M106 Voltage Controlled Low Frequency Oscillator

FUNCTION DESCRIPTION

The M106 VCLFO is a mixed version of the famous ASM-1 Sawtooth VCO core and the wave shapers used in some MOTM VCO's (Synthesis Technology). The front panel frequency control is made of a 360 deg. span precision potentiometer that gives a +/-2% linearity with 1,000,000 rotations lifespan compared to the original Allen-Bradley carbon types with a linearity of 20% used in the early Moog modules.
There are input jacks for 1V/oct and linear FM frequency modulation. A big Frequency control knob scaled by octaves varies from a 64sec. period down to 62.5msec. in 10 smooth octaves span. The center position ("0") gives a 2 seconds period waveforms on all the outputs.
Without any control voltages connected to the CV inputs the complete Frequency knob rotation gives periods of:

-5 = 62s
-4 = 32s
-3 = 16s
-2 = 8s
-1 = 4s
 0 = 2s (center)
 1 = 1s
 2 = 0.5s
 3 = 0.25s
 4 = 0.125s
 5 = 0.0625s

When an external CV is connected to the 1V/oct input, the VCO core follows the incoming CV the same way a standard VCO would but at very low frequency.
A positive signal pulse connected to the SYNC input synchronizes the VCO frequency with the incoming pulses.

The M106 LFVCO features 5 different waveforms: SINE, TRIANGULAR, PULSE, SAWTOOTH UP & SAWTOOTH DOWN. All these waveforms are 10vpp in amplitude.

The printed circuit board

The PCB has been designed to fit behind a 1U Moog style front panel. It is a double side board 4.25" X 5.5" and is mounted using 4-40 1.5" hexa standoffs to keep accessibles all the onboard trimmers. All the parts are through hole types. Power is connected by use of a 6 pins 0.156" Molex type connector. The PCB has 4 mounting holes, one on each corner.

The circuit description

For precision and lasting reliability a voltage reference IC is used
for accurate and stable voltage reference for the FREQUENCY vernier span VR100.
U9 is a high precision voltage reference IC that gives a stable +5.00volts.
This voltage reference drives the R102,VR102,R103 precision resistors chain.
VR102 adjust the overall voltage span that the FREQUENCY vernier will use
and is adjusted at +1.100vdc then buffered by a precision opamp LF412(U10A).

Front panel potentiometer FREQUENCY cursor's voltage is buffered by IC
LF412(U10B). This buffered voltage gives +0.550vdc at FREQ center position on IC
U10B pin7. On the CV summing bus made by U4B pin6 this voltage must be canceled
out at center position with the use of an inverting buffer generating
-0.550vdc at U11A pin1. This is done by inverting the previous +1.100vdc and
dividing it by 2, then summing it on the CV bus.
This gives 0.00vdc at FREQUENCY vernier center position on the summing bus.
VR101 (freq offset) is used to set the M106 'resting' centered 0vdc frequency at
a period of 2sec while the Freq precision pot is at "0" position. Its voltage is
summed on the CV summing bus.

When an external incoming CV voltage is connected to the J5 jack R45 connects
this 1V/oct CV to U4B pin6 summing bus. J6 LIN FM jack receives any external
control voltage to be used for linear freq. modulation. VR104 PWM signal goes to
R14 and U2B pin6 to adjust the LFVCO's rectangular wave pulse width from 10-90%.

Adjustments and trimmings:

The following is the adjustment procedure for all PCB trimpots:

-Connect a frequency counter or a very accurate frequency/period meter
 to the PULSE wave output jack.

-Connect a very precise voltage source like a 1V/oct (+/-0.1%) keyboard
 or one of the M100 MIDI interface 1V/oct output to the M106 1V/oct input.

-Adjust VR102 SPAN trimmer to get +1.100v on pin#1 of U10A LF412.
 Now U11A pin#1 should read -0.550v.

-(1)Feed the 1V/oct input jack with a precise +5.00vdc (top keyboard C).

-(2)Adjust front panel FREQ knob to get precise 16Hz pulses at PULSE OUT J4.

-(3)Disconnect the +5vdc from the 1V/oct input jack.

-(4)Measure the Pulse frequency that should be now around 0.5Hz (2sec period).

-(5)Adjust the VR103 1V/oct trimmer to get a precise 2seconds period.

-(6)Go back to procedure (1) until 0vdc input gives 2seconds period
    and +5vdc gives 16Hz (0.0625sec period)

-VR101 trimmer adjusts the 'resting' LFVCO frequency when nothing is connected to the 1V/oct jack. Disconnect any connected CV voltage from the 1V/oct jack. Place the front panel FREQ knob to ZERO position. Adjust VR101 to get 0.5Hz (2 seconds period) on the rectangular output jack.

-VR30 SINUS Symmetry trimmer adjust the both sinus output peaks for symmetry. Connect an oscilloscope at J1 (SINE out) and adjust VR30 for both wave peaks to get 'similar' rounded shapes.

-All needed trimmings done !

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ELECTRONIC SPECIFICATIONS

POWER CONNECTOR PIN ASSIGNMENTS

1	-15V
2	A GND
3	A GND
4	+15V
5	D GND
6	+5V

Panel Size: Single width 2.125"w x 8.75"h.

Controls:

Frequency pot range octaves: +/- 5
Pulse Width pot range: 10%...90%

Waveform input levels: -13V to +13V
Waveform output levels: 10Vpeak to peak
All output impedances: 1000ohms, nom.
Frequency Span: 0.0156Hz to 16Hz, nom.
(64sec to 0.0625sec periods)
FM modes: Exponential & linear (DC coupling)
1V/oct input impedance: 100k +/-1%
LIN FM input impedance: 560k +/-5%

SYNC IN: Positive going pulse (+3 to +15v)
SYNC input impedance: 10k

Waveform outputs:
Sine, Triangular, Pulse, Saw up, Saw down

Power:
+15V @ 40mA,
-15V @ 30mA,
+5V @ 0mA.