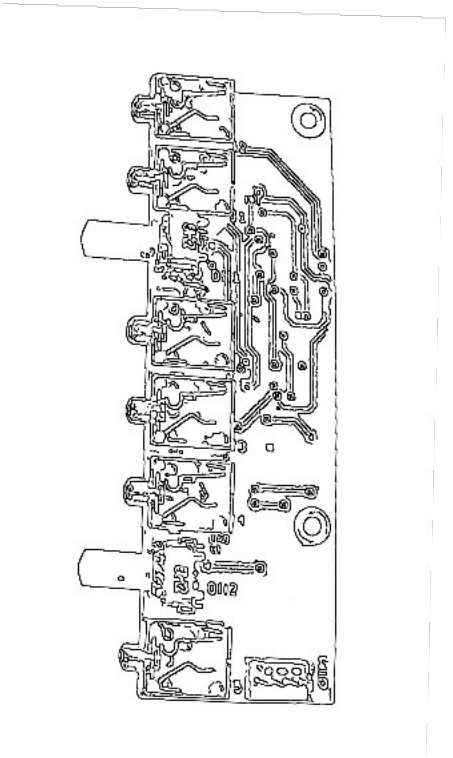
Two-Channel Voltage-Controlled Amplifier

Model 9741
Assembly and Using Manual



This second-generation 9700-series processing element for modular sound synthesizers is designed to provide great sound and excellent value.

This dual voltage-controlled amplifier module can be used to modify audio or control signals. A control voltage ranging from 0-10V linearly varies the amount of input signal which appears at the output. Offset controls are provided to bias the control voltage for minimum output with minimum control.

This high-performance module is designed to be compatible with most modular synthesizer systems with little or no modification. Most active components are already mounted, making assembly a snap.

ASSEMBLING THE 9741 Dual VCA

Before beginning assembly, go through the manual. Look at the drawings. Feel the parts. You're naturally eager to plunge right in, but take a few deep breaths first. Check the parts supplied against the packing list at the back of this manual.

In some cases, notes packed with the parts will be used to call your attention to special situations. ***If parts are missing, please notify PAiA at missing@paia.com or by phone at (405) 340-6300, fax (405) 340-6378.*** *A NOTES page is included at the end of this manual.*

Notice that each step in the manual is marked with a checkoff box like this:

DESIGNATION	DESC.	MARKING
( ) R27	100ohm	brn-blk-brn-gld

Checking off each step as you do it may seem silly and ritualistic, but it greatly decreases the chance of omitting a step and also provides some gratification and reward as each step is completed.

Numbered figures are printed in the Illustrations Supplement in the center of this manual. These pages may be removed for easy reference during assembly.

THE CIRCUIT BOARD

The 9741 Dual VCA is built on a double-sided circuit board. Note the “top” side of the board has the connector and control placement designators. Surface-mounted components are on the “bottom” of the board. Install parts to the top of the board and solder them on the bottom.

TOOLS

You'll need a minimum of tools to assemble the kit – a small pair of diagonal wire cutters, pliers, screwdriver, soldering iron, and solder.

Modern electronic components are small (in case you hadn't noticed) and values marked on the part are often difficult to see. Another handy tool for your bench will be a good magnifying glass. Also use the magnifier to examine each solder joint as it is made to make sure that is doesn't have any of the problems in the SOLDERING section which follows.

SOLDERING

Select a soldering iron with a small tip and a power rating of not more than 35 watts. Soldering guns are completely unacceptable for assembling solid-state equipment because the large magnetic field they generate can damage components.

Use only a high quality electronic solder. Your kit is compatible with lead-free and/or tin-lead flux-core solders made especially for electronic assembly. Plumbing solder will destroy your kit with its acid core. Jewelry solder (silver solder) will destroy your kit with its high working heat. Neither is for electronics work.

A proper solder joint has just enough solder to cover the soldering pad and about 1/16-inch of the lead passing through it.

There are two improper connections to be aware of: Using too little solder will sometimes result in a connection which appears to be soldered when actually there is a thin layer of flux insulating the component lead from the solder bead. This situation can be cured by reheating the joint and applying more solder.

Too much solder may produce a conducting bridge of excess solder between adjacent pads causing a short-circuit. Continued feeding of solder into a hot joint can result in accumulation on the underside of the board and may cause bridges or impede the action of mechanical components. If you see this, position the board above the iron tip and the excess will flow to the tip.

Use care when mounting all components. Never force a component into place.

