

# Thomas Henry's VCO MAXIMUS (Eurorack DIY)



## Features

- triangle, ramp, sine and pulse outputs
- PWM
- pulse/sub blend
- switchable fifth/octave, add/subtract, sub/sub-sub effects
- strong and weak sync
- linear and exponential FM
- 1V/octave response
- easy to build for what it does
- no matched pair and/or TEMPCO resistor needed

## Introduction

Back in 1987 Thomas Henry published the CEM3340 based Deluxe VCO in his book Build A Better Music Synthesizer. Alas, in the following years everything went digital and the CEM chips went out of production. With the recent re-issues of the classic CEM synthesizer function block ICs these chips have become easily available again at a decent price. And Thomas Henry re-visited and re-invented the Deluxe VCO that transformed quickly into something completely new, the VCO MAXIMUS.

You can find a detailed description of this design at Scott Stites [birthofasynth.com](http://birthofasynth.com) page, where he hosts a lot of information for Thomas Henry designs.

As usual Thomas Henry did design this project for 15V, alas, time has shown that this circuit could not be used with 12V w/o a lot of changes. Especially the PWM did have an impact on the overall pitch. I am very thankful that 'chrissugar' from Romania did a lot of valuable work and tests to tackle the PWM/pitch-issue. I amended this documentation accordingly.

## Specifications

The frontpanel measures: 16HP (Eurorack)

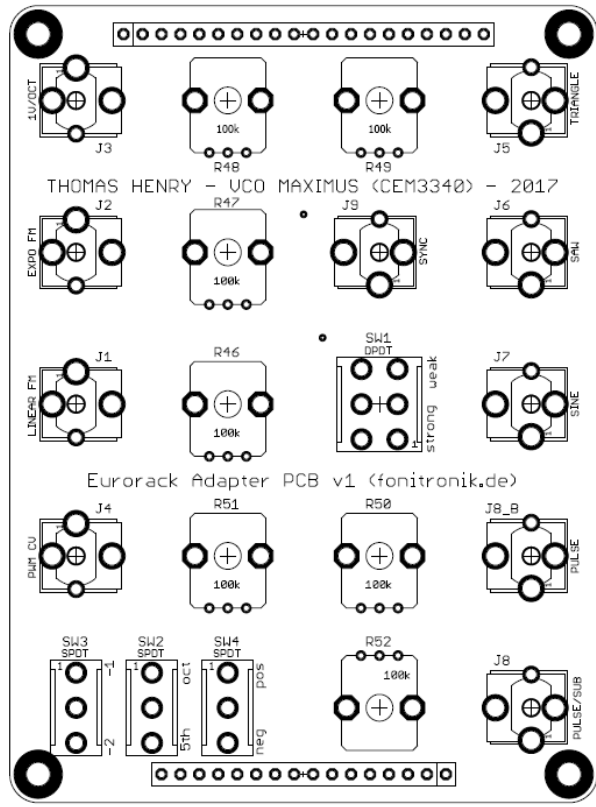
Mounting depth behind frontpanel incl. power plug: 40mm

Power consumption: TBA

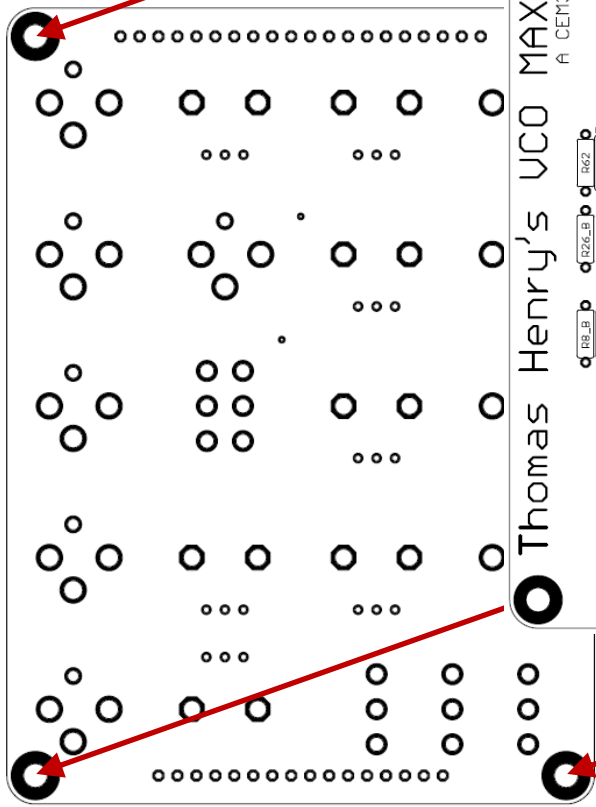
*BTW this is not meant as a beginners project. I do not provide step-by-step building instructions. I just assume that you already build quite a few projects and know how to read the BOM and schematics.*

