

OPERATION MANUAL

FOR

PPG WAVE COMPUTER 360A

**Hamburg 1979
PPG-Synthesizer
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1. INTRODUCTION

The PPG wave computer works according to a completely different and novel principle of sound generation, than a conventional synthesizer. Therefore, at the beginning of this instruction manual, this principle will first be explained in more detail.

In conventional synthesizers, the waveforms sawtooth, rectangle and triangle are used as sound output materials. These waveforms are changed in their timbre and therefore the overtone content via a "Voltage Controlled Filter". The Wave Computer, on the other hand, does not require any analog filters. It has the ability to directly use any waveform from the generator to create sounds. The Wave Computer can generate any waveform directly, since these waveforms are calculated and compiled by a microprocessor, this why it is called the "wave computer".

If you want to create dynamic sounds, for example sounds that change in timbre, this is how it can be achieved.

With the Wave Computer different waveforms can be heard one after the other, using so-called wave tables. These are combinations of 64 individual complex waveforms, each one is arranged in a fixed order to each other. The individual waveforms in a wave table are referred to as partial waves and are numbered by 0 to 63. These numbers are called partial wave numbers. These expressions are used below and are also called "Partial Wave Number" ("PWN") on the front panel of the Wave Computer.

The individual partial waves are complex waveforms, so they are constructed harmoniously and already contain a more or less large number of harmonic tones.

Which of the 64 partial waves a generator should generate at a certain point in time depends on several influences. The most important parameter is probably the APDSR envelope, which means in detail: Attack, Peak, Decay, Sustain and Release. If you apply this envelope curve to the Partial wave number, a key press will create a whole sequence of waveforms.

To illustrate how wave sequencing works let's use the principle of a cartoon. A cartoon also consists of many individual images, all of which were drawn individually and which all have small differences from each other. If you run through these images quickly one after the other, the eye sees a moving sequence. The Wave Computer has 64 individual waveforms that are indistinguishable from each other, and if these waveforms sound quickly one after the other, a dynamic sound of colours develops.

The wave computer has 30 wave tables which are defined in the presets (programs programmed by the manufacturer). Each of these wave tables is constructed differently and uses different wave forms, so there is a total of $30 \times 64 = 1920$ different wave forms.

This results in waveforms that the wave computer can create sounds from. The principle of the wave tables can be used to create many different tone colours. For example, the sound generated by the wave computer, when you hit a key, can be the sound of a church organ that slowly begins to change into the sound of a violin and finally ends with the sound of a piano. These possibilities are of course not feasible with conventional synthesizers.

There are a total of 100 programs (0-99) that can be stored in the Wave Computer with the first 30 (0 - 29) held as factory presets with the remaining 70 (30 - 99) used for user editable programs.

The wave computer can generate two different and totally unrelated programs at the same time called Group A and Group B, which appear separately on the signal outputs on the rear panel (CHANNEL 1 = GROUP A, CHANNEL 2 = GROUP B) along with a combined output (MONO).

Some wave tables in the 30 factory presets are laid out so that the differences from a partial waveform have extreme changes. If you run the envelope through these wave tables, you get completely new long term effects that can be appealing. The wave table in Preset 11 is an example of such a wave set, as is Preset 3, which creates an effect that resembles traditional Sample & Hold. In Preset 26 there is an echo effect when the envelope is running raw. Figures 1, 2 and 3 are intended to explain this in more detail.

If you want to get the best out of your Wave Computer and want to make full use of the possibilities, please thoroughly understand the analog control unit and especially the digital parameters (which will be described in detail below).

The waveforms can be modified by the analog and digital controls, so that you can make a preset sound that has absolutely nothing to do with the original preset.

