Haible Living VCOs by RANDOM*SOURCE -

All values for +/-15V operation -
values in (round backets) are suggestions for +/-12V
(updated 2016-12-23)

1	**10p**	**C37**	C0G/NP0 recommended
4	**22p**	**C5A C5B C5C CM1**	C0G/NP0 recommended
5	**100p**	**CD27 CD30 C1 C12 C25**	C0G/NP0 recommended
4	**1n**	**CD1 C2A C2B C2C**	C0G/NP0 recommended
3	**2n7**	**C3B C3Q C3S**	Polystyrene / Styroflex
1	**47n**	**CD31**	
7	**100n**	**CB1 CB2 CB3 CB4 CB5 CB6**	Bypass Caps - not (all) needed if SMT Bypass caps are installed
1	**100n C0G**	**CD28**	C0G/NP0 recommended
10	**1uF**	**C6A C6B C6C CT2A CT2B CT2C CTA CTB CTC CD29**	Film (WIMA MKS2-5 or similar)
2	**10uF**	**C1P C2P**	POLARIZED CAPACITOR, 25V or higher rated
6	**22u**	**C7 C8 C15 C16 C27 C28**	POLARIZED CAPACITOR, 25V or higher rated
23	**100n SMT**	**C3 C4 C9 C10 C11 C13 C18 C20 C21 C22 C23 C24 C30 C32 C33 C34 C35 C36 C38 C39 C40 C41 C42**	**BYPASS CAPS, X7R (1206)**
24	**1N4148**	**D1A D1B D1C D2A D2B D2C D3A D3B D3C D4A D4B D4C D15A D15B D15C D16 D18 D19 DT1 DT2 DT3 DT4 DT5 DT6**	DIODE
2	**5V1**	**D17 D20**	ZENER DIODE
12	**BC550C**	**Q3A Q3B Q3C Q4 Q4A Q4C Q5A Q5B Q5C Q7A Q7 Q7C**	NPN Transistor, **Q3, Q4: Rectangular pad = Emitter**
12	**BC560C**	**Q1A Q1B Q1C Q2A Q2B Q2C Q6A Q6B Q6C Q28 QD22 QD23**	PNP Transistror
3	**BC847C**	**Q9 Q9A Q9C**	IGNORE (SMT ALTERNATIVE TO Q7)
6	**BCM847DS**	**T1 T2 T4 T5 T7 T8**	**NXP BCM847 Transistor Array - BOTTOM SIDE!! USE BCM847DS OR THAT300 - NOT BOTH!!!**

3	**THAT300S**	**Q8A Q8B Q8C**	**ALTERNATIVE TO BCM847DS (T1, T2, T4, T5, T7, T8) - DO NOT USE BOTH!**
3	**PMP4201Y**	**QM QM1 QMC**	IGNORE (NXP PMP4201Y AS ALTERNATIVE TO Q4, Q5)
3	**SSM2212RZ**	**QSSMA QSSMB QSSMC**	IGNORE ($$$ SMT ALTERNATIVE TO Q4, Q5)
1	**LM13700N**	**UD1**	OTA
3	**LM311N**	**IC2A IC2B IC2C**	COMPARATOR
7	**OPA2134P**	**UD5 IC7A IC7B IC7C (= IC7 IC10 IC12) IC1A IC1B IC1C**	**Use OPA2134 as IC1x for better tracking!!**
1	**TL072**	**UD4**	or OPA2134
2	**TL072**	**UD2 UD3**	
3	**TL074**	**IC3A IC3B IC3C**	
3	**1k tempco**	**R11A R11B R11C**	**Tempco 3000ppm/K ... 3500ppm/K - Mount on Top of Transistor Array (THAT300 or BCM847DS)**
8	**BEAD**	**L1A L1B L1C L2A L2B L2C FD1 FD2**	FERRIT BEAD
1	**68R**	**R121**	
1	**100R**	**R119**	
2	**220R**	**R127 R129**	
4	**300R**	**R35A R35B R35C R148**	
3	**330R**	**R17B R17C R49**	
3	**390R**	**RS4B RS4C RS10**	
18	**1k**	**R23A R23B R23C R27A R27B R27C R29A R29B R29C RA5X RA5Y RA5Z R131 R143 RM6 RA4A RA4 RA4C**	
3	**1M(1M5)**	**R39A R39C R39B**	R39A and R39X are in series to allow easier experimenting / adding resistors. For 15V using 1M + link (or 10R) equals Jürgens original value. **For 12V use 1M5 + link.**
3	**10R/LINK**	**R39X R39Y R39Z**	See R39A ... Above
1	**1k5**	**R124**	
3	**2k(1k8)**	**R12A R12B R12C**	
3	**2k(1k96?)**	**R25A R25B R25C**	
7	**2k2**	**RS1A RS1B RS1C RS6 RS6A RS22 R123**	
3	**3k3**	**R19A R19B R19C**	