### General mounting instructions

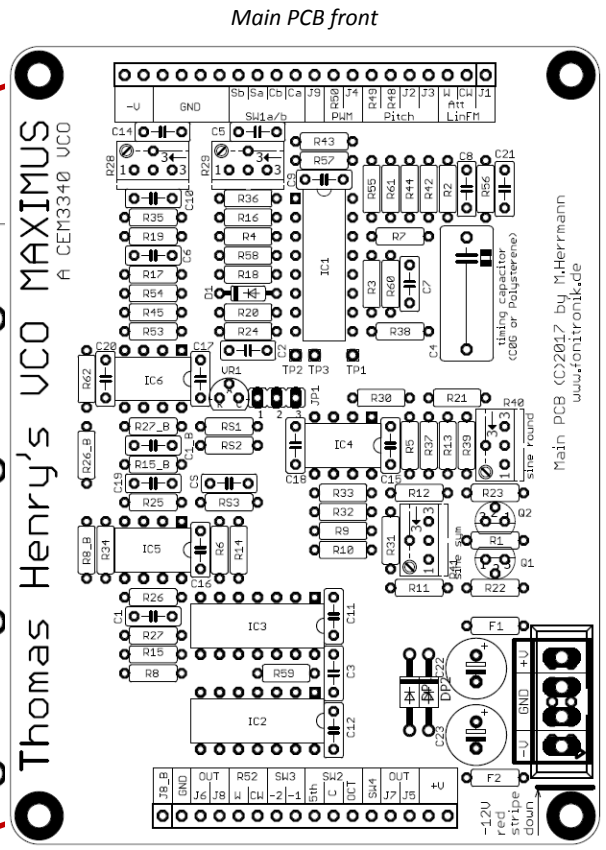
This project uses two PCBs, one board with the actual circuitry and an additional adapter PCB carrying the front panel components. The adapter PCB is used to mount the PCBs to the front panel. The PCBs are sitting back to back and are supposed to be connected using two SIL headers/receptables (16 pin 7 20 pin) with 2,54mm pitch (.1in). Additionally you can use stand-offs. When these stand-offs are made from metal they will provide an additional GND path from main PCB to adapter PCB. Look out for something like this (right):