2. ANALOG CONTROL UNIT (LEFT HAND PANEL)

The 11 sliders on the left-hand side of the control panel of the PPG Wave computer enable sound adjustment or sound modification of an existing program. These sliders do not show the sound setting when a program is called up from memory. This "update" problem is released by the synthesizer manufacturers in various more or less elegant ways. With the PPG wave computer the following solution has been developed:

If you select a program from the memory, this program appears 100% with all the parameters set for that program:

- Basic pitch of each individual tone generator (oscillator)
- Fine tuning of the generators to each other
- All low frequency oscillator parameters
- All envelope generator parameters
- All keyboard dynamic routing options and keyboard mode
- The required wave table with its 64 partial waves

If you want to change this program, you only need one to adjust the appropriate slider; the microprocessor provides the change and switches automatically and only this control is modified within the program.

The functions of the individual sliders are similar to those of the conventional synthesizers. There are sliders to control the LFO "Waveform", "Peak", "Attack" and "Transform".

LFO Waveform Slider – (Wave form and modulation depth)

The LFO slider controls two functions at the same time;

1. It sets the waveforms that the LFO creates; triangle, sawtooth, rising sawtooth and rectangle.
2. It determines the intensity with which the LFO acts on the functions that are used with the digital parameters 13, 14 and 15 (which will be explained later).

LFO Speed Slider

This slider controls the frequency of the LFO in 32 steps.

LFO Delay Slider

This slider controls the delay time before the LFO is applied, the slider is quantized to just 8 values.

APDSR Envelope with Peak and Attack

The APDSR¹ envelope has the usual ADSR envelope with an additional parameter, Peak. This slider determines the maximum value to which the envelope curve increases to. When a key is pressed, the envelope curve rises from zero to the Peak value, with the Attack time, then it falls to the Sustain level with the Decay time. After releasing a key, the envelope curve falls with the Release time again to zero.

The Attack slider has two control areas;

¹ The Attack, Decay and Release sliders are quantized to just 16 values, whilst the Peak and Sustain sliders have 64 values, to match the number of partial waves in a wavetable.

NORMAL In the lower half of the Attack slider, the attack phase only works as long as the key on the keyboard is held down. With long attack times, the envelope curve value drops so when you release the key, it will go back to zero without having reached the peak.

HOLD In the upper half of the Attack slider the envelope curve continues up to the peak, even if the key is released before hand. The envelope curve then goes into the release phase.

The two control areas only apply to the Attack slider in the APDSR generator.

The APDSR envelope can control the partial waves as well as the volume (which will be explained later). In the case of partial wave control, the envelope curve directly changes the partial number. The scale of both the peak and sustain values is from 0 to 63.

Figure 4 is intended to illustrate the APDSR envelope curve.

AR Envelope

This is a standard two stage envelope with Attack and Decay sliders, and it can be used to control the volume of the sounds generated by the Wave Computer (see later for details).

Transform Slider

The transform slider sets the initial value of the partial wave number from 0 to 63. It is from this initial value that the envelope values are added to, and which control the partial wave generated by the oscillators.

When the transform and envelope value is greater than 63, the envelope runs back into the zero partial wave 0. Peak = 63 decay in the middle Sustain = 0 and release on Mittee If you hit a key now, you hear the partial wave 32 for a moment, then deeper partial waves sound down to the zero and then suddenly the 63rd partial wave comes the change and switches automatically and only this control to the sound setting

3. GROUPS AND KEYBOARD MODES

The PPG Wave Computer has 8 tone generators which the computer (a microprocessor) can control in a variety of ways. A parameter number is assigned to each of the 8 generators. All digital setting options for the Wave Computer have been named with parameters. The first oscillator is numbered 0 and the last one is numbered 7. The oscillators are also divided into two groups. One group has been named A, this includes the generators with the parameters 0,2,4,6 whilst the other group is called group B and has the numbers 1,3,5,7.

Groups A and B have separate sound outputs on the back of the PPG 360, so that you can work in stereo. You can set these two groups to be sonically totally different (will be described later). The way in which the two groups the keys played on the manual to be assigned depends on the "Keyboard Mode".