CONTROLS AND CONNECTORS

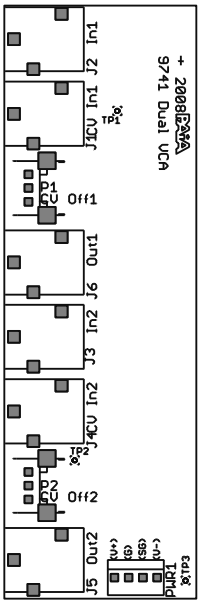
Controls and connectors will be installed on the top side of the board with the placement designators as shown in the illustration to the right.

Miniature phone connectors referenced as “stereo phone jacks” in the manual parts list are specified below with the contact/terminal names, Tip, Ring, and Sleeve (TRS) and are labeled on the board and schematic as such.

The potentiometers have tabs extending from their body for stability. They have a snap-fit to the board. Align the tabs and pins with their holes and press them into place. There is no need to bend the tabs or terminals.

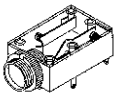
To ensure the best alignment with these parts with the front panel, begin by soldering only one of the multiple terminals associated with each of the following parts as it is installed. Then, if a part is tilted or crooked, it is only a matter of reheating the joint as the part is aligned.

Match the tab of the polarized power connector with the corresponding board marking.

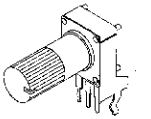


Top of circuit board

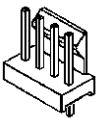
DESIG.	DESC.	MARKING
( ) J1	TRS socket	
( ) J2	TRS socket	
( ) J3	TRS socket	
( ) J4	TRS socket	
( ) J5	TRS socket	
( ) J6	TRS socket	
( ) P1	100K ohm Potentiometer, linear	B100k
( ) P2	100K ohm Potentiometer, linear	B100k
( ) PWR1	Header	



TRS socket
"Stereo phone jack”



Potentiometer



Header

COMPLETION

The front panel is used for mounting the module in a rack system or cabinet. Complete the module assembly by mounting the 9741 PCB subassembly to the front panel as follows:

Referring to Fig. 1A of the illustration supplement, use the knurled phone jack nuts to secure the subassembly to the front panel. Check for clearance of the potentiometer shafts to ensure they rotate freely. Finger-tighten the phone jack nuts and then use the tips of the diagonal cutters to give them another quarter of a turn or so.

Complete the soldering of all multi-terminal parts. Take care the solder doesn't run through to the opposite side of the board when soldering the mounting tabs. With practice, it is possible to flow solder to cover the opening; otherwise, just flow a bit to secure the tab to the pad ring.

Cut a 3/8" (10mm) long shim sleeve for each pot from the length of polyethylene sleeve provided. Set the shafts fully counter-clockwise, slip the shims over the pot control shafts, put the knob in place with the pointer aligned to about a 7:00 setting, and use a small screwdriver to tighten the set-screw just enough that it grips.

POWERING AND TESTING

Power to the circuit is via a four-circuit, dual-polarity dc power supply. A power connector cable matches the header for connection with one of the PAiA 977x supplies at 15v or more. Connect the circuit labeled (+) to the positive dc source (V+), the circuit labeled (-) to the negative dc source (V-), the circuit labeled (G) to the power ground (G), and the circuit labeled (SG) to the signal ground (SG). For other supplies without separate signal and power grounds, use two wires to join the two grounds (G and SG) to the one ground (aka GND, 0VDC or common) at the supply.

Before applying power, check again, to be sure the wiring for the two dc polarities and that the polarized 4ckt connectors are as intended (see Fig.1B).

Use two-circuit, Tip-Sleeve (TS or mono), cords for patching in or out of the VCA from external devices. Within a 9700-series system, either single conductor (Tip-only), or TS cords may be used. If this seems confusing, remember that a regular mono cable will always work for most home studios. PAiA equipment allows tip-only connections for professional applications where star grounding is required.

An audio signal input to a VCA section should only pass though to the output when there is a control voltage applied to the CV input; however, the panel Offset control adjusts this condition. Clockwise rotation of the control works to let sound get through. Advance the control until the input can be detected and then go back, just to the point it quiets, or the output is minimized.

