TBdoubletVL.fr Model Description

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This document lists the default values for the parameters used in the *TBdoubletVL.fr* FeynRules model implementation [1,2]. Unless specified otherwise, the default MadGraph5 values are systematically used for the Standard Model parameters [3], as given in Table 1. All fermion masses can be set to zero using the restriction file *Massless.rst* when loading the FeynRules model *TBdoubletVL.fr*, except for the top, the bottom and the tau lepton masses. The new fields in Table 2, as well as the values for the new parameters given in Table 3, are defined according to the parametrization detailed in [1,2] for a vector-like (T, B) doublet mixing with the first and third family SM quarks. These parameters are set by default such that T and B decay 50% into first generation quarks, and 50% into third generation quarks.

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	0.00679 GeV
CKM BLOCK[(2)]			
CKM matrix elements (real)	V_{ud}	CKM1x1	0.97428
	V_{us}	CKM1x2	0.2253
	V_{ub}	CKM1x3	0.00347
	V_{cd}	CKM2x1	0.2252
	V_{cs}	CKM2x2	0.97345
	V_{cb}	CKM2x3	0.04100
	V_{td}	CKM3x1	0.00862
	V_{ts}	CKM3x2	0.04030
	V_{tb}	CKM3x3	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 [4].

[(2)] The Higgs total width is a model-dependent quantity, here defined as an external parameter. 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	T quark	B quark
PDG number	6000006	6000007
3 times electric charge	2	-1
number of spin states (2S+1)	2	2
colour rep (1: singlet, 3: triplet, 8: octet)	3	3
Particle/Antiparticle distinction (0=own anti)	1	1

Table 2 : Vector-Like (T,B) doublet quark field as defined in [1,2].

Parameter	Symbol	MG Symbol	Default value
KAPPA BLOCK			
(T, B) quarks coupling strength for single production (in units of the weak coupling g)	g^*	gstar	0.1
MASS BLOCK			
T, B quark masses (degenerate)	m_Q	MQ	1000 GeV
DECAY BLOCK[(1)]			
T quark width	Γ_T	WTP	1 GeV
B quark width	Γ_B	WBP	1 GeV
GVL BLOCK			
Gauge-T-$\bar{T}$ and gauge-B-$\bar{B}$ couplings	G_{VL}	Gvl	1
ZETA BLOCK			
Rate of T and B quark decays into light quarks	R_L	RL	0.5

Table 3 : $(\mathbf{T}, \mathbf{B})$ doublet default parameters in parameter_card.dat.

[(1)] Although it is fixed to 1 GeV in the default parameter card, the (T,B) doublet quark widths must be defined consistently by the user depending on the choice of the quark couplings, using MadGraph to compute systematically their numerical values.

References

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

[2] http://feynrules.irmp.ucl.ac.be/wiki/VLQ_tbdoubletvl

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

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