The Wave Computer has nine different keyboard modes which enable the keyboard to be both split and layered but not at the same time. These modes are labelled on the front panel:

KEYBOARD MODE		
0 =	POLY	8 = 1
1 =	QUAD	4 = 2
2 =	DUO	2 = 4
3 =	MONO	1 = 8
4 =	A QUAD	B - QUAD
5 =	A - M = 4	B - QUAD
6 =	A - M = 2	B - POLY
7 =	A - M = 2	Ext, B - QUAD
8 =	A - M = 4	S M = 4

Keyboard Mode 0 (8 voice polyphonic)

In this mode, and only this mode, all 8 oscillators have the same timbre. All oscillators are controlled by either Group A or B. Each key played on the keyboard is assigned an oscillator, to provide eight note polyphony. If more than 8 notes are played, the sound played at the ninth sound is taken away from the first and the generator that has been released is now the ninth note. This also applies to striking a key.

Keyboard Mode 1 (4 voice polyphonic, no keyboard split)

In this mode, the two wave generators are simultaneously played when a key is pressed. This limits the polyphony to four voices. When a key is pressed one of the two generators produces the sound of a group or other that of Group B. To have two different sounds on each key simultaneously

This sound can use different Attack and Decay settings.

In this mode, when pressing down a button, two generators are simultaneously attached to this has to the conse quenz, since the keyboard is only playable in four parts. When hitting a button, one of the two generators generates the sound of group veins other Group B. I have the possibility to make two different sounds sound at the same time on each button. This sound can have different attack and Decay

Keyboard mode 2 (2 voice polyphonic, no keyboard split)

In this mode there are 4 oscillators on each key, 2 from Groups A and 2 from Group B. The keyboard is now only playable in two voices.

Keyboard mode 3 (Unison)

In this mode all 8 wave generators are played by one key, and the keyboard can be played monophonically.

Keyboard mode 4 (4 voice polyphonic with keyboard split)

Here the keyboard is split, with the bottom octaves playing Group B and the top octaves playing Group A. You can play polyphonically in four parts in the upper and lower parts and the Groups can be set to different sounds.

Keyboard mode 5 (4 voice polyphonic with keyboard split)

The keyboard is split at the SPLITPOINT Group A controls the upper part of the keyboard and can now be played monophonically, i.e. there are 4 oscillators on a key, whereas the lower two octaves are in four parts are playable and controlled by Group B.

Keyboard mode 6

Group A controls the upper part of the manual again and can now be played monophonically with 2 oscillators, the lower part is polyphonic in six voices

Keyboard mode 7

The upper part is controlled by group A and has two parts, the lower part is controlled by group B and is four voice. The remaining two oscillators are the are controlled by group A for the external input reserved so that when connecting a digital sequencer it can play 3 melodies at the same time.

Keyboard mode 8

In the upper part of the manual you can play monophonically four voices from group A, in the lower part four parts monophonically with group B.

4. THE DIGITAL PARAMETERS OF THE WAVE COMPUTER

Overview

The PPG Wave Computer has both analog controls (the sliders on the left side of the control panel) and digital parameter controls (the buttons on the lower half of the right side of the front panel).

The digital parameters are numbered from 0 to 20. The parameters for each program, whether preset or your own program, are duplicated, so that you can save two different sounds on each program number at the same time. How these sounds are generated depends on the keyboard mode selected (see the Keyboard Modes section).

When in Keyboard Mode 0 there is only one group in use across all the keys, the group that was selected with the "Group Selector" button. The Group Selector has a LED display that shows which Group is selected (LED off is Group A and LED on is Group B). The Group Selector determines which Group the analog and digital settings act on. If the LED is off, you can change all the sound parameters in sound A without affecting sound B. If you switch the group selector to group B (LED is on), I have exactly the sound B as it was previously set only when I move a slider does the function of this and only this one set the controller Sound is also the same with the digital parameters o I can set all parameters for groups A and B completely separately o So I can set the mood of the generators for groups A and B differently, I can program the vibrato control differently and all other parameters can also be set separately

In Keyboard Mode 1 you will always hear both groups at the same time. However, the controls only affect the group that was selected with the group selector and only you can only change one parameter in one group at a time

Parameters 0 to 7 – Oscillator Tuning

The digital parameters 0 to 7 allow the tuning for each individual generator (voice) in either semitone intervals or in fine tuning intervals. For example if preset 9 is selected which uses Keyboard Mode 0 you can now hear one voice for each key pressed, Oscillato The wave computer is designed so that every time a key is pressed, even if I press the same key several times in succession, a different generator (voice) is used. Press the C key eight times and you will hear the eight generators (voices) in succession, and generating the tone C each time.

