VLQ.fr Model Description

M. Buchkremer, G. Cacciapaglia, A. Deandrea, L. Panizzi

This document lists the default values for the parameters used in the *VLQ.fr* FeynRules model implementation [1]. Unless specified otherwise, the default MadGraph5 values are systematically used for the Standard Model parameters [2], as given in Table 1. All fermion masses are set to zero using the restriction file *Massless.rst* when loading the FeynRules model *VLQ.fr*, except for the top, the bottom and the tau lepton masses. The new fields in Table 2, as well as the default values for the new parameters given in Table 3, are defined according to the parametrization detailed in [1].

Parameter	Symbol	MG Symbol	Value
SMINPUTS BLOCK			
Inverse of the electromagnetic coupling	$\alpha_{EW}^{-1}(M_Z)$	aEWM1	127.9
Fermi constant	G_F	Gf	1.166×10^{-5} GeV^{-2}
Strong coupling	$\alpha_s(M_Z)$	aS	0.118
MASS BLOCK[1]			
b quark pole (Yukawa) mass	$m_b^{(Yuk)}$	MB (ymb)	4.2 GeV
t quark pole (Yukawa) mass	$m_t^{(Yuk)}$	MT (ymt)	1.743 GeV
τ lepton pole (Yukawa) mass	$m_\tau^{(Yuk)}$	MTA (ymtau)	1.777 GeV
Z pole mass	m_Z	MZ	91.1876 GeV
Higgs mass	m_h	MH	125 GeV
DECAY BLOCK			
t quark width		WT	1.510135 GeV
Z width		WZ	2.4464 GeV
W width		WW	2.0354 GeV
H width		WH	0.00403 GeV
CKM BLOCK[2]			
CKM matrix elements (real)	V_{ud}	CKM11	0.97428
	V_{us}	CKM12	0.2253
	V_{ub}	CKM13	0.00347
	V_{cd}	CKM21	0.2252
	V_{cs}	CKM22	0.97345
	V_{cb}	CKM23	0.04100
	V_{td}	CKM31	0.00862
	V_{ts}	CKM32	0.04030
	V_{tb}	CKM33	0.999152

Table 1 : SM default parameters in parameter_card.dat.

[1] The 3×3 CKM matrix elements are model-dependent quantities, defined here as real external parameters [3].

[2] The Higgs total width is a model-dependent quantity, here defined as an external parameter. The default value is as given by [4] for $m_H = 125$ GeV in the low- and intermediate- mass ranges. All the quantities given in the block DECAY are dependent parameters, given by the model restrictions. Although MadGraph ignores these values, they should be edited correspondingly to the analytical expressions when interfacing the output to external softwares, including Pythia.

Parameter	X quark	T quark	B quark	Y quark
PDG number	6000008	6000006	6000005	6000007
3 times electric charge	5	2	-1	-4
number of spin states (2S+1)	2	2	2	2
colour rep (1: singlet, 3: triplet, 8: octet)	3	3	3	3
Particle/Antiparticle distinction (0=own anti)	1	1	1	1

Table 2 : Vector-Like quark fields as defined in [1].

Parameter	Symbol	MG Symbol	Default value
KAPPA BLOCK			
X quark coupling strength	κ_X	KX	1
T quark coupling strength	κ_T	KT	1
B quark coupling strength	κ_B	KB	1
Y quark coupling strength	κ_Y	KY	1
MASS BLOCK			
X quark mass	m_X	MX	600 GeV
T quark mass	m_T	MTP	600 GeV
B quark mass	m_B	MBP	600 GeV
Y quark mass	m_Y	MY	600 GeV
DECAY BLOCK(1)			
X quark width	Γ_X	WX	1 GeV
T quark width	Γ_T	WTP	1 GeV
B quark width	Γ_B	WBP	1 GeV
Y quark width	Γ_Y	WY	1 GeV
XI BLOCK			
TW, TZ, TH couplings	$(\xi_W^T, \xi_Z^T, \xi_H^T)$	(xitpw, xitpz, xitph)	(0.4, 0.3, 0.3)
BW, BZ, BH couplings	$(\xi_W^B, \xi_Z^B, \xi_H^B)$	(xibpw, xibpz, xibph)	(0.4, 0.3, 0.3)
ZETA BLOCK			
Xq couplings	$\begin{cases} (\zeta_{1L}^X, \zeta_{2L}^X, \zeta_{3L}^X) \\ (\zeta_{1R}^X, \zeta_{2R}^X, \zeta_{3R}^X) \end{cases}$	$\begin{cases} \text{(zetaXuL,zetaXcL,zetaXtL)} \\ \text{(zetaXuR,zetaXcR,zetaXtR)} \end{cases}$	$\begin{cases} (0.3, 0.3, 0.4) \\ (0, 0, 0) \end{cases}$
Tq couplings	$\begin{cases} (\zeta_{1L}^T, \zeta_{2L}^T, \zeta_{3L}^T) \\ (\zeta_{1R}^T, \zeta_{2R}^T, \zeta_{3R}^T) \end{cases}$	$\begin{cases} \text{(zetaTuL,zetaTcL,zetaTtL)} \\ \text{(zetaTuR,zetaTcR,zetaTtR)} \end{cases}$	$\begin{cases} (0.3, 0.3, 0.4) \\ (0, 0, 0) \end{cases}$
Bq couplings	$\begin{cases} (\zeta_{1L}^B, \zeta_{2L}^B, \zeta_{3L}^B) \\ (\zeta_{1R}^B, \zeta_{2R}^B, \zeta_{3R}^B) \end{cases}$	$\begin{cases} \text{(zetaBdL,zetaBsL,zetaBbL)} \\ \text{(zetaBdR,zetaBsR,zetaBbR)} \end{cases}$	$\begin{cases} (0.3, 0.3, 0.4) \\ (0, 0, 0) \end{cases}$
Yq couplings	$\begin{cases} (\zeta_{1L}^Y, \zeta_{2L}^Y, \zeta_{3L}^Y) \\ (\zeta_{1R}^Y, \zeta_{2R}^Y, \zeta_{3R}^Y) \end{cases}$	$\begin{cases} \text{(zetaYdL,zetaYsL,zetaYbL)} \\ \text{(zetaYdR,zetaYsR,zetaYbR)} \end{cases}$	$\begin{cases} (0.3, 0.3, 0.4) \\ (0, 0, 0) \end{cases}$

Table 3 : Vector-like quarks default parameters in parameter_card.dat.

(1) Although they are fixed to 1 GeV in the default parameter card, the VLQ widths must be defined consistently by the user depending on the choice of the quark couplings, using MadGraph to compute systematically the numerical value of the VL quarks input widths.

References

[1] M. Buchkremer, G. Cacciapaglia, A. Deandrea, L. Panizzi, Model Independent Framework for Searches of Top Partners, arXiv:1305.4172 [hep-ph]

[2] J. Alwall, M. Herquet, F. Maltoni, O. Mattelaer, T. Stelzer, *MadGraph 5 : Going Beyond*, JHEP 06 (2011) 128, arXiv:1106.0522 [hep-ph]

[3] K. Hagiwara, *et al.*, *Review of particle physics*, PRD 86 (2012) 010001 (http://pdg.lbl.gov)

[4] LHC Higgs Cross Section Working Group Collaboration, *Handbook of LHC Higgs Cross Sections: 1. Inclusive Observables*, CERN-2011-002, arXiv:1101.0593 [hep-ph]