i} - \mathcal{O}^{(3)}_{\varphi q_i}$	$\mathcal{O}^{(-)}_{\varphi Q}$	cpQM	$\mathcal{O}^{(1)}_{\varphi Q} - \mathcal{O}^{(3)}_{\varphi Q}$
$\mathcal{O}_{\varphi u_i}$	cpu	$\sum_{i=1,2} i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{u}_i \gamma^\mu u_i\big)$	$\mathcal{O}_{\varphi d_i}$	cpd	$\sum_{i=1,2(,3)} i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{d}_i \gamma^\mu d_i\big)$
$\mathcal{O}_{\varphi t}$	cpt	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{t} \gamma^\mu t\big)$	$\mathcal{O}_{\varphi b}$	cpb	$i\big(\varphi^\dagger \overleftrightarrow{D}_\mu \varphi\big)\big(\bar{b} \gamma^\mu b\big)$

2 quark 2 lepton			SLHA Block: DIM64F2L		
$\mathcal{O}_i$	UFO	Definition	$\mathcal{O}_i$	UFO	Definition
$\mathcal{O}^{-(1)}_{Ql}$	cQlM1	$[C^1_{lq}]^{1133} - [C^3_{lq}]^{1133}$	$\mathcal{O}^{3(1)}_{Ql}$	cQl31	$[C^3_{lq}]^{1133}$
$\mathcal{O}^{-(2)}_{Ql}$	cQlM2	$[C^1_{lq}]^{2233} - [C^3_{lq}]^{2233}$	$\mathcal{O}^{3(1)}_{Ql}$	cQl32	$[C^3_{lq}]^{1133}$
$\mathcal{O}^{-(3)}_{Ql}$	cQlM3	$[C^1_{lq}]^{3333} - [C^3_{lq}]^{3333}$	$\mathcal{O}^{3(1)}_{Ql}$	cQl33	$[C^3_{lq}]^{1133}$
$\mathcal{O}^{(1)}_{tl}$	ctl1	$[C_{lu}]^{1133}$	$\mathcal{O}^{(1)}_{bl}$	cbl1	$[C_{ld}]^{1133}$
$\mathcal{O}^{(2)}_{tl}$	ctl2	$[C_{lu}]^{2233}$	$\mathcal{O}^{(2)}_{bl}$	cbl2	$[C_{ld}]^{2233}$
$\mathcal{O}^{(3)}_{tl}$	ctl3	$[C_{lu}]^{3333}$	$\mathcal{O}^{(3)}_{bl}$	cbl3	$[C_{ld}]^{3333}$
$\mathcal{O}^{(1)}_{te}$	cte	$[C_{eu}]^{1133}$	$\mathcal{O}^{(1)}_{be}$	cbe	$[C_{ed}]^{1133}$
$\mathcal{O}^{(2)}_{te}$	ctmu	$[C_{eu}]^{2233}$	$\mathcal{O}^{(2)}_{be}$	cbmu	$[C_{ed}]^{2233}$
$\mathcal{O}^{(3)}_{te}$	ctta	$[C_{eu}]^{3333}$	$\mathcal{O}^{(3)}_{be}$	cbta	$[C_{ed}]^{3333}$
$\mathcal{O}^{(1)}_{Qe}$	cQe	$[C_{eQ}]^{1133}$	$\mathcal{O}^{S(3)}_{t}$	ctlS	$[C^{(1)}_{lequ}]^{3333}$
$\mathcal{O}^{(2)}_{Qe}$	cQmu	$[C_{eQ}]^{2233}$	$\mathcal{O}^{T(3)}_{t}$	ctlT	$[C^{(3)}_{lequ}]^{3333}$
$\mathcal{O}^{(3)}_{Qe}$	cQta	$[C_{eQ}]^{3333}$	$\mathcal{O}^{S(3)}_{b}$	cblS	$[C_{ledq}]^{3333}$