To adjust the tuning of oscillator 0 press button "PAR. 0 - 7" (this is the second button at the bottom right next to the numeric display). The display "Parameter-Number" shows the selected oscillator from 0 – 7 and the "Parameter Magnitude" shows the numeric value of the parameter.

To detune an oscillator by semitones press the "Semitone" button and release it. The numeric value in "Parameter Magnitude" shows the number of semitones by which this oscillator is from a normal tuning. Now press and hold the button "Semitone", and press a key on the keyboard, for example the "G" key. The number 7 now appears in the Parameter Magnitude display and the first oscillator with the parameter number 0 has been tuned seven semitones upwards.

If I hit the C key on the keyboard eight times in a row again, it will sound not C, but G. This way I can do each one. A value of 0 in the Magnitude Display equates to a normal tuning.

Detune the oscillator as required o I have to select the parameter number each time and then do the semitone tuning process (press the semitone key, hold it down and press a key) o Only moods that are at their maximum can be recorded

Parameter 8 – Keyboard to PWN (Values 0 – 7)

This parameter controls the effect the keyboard has on the partial waves within the selected Patch. When the value is set to 0, all the keys of the keyboard play the same partial wave, or follow partial waves controlled by the APDSR envelope. When the envelope is not controlling the partial wave number, the waveform generated has the partial wave number that was set with the transform slider.

When the value is increased to higher values (maximum is 7) this setting causes da.f3 with each different key a different partial wave he is generated; in the sense that the partial wave number that the Transformally indicates, on the key Cis, the next higher key, a partial wave number is taken lower, on the key D one wave lower again and finally on the highest C the lowest partial wave is heardo This leads in most cases because. 13 in the upper part of the manual, the sound is softer than the lower ones. The effect of parameter 8 on the sound naturally depends on the wave set

Parameter 9 – Keyboard to Volume (Values 0 – 7)

Parameter 9 controls the volume of the Patch from the keyboard note played. When set to 0 all keys have the same volume, when set to 7 the keys in the upper part of the keyboard are quieter than the lower ones.

Parameter 10 – Envelope Mode (Values 0 – 2)

This parameter controls the way in which the two envelope generators (APDSR and AR) affect the sound, it is therefore called "Envelope Mode". The parameter has three settings;

- 0 = APDSR controls partial wave number and the AR controls volume
- 1 = APDSR controls volume and the AR has no function
- 2 = APDSR controls partial wave number and volume at the same time. AR has no function.

Parameters 11 – 20 (Switch Settings)

These parameters have pure switch functions with only two states: switched on or switched off. On the Parameter Magnitude display, ON = 1, OFF = 0.

The button "Parameter: 11-20 Step" selects the parameters 11 to 20 in sequence and the value of a parameter is changed with the button "Magnitude".

11	SUSTAIN SWITCH
12	LFO TRIGGER
13	LFO → PITCH
14	LFO → PARTIA WAVE NO.
15	LFO → LOUDNESS
16	DYN → PITCH +
17	DYN → PITCH -
18	DYN → PARTIAL WAVE NO.
19	DYN → LOUDNESS
20	DYN → MODULATIONS INT.

Parameter 11 – Sustain Switch

Parameter 11 controls whether the sustain switch (an external foot switch connected to the rear) is active.

0 = OFF sustain switch has no function.

1 = ON the sound is sustained when the foot switch is on.

Note: Parameters for both sound groups (A and B) can be programmed separately. For example in Keyboard Mode 4 only sustains the lower side of the keyboard.