3	**5k1(4k7)**	**R24 R24A R24C**	
3	**6.2k**	**R30A R30B R30C**	
35	**10k**	**R6A R6B R6C R16A R16B R16C R21A R21B R21C RA RB RC RS2A RS2B RS2C RS5 RS5A RS7 RS7A RS8A RS8B RS19 RS23 RS24 RT6A RT6B RT6C RT7A RT7B RT7C R147 R149 R153 R154 R157**	
3	**12k(10k)**	**R34A R34B R34C**	
17	**15k**	**R20A R20B R26A R26B R26C R28A R28B R28C R31A R31B R31C R96 RA1X RA1Y RA1Z R125 R156**	
1	**15k(10k)**	**R150**	
3	**20k(47k)**	**R22A R22B R22C**	
21	**20k**	**RA1 RA1A RA1C RA2 RA2A RA2C RA2X RA2Y RA2Z RA3X RA3Y RA3Z RT1A RT1B RT1C RT2A RT2B RT2C RT5A RT5B RT5C**	
3	**20k(22k-27k)**	**R33A R33B R33C**	12V: value determines PW-Knob behavior at min (CCW): 22k means a thin pulse, 27k means too thin = silence. Great for rhythmic effects as 0V CV can be used to mute the Pulse output. Picj according to taste.
1	**22k**	**R130**	
3	**51k**	**R10A R10B R10C**	
1	**56k**	**R155**	
6	**62k**	**RA3 RA3A RA3C RA4X RA4Y RA4Z**	
3	**68k**	**R13A R13B R13C**	
19	**100k**	**R4A R4B R4C RT8A RT8B RT8C R120 R122 R128 R137 R141 R144 R151 R158 RM1 RM2 RM3 RM4 RM5**	

11	**100k .1%**	**R1A R1B R1C R2A R2B R2C R3A R3B R3C R145 R146**	Resistors, 0.1% - you can also use 1% and match them in pairs or triples. You should match all resistors that go from CV inputs to one node, like R1A, R2A, R3A. Similarly R1B, R2B, R3B etc.. Finally, R145, R146. There is no need to match between these groups.
1	**100k(75k)**	**R160**	
3	**150k(120k)**	**R5A R5B R5C**	
3	**150k(510k)**	**R38A R38B R38C**	**12V: updated value for PWM**
1	**200k**	**R159**	
1	**220k**	**R161**	
6	**300k**	**RT3A RT3B RT3C RT4A RT4B RT4C**	
1	**430k(150k)**	**R140**	
1	**510k**	**R152**	
3	**510k(390k)**	**R7A R7B R7C**	
3	**750k(1M5)**	**R36A R36B R36C**	
12	**1M**	**R15A R15B R15C R32A R32B R32C R126 R139 R142**	
3	**1M(4.3M)**	**R37A R37B R37C**	**12V: updated value for PWM**
1	**4.7M**	**R138**	
3	**10M**	**R14A R14B R14C**	
			Check size of footprints for trimmers to see if they fit!
1	**10k**	**VCA-CV - not 100k as in previous BOM1**	Trimpot (3362P) or small Multiturn
9	**100k**	**OCT_DOWN OCT_UP RND RND1 RND2 TRI-LEVEL TRI-LEVEL1 TRI-LEVEL2 VCA**	Trimpot (3362P) or small Multiturn
3	**100k**	**TR8-FREQ TR8-FREQA TR8C-FREQ**	Multiturn-Trimpot S64YW
3	**10k**	**TR9A-SCALE TR9B-SCALE TR9C-SCALE**	Multiturn-Trimpot S64YW
3	**LINK or 2K**	**TR18-HF TR18-HF1 TR18-HF2**	HF-Compensation: R*S mod: use **link between pin 1 and 2 (center)** and **OPA2134 as IC1x**

6	**50k**	**SYMMETRY SYMMETRY1 SYMMETRY2**	Trimpot (3362P) or small Multiturn