4 quark (2 heavy 2 light)			SLHA Block: DIM64F		
$\mathcal{O}_i$	UFO	Definition	$\mathcal{O}_i$	UFO	Definition
$\mathcal{O}_{Qq}^{1,1}$	cQq11	$\sum_{i=1,2}[C_{qq}^{(1)}]^{ii33}+\frac{1}{6}[C_{qq}^{(1)}]^{i33i}+\frac{1}{2}[C_{qq}^{(3)}]^{i33i}$	$\mathcal{O}_{Qq}^{1,8}$	cQq18	$\sum_{i=1,2}[C_{qq}^{(1)}]^{i33i}+3[C_{qq}^{(3)}]^{i33i}$
$\mathcal{O}_{Qq}^{3,1}$	cQq31	$\sum_{i=1,2}[C_{qq}^{(3)}]^{ii33}+\frac{1}{6}[C_{qq}^{(1)}]^{i33i}-\frac{1}{6}[C_{qq}^{(3)}]^{i33i}$	$\mathcal{O}_{Qq}^{3,8}$	cQq38	$\sum_{i=1,2}[C_{qq}^{(1)}]^{i33i}-[C_{qq}^{(3)}]^{i33i}$
$\mathcal{O}_{tu}^{1}$	ctu1	$\sum_{i=1,2}[C_{uu}]^{ii33}+\frac{1}{3}[C_{uu}]^{i33i}$	$\mathcal{O}_{tu}^{8}$	ctu8	$\sum_{i=1,2}2[C_{uu}]^{i33i}$
$\mathcal{O}_{td}^{1}$	ctd1	$\sum_{i=1,2(,3)}[C_{ud}^{(1)}]^{33ii}$	$\mathcal{O}_{td}^{8}$	ctd8	$\sum_{i=1,2(,3)}[C_{ud}^{(8)}]^{33ii}$
$\mathcal{O}_{tq}^{1}$	ctq1	$\sum_{i=1,2}[C_{qu}^{(1)}]^{ii33}$	$\mathcal{O}_{tq}^{8}$	ctq8	$\sum_{i=1,2}[C_{qu}^{(8)}]^{ii33}$
$\mathcal{O}_{Qu}^{1}$	cQu1	$\sum_{i=1,2}[C_{qu}^{(1)}]^{33ii}$	$\mathcal{O}_{Qu}^{8}$	cQu8	$\sum_{i=1,2}[C_{qu}^{(8)}]^{33ii}$
$\mathcal{O}_{Qd}^{1}$	cQd1	$\sum_{i=1,2(,3)}[C_{qd}^{(1)}]^{33ii}$	$\mathcal{O}_{Qd}^{8}$	cQd8	$\sum_{i=1,2(,3)}[C_{qd}^{(8)}]^{33ii}$
$\mathcal{O}_{ub}^{1}$	cub1	$\sum_{i=1,2}[C_{ud}^{(1)}]^{ii33}$	$\mathcal{O}_{ub}^{8}$	cub8	$\sum_{i=1,2}[C_{ud}^{(8)}]^{ii33}$

4 quark (4 heavy)			SLHA Block: DIM64F		
$\mathcal{O}_i$	UFO	Definition	$\mathcal{O}_i$	UFO	Definition
$\mathcal{O}_{QQ}^{1}$	cQQ1	$2[C_{qq}^{(1)}]^{3333}-\frac{2}{3}[C_{qq}^{(3)}]^{3333}$	$\mathcal{O}_{QQ}^{8}$	cQQ8	$8[C_{qq}^{(3)}]^{3333}$
$\mathcal{O}_{Qt}^{1}$	cQt1	$[C_{qu}^{(1)}]^{3333}$	$\mathcal{O}_{Qt}^{8}$	cQt8	$[C_{qu}^{(8)}]^{3333}$
$\mathcal{O}_{Qb}^{1}$	cQb1	$[C_{qd}^{(1)}]^{3333}$	$\mathcal{O}_{Qb}^{8}$	cQb8	$[C_{qd}^{(8)}]^{3333}$
$\mathcal{O}_{tb}^{1}$	ctb1	$[C_{ud}^{(1)}]^{3333}$	$\mathcal{O}_{tb}^{8}$	ctb8	$[C_{ud}^{(8)}]^{3333}$
$\mathcal{O}_{tt}$	ctt	$[C_{uu}^{(1)}]^{3333}$			
$\mathcal{O}_{QtQb}^{1}$	cQtQb1	$\mathrm{Re}[C_{quqd}^{(1)}]^{3333}$	$\mathcal{O}_{QtQb}^{8}$	cQtQb8	$\mathrm{Re}[C_{quqd}^{(8)}]^{3333}$

Definitions

$$\varphi^\dagger \overset{\leftrightarrow}{D}_\mu \varphi = \varphi^\dagger D^\mu \varphi - (D_\mu \varphi)^\dagger \varphi \tag{1}$$

$$\varphi^\dagger \tau_K \overset{\leftrightarrow}{D}^\mu \varphi = \varphi^\dagger \tau_K D^\mu \varphi - (D^\mu \varphi)^\dagger \tau_K \varphi \tag{2}$$

$$W_{\mu\nu}^K = \partial_\mu W_\nu^K - \partial_\nu W_\mu^K + g\epsilon_{IJ}{}^K\, W_\mu^I W_\nu^J \tag{3}$$

$$B_{\mu\nu} = \partial_\mu B_\nu - \partial_\nu B_\mu \tag{4}$$

$$D_\rho W_{\mu\nu}^K = \partial_\rho W_{\mu\nu}^K + g\epsilon_{IJ}^K W_\rho^I W_{\mu\nu}^J \tag{5}$$

$$D_\mu \varphi = \left(\partial_\mu - i\frac{g}{2}\tau_K W_\mu^K - i\frac{1}{2}g' B_\mu\right)\varphi \tag{6}$$

$$\tau^{\mu\nu} = \frac{1}{2}\left(\gamma^\mu\gamma^\nu - \gamma^\mu\gamma^\mu\right) \tag{7}$$

where τ_I are the Pauli sigma matrices.

References

[1] B. Grzadkowski, M. Iskrzynski, M. Misiak, and J. Rosiek, "Dimension-Six Terms in the Standard Model Lagrangian," *JHEP* **10** (2010) 085, arXiv:1008.4884 [hep-ph].

[2] D. Barducci *et al.*, "Interpreting top-quark LHC measurements in the standard-model effective field theory," arXiv:1802.07237 [hep-ph].