Parameter 12 – LFO Trigger Switch

This controls the LFO (Low Frequency Oscillator) switch the trigger, That means, with every new one LFO oscillation process triggered the high-frequency curves will. This leads to rhythmic tone draws. With each new draw, a different generator of the Controlled by wave computers. This makes it possible to create very nice overlap effects, which is not possible with monophonic synthesizers. The pitch of such a sequence depends on the tuning of the 0 oscillators. If necessary, parameters 0-7 nachleseno The type of sequence depends on the keyboard mode.

When in Keyboard Mode 0, I can do that with Group Selector switch from one sequence with 8 different ones Pitch on a different sequence with other pitches So that the speed of the Tone draw remains the same, parameter 12 is only in Group A is effective, so the LFO from Group A becomes effective in everyone Trap used for speed control

Parameter 13 – LFO to Pitch

This parameter allows the pitch of the oscillators to be controlled by the LFO. This enables vibrato or noise effects to be achieved.

0 = OFF and 1 = ON.

Parameter 14 – LFO to Partial Wave Number

This parameter controls whether the LFO modifies the partial wave being used by the oscillators, which enables the timbre to be controlled by the LFO frequency and wave shape.

0 = OFF and 1 = ON.

Parameter 15 - LFO to Volume

This parameter controls whether the LFO modifies the volume. The LFO waveform is added to envelope curve, with modulation depth set by this parameter.

0 = OFF and 1 = ON.

Parameter 16 – Dynamics to Pitch Upwards

This parameter enables the keyboard Dynamics to positively modify pitch with the pressure sensor of the keyboard changing the pitch upwards.

0 = OFF and 1 = ON.

Parameter 17 – Dynamics to Pitch Downwards

This parameter enables the keyboard Dynamics to negatively modify pitch with the pressure sensor of the keyboard changing the pitch downwards.

0 = OFF and 1 = ON.

Parameter 18 – Dynamics to Partial Wave Number

This parameter enables the keyboard Dynamics to modify the partial wave number, with the pressure sensor of the keyboard changing the partial number and the timbre.

0 = OFF and 1 = ON.

Parameter 19 – Dynamics to Volume

This parameter enables the keyboard Dynamics to increase volume with the pressure sensor of the keyboard.

0 = OFF and 1 = ON.

Parameter 20 – Dynamics to LFO

This parameter enables the keyboard Dynamics to control LFO modulation intensity. This parameter works in conjunction with parameter 13 or 14. If parameter 13 is set to 1 (ON) you can now also set parameter 20 to 1 (ON), so that the intensity of the LFO no longer determined by the waveform selector, but by using the keyboard dynamic and pressing down on the keyboard.

0 = OFF and 1 = ON.

And finally, it is worth noting that parameters 11-20 can be set to both groups independently and separately and several parameters can be set at the same time, for example switching parameters 13 and 14 on, will result in the LFO controlling both the pitch and timbre.

5. MEMORY SUPERVISOR

This section of the front panel of the wave computer controls how the program memory is managed. The "Memory Supervisor" can be stepped through 10 positions using the "Step" key and the position displayed on the numeric display.

The "Program Select" section enables Programs to be selected inconjunction with the keyboard.

Position 0 – Program (Program Load)

In this position a patch can be loaded from memory. To do this, press the "Program Select Keyboard" key, hold this key down and presses any key on the manual. At the same time the number of this key appears on the numerical display "Program Select". The "Keyboard" key can be released and the complete program is then available to play sounds. The data is now in one If I now change the setting of the wave computer, this change is only in the

Program numbers above 60 (maximum of 100) can be reached by pressing the key twice on the keyboard.

Position 1 – Waves (Wave Table Load)

In this position a wave table of 64 partial waves can be loaded into the working memory from a sound program. Press and hold the key number of the location you want to load a wave table from and tap on the 1 with the "Step" button. When the key is released the wave table will be loaded and can be played. All other parameters, envelopes, tunings This means that I can combine different existing programs with each other or have a similar effect

Positions 2, 3, 4 and 5 (Group Interchange)

These four positions allow the sounds in the two Groups to be interchanged:

Position 2 – Group A → A The data of Group A is loaded into working memory, whilst the Group B wavetable, keyboard mode and split are unchanged.