Adapter PCB front



Adapter PCB rear



Main PCB front

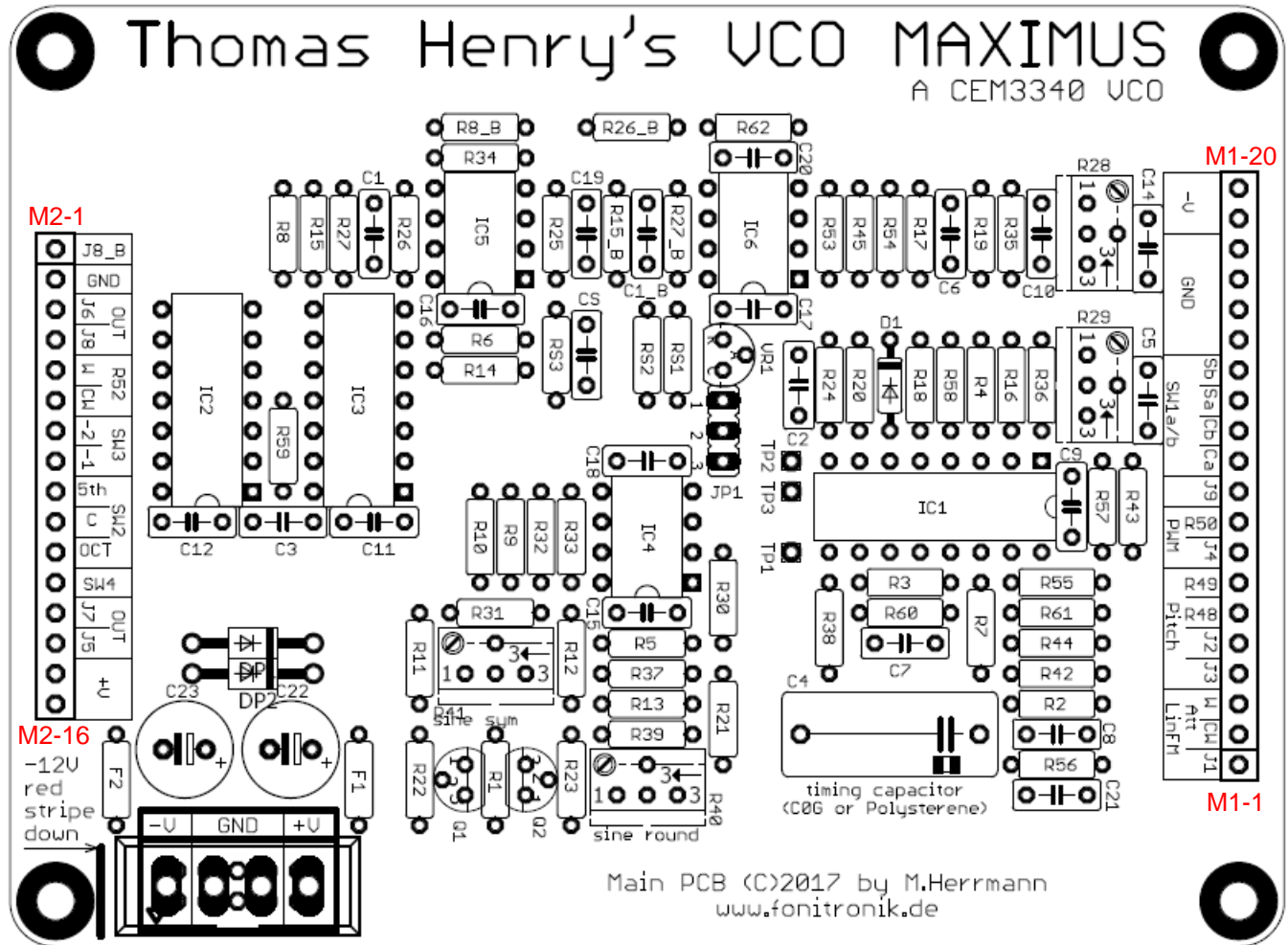
Thomas Henry's VCO MAXIMUS  
A CEM3340 VCO  
Main PCB (C)2017 by M.Herrmann  
www.fonitronik.de

# Overlay for Reference & Manual Wiring Guide

Maybe you want to build this VCO to another common form factor standard than Eurorack, or even build it to you own standards. Then you will not use the front panel components PCB and commit yourself to manual wiring.

For manual wiring refer to schematic: The part shown inside the colored dashed boxes are off-board.

Take special care not to get confused when doing the switches.





## BOM (12V operation w/o TL431)

Qty	Value	Parts
<b>Resistors</b>		
2	Ferrite	F1, F2 (or just jumper)
1	100R	RS3 (optional)
1	390R	R1
2	470R	R2, R3
1	1k2	R4
4	100k	R42, R43, R44, R45
3	1k	R5, R6, R9
1	1k8	R7
5	2k	R8, R8_B, R10, R15, R15_B
2	2k2	R11, R12
1	3k	RS2 (optional)
2	4k7	R13, R14
2	5k6	R16, R17
12	10k	R18, R19, R20, R21, R22, R23, R24, R25, R26, R26_B, R27, R27_B
1	11k	RS1 (optional)
1	15k	R30
1	18k	R31
3	20k	R32, R33, R34
1	47k	R35
1	24k	R36
1	30k	R37
2	47k	R38, R39
1	91k	R53
2	300k	R54, R55
4	1M	R56, R57, R58, R59
1	1M5	R60
1	3M3	R61
2	50k	R40, R41 (Trimmer S64Y)
2	10k	R28, R29 (Trimmer S64Y)

**R4** The goal is to have -5V at pin3 of the 3340. The needed resistor value might differ from manufacturer to manufacturer.

**R19** AS3370 needs 51k

Qty	Value	Parts
<b>Capacitors</b>		
2	22pF	C1, C1_B
1	33pF	C2
1	47pF	C3
1	1n	C6
1	1n poly	C4 (polystyrene or COG)
2	10n (film)	C7, C8
13	100n	C5, C9, C10, C11, C12, C14, C15, C16, C17, C18, C19, C20, CS (optional)
1	220n (film)	C21
2	10uF (elec)	C22, C23
<b>Semi's</b>		
2	1N4001	DP1, DP2 (optional: reverse voltage protection)
1	1N4148	D1
2	2N3904	Q1, Q2
1	CEM3340	IC1
1	CD4070	IC2
1	CD4013	IC3
3	TL072	IC4, IC5, IC6 (or compatible OpAmp)
1	TL431	VR1 (optional)
<b>Misc</b>		
10	Jack Sockets type PJ301-BM	
7	Potentiometer 9mm vertical B100k (i.e Alpha)	
3	Miniature Switch SPDT on-on	
1	Miniature Switch DPDT on-on	
4	Standoffs (M3)	
1	2x5 pole boxed Eurorack power-header	
2	1x 16 SIL socket/header (female/male, 2.54 pitch)	
2	1x 20 SIL socket/header (female/male, 2.54 pitch)	
1	2x5 pole boxed Eurorack power-header, or MTA-156	

Optional parts for use with Precision Voltage Regulator (with VR1 connect JP1 1&2, without VR1 connect JP1 2&3) – also refer to next page for more details.