Position 3 – Group B → B The data of Group B is loaded into working memory, whilst the Group A wavetable, keyboard mode and split are unchanged.

Position 4 – Group A → B The data of Group A is loaded into working memory onto Group B, whilst the Group A wavetable, keyboard mode and split are unchanged.

Position 5 – Group B → A The data of Group B is loaded into working memory onto Group A, whilst the Group B wavetable, keyboard mode and split are unchanged.

Position 6 – Store (Program Save)

This position enables a modified program to be saved in the program memory, and the data from the buffer needs to be transferred into the program memory. Press the keyboard key with a number above 29, hold it down, and now press the "Memory Supervisor Step" up to the corresponding digits displays 7. The complete sound setting is stored on the specified number and can

Program numbers above 60 can be reached by pressing the key twice on the keyboard. Saving or deleting the program that was previously available on the storage space can only be done if the small toggle switch on the rear of the device labelled "Memory" is in the up position. You should normally leave this switch down! (To ensure data protection).

If I only wanted to load the wave set (the 64 partial waves) into the working memory from a sound program, then so I press the keyboard button again, hit the Manual the number from whose program I would like to load the shaft set and now tap on the 1 with the "Step" button. If I release the "Keyboard" button now, the shaft set will be loaded. All other parameters, envelopes, tunings where previously the sound has been determined remains unchanged. With this procedure I can combine different existing programs with each other.

Position 7 – Not Used

Position 8 – Clear (Clear Program)

This position enables a user program (30 - 70) to be cleared and the data in that memory position to be erased. Select Position 8 then press the keyboard key, hold it down, also press a key on the keyboard with a number above 29 and now press the "Memory Supervisor Step" up to the corresponding display shows 7.

Position 9 – Clear All (Clear All Programs)

This position

6. TECHNICAL SPECIFICATIONS

INPUTS and OUTPUTS

MONO	Combined Output
CH1	Channel 1 Group A
CH2	Channel 2 Group B
HEADPHONES	Stereo Headphone Output
CV IN	Control voltage input
GATE INPUT	Gate signal input
CV OUT	Control voltage output, highest note played
GATE OUT	Gate signal output, highest note played
DATA I/O	Input and/or Output for data

DIMENSIONS

Width 930mm x Height 205mm x Depth 550mm

WEIGHT

23kg

PCB DESIGN

- Motherboard – contains the power rail regulators and edge connectors for 8 boards:
- CPU Board – contains the Motorola 6800 microprocessor
- SRAM Board – contains working memory
- ROM Board – contains the wavetable memory
- Voice Board (2 voices per card) – contains the voice circuits, 4 cards in an 8 voice PPG 360
- TR Board

PROM (waves)	2732? 4Kx8 x 15	
RAM (program)	64k x 15	16k x 8
RAM (sound)	1k x 4 x 8 bits	16k x 8

HISTORICAL NOTES

The 360 Wave Computer was developed in, and there are least 3 versions:

- Original 360 with black panel
- 360A with black panel and revised panel layout
- 360A with white panel and revised panel layout

The 360 had only 10 control buttons and three 7 segment displays, whilst the 360A has 12 buttons and seven 7 segment displays. The 360 also had the LFO slider next to the pitch bend wheel.

The 360 was the hardware and software basis for the subsequent Wave 2 (360C), 2.2(360D) and 2.3 (360E) and many of the original 360 features were retained beyond the obvious reuse of wave tables.

- The Memory Supervisor was renamed Data Transfer Modes.
- The Keyboard Modes was retained with the panel lettering simplified.
- An LCD replaced the 7 segment displays and a Display Select bank of 10 buttons replaced the one off buttons are the 360 panel.
- A set of numeric keys negated the need for the keyboard notes being used for numeric inputs.
- Sequence Modes was added for the inbuilt sequencer.