## BOM (changed values when using TL431)

### Use of TL431 precision voltage regulator

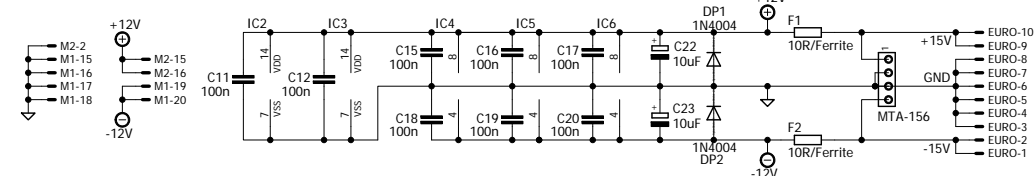
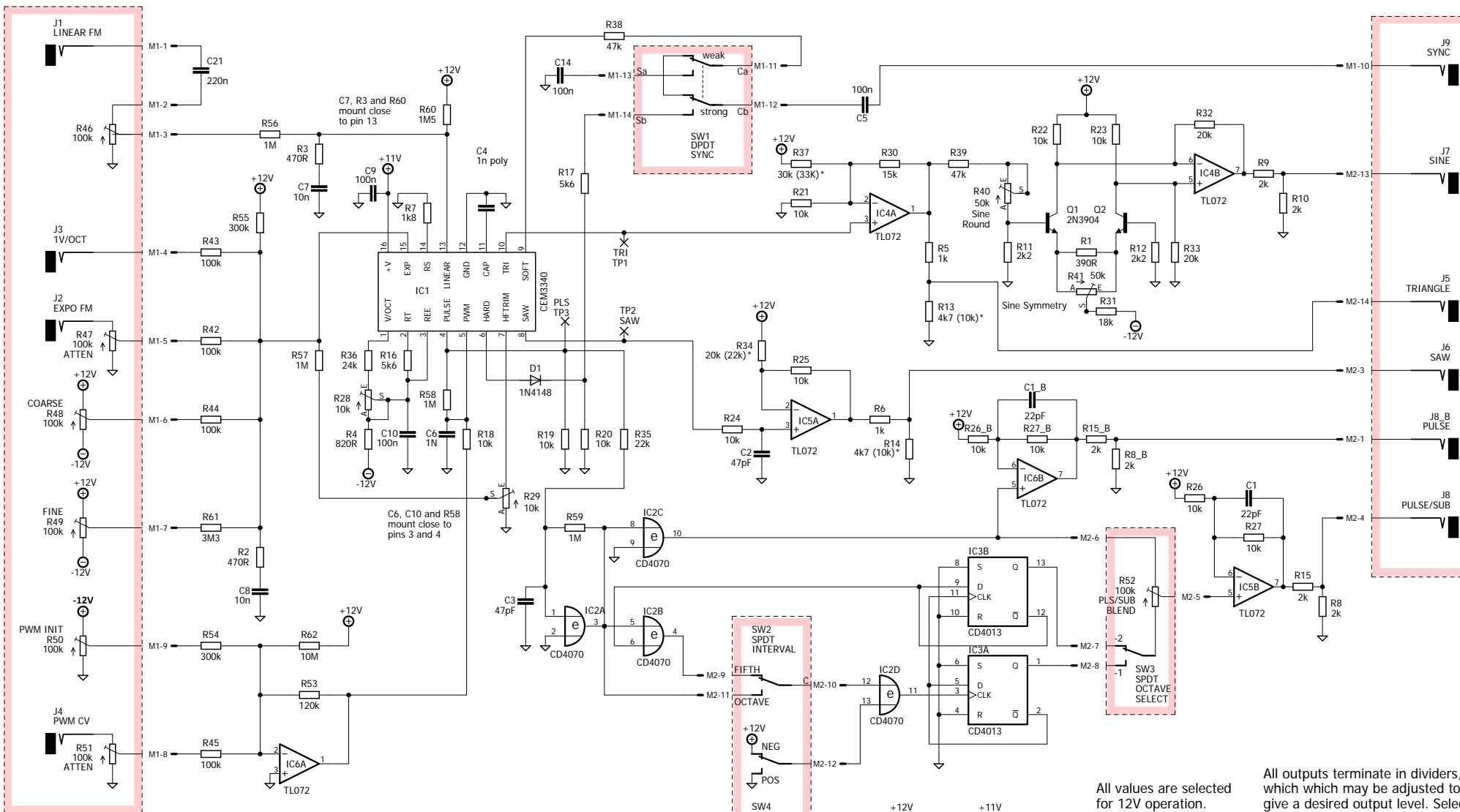
Thomas Henry designs his projects for 15V. For use with 12V a few values have to be changed to compensate the signal strength.

Furthermore Thomas Henry suggests to build or buy a decent stable linear power supply for your synth. If you don't trust your PSU you might want to use the TL431 precision voltage regulator to supply the CEM3340 to further stabilize the VCO. You will have to change a few values to compensate a further loss of signal strength then.

To the right you find a small table showing the relevant parts and their values when running this circuit from 15V or 12V, with or without the TL431

Part	15V		12V	
		TL431		TL431
C2	33pF	56pF	47pF	47pF
R5	1k5	1k5	1k	1k
R6	1k5	1k	1k	1k
R8	1k8	1k8	2k	2k
R8_B	1k8	1k8	2k	2k
R13	3k	3k	4k7	10k
R14	3k	omit	4k7	10k
R15	3k	3k	2k	2k
R15_B	3k	3k	2k	2k
R34	20k	30k	20k	22k
R37	30k	43k	30k	33k
R55	360k	360k	300k	300k





All values are selected for 12V operation.  
 \* Values in brackets valid when using TL431 precision voltage.

All outputs terminate in dividers, which may be adjusted to give a desired output level. Select the pairs of resistors so that the parallel resistance is a nominal 1K to give an output impedance of 1k.

<b>VCO MAXIMUS (CEM3340)</b>	
Thomas Henry 2017 - schematic redrawn by Matthias Herrmann	
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