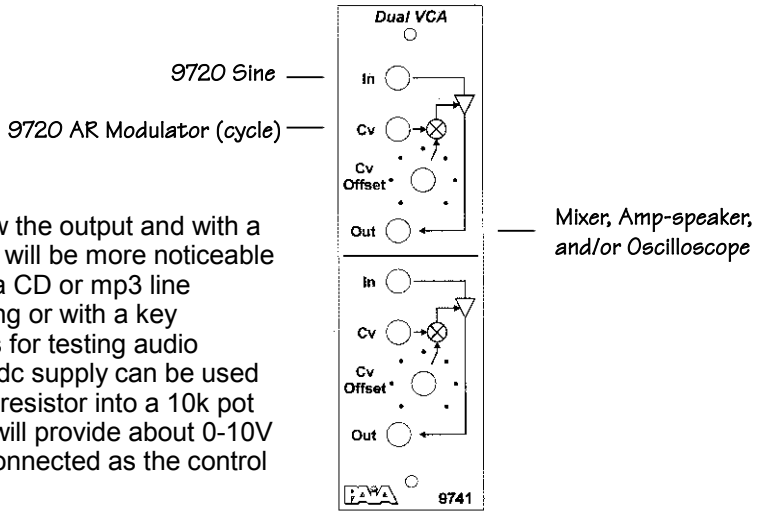
When patched to 0-10V CV or some other varying dc voltage such as the output from a MIDI to CV converter, an AR or ADSR Envelope Generator, or Low Frequency Oscillator, the control is adjusted to match the cv range to the expected audio output range.

The control response of this VCA is linear. This means for linear control, the volume changes linearly, but our ears expect more and more signal for it to be increasingly louder. This is acceptable for varying control signals within a modular system and general volume adjustments, but to get this true change as could be desired with applications requiring precise audio level control, a linear to exponential conversion should be implemented (use PAiA 9756 or similar).

When first applying power, check for smoke or a burning smell which might indicate backwards power wiring or the board being in contact with wires, tools, metal, or other conductors causing short-circuits.

Audio can be input and should be heard at the output as control voltage is applied to the VCA, but just as a quick check, advancing the Offset control will work to let some of the sound through to the output.

In this example, the sine waveform from a 9720 VCO is patched to the VCA Input, the Modulator output on this 9720 is patched to the CV input, and the VCA Output is patched to an amplifier and speaker, or a mixer preceding an amplifier and speaker.



An oscilloscope may be used to view the output and with a sine as input, any distortion or noise will be more noticeable than with other waves. Music from a CD or mp3 line output, or a portable keyboard looping or with a key weighed-down are other possibilities for testing audio through the VCA. A variable output dc supply can be used for the 0-10V CV input. A 2200ohm resistor into a 10k pot with 12VDC connected at the ends will provide about 0-10V DC. The 9744 CV Source can be connected as the control voltage to the VCA.

Adjust the Offset control for a quiet output with no CV (0V DC). A 10V CV should 'open' the VCA so all the input is getting through to the output.

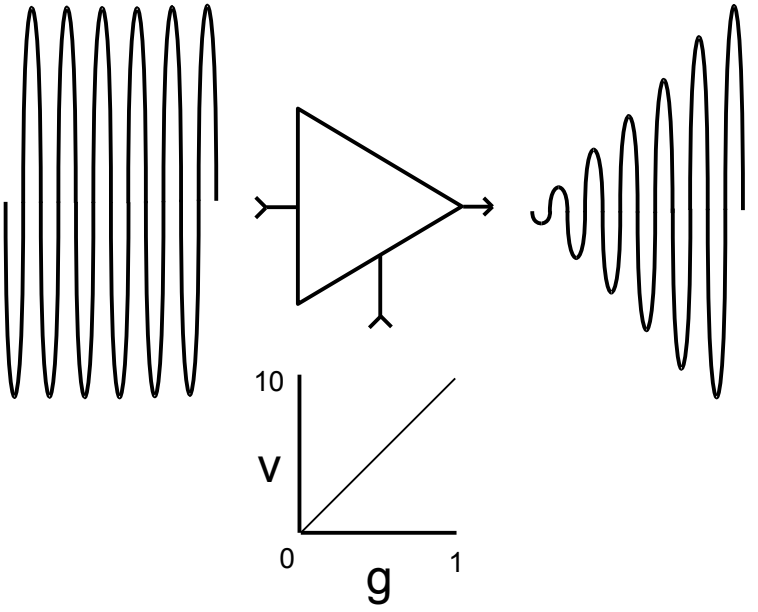
Test the lower section in a similar manner.

The example below illustrates the relationship between the signals at the input and output of the VCA with the CV changing over a 10V range. With zero volts input, and the offset control adjusted for minimum output, the gain is zero and the output signal is completely reduced. As the CV goes positive, over a 10V range, the gain increases and the output signal changes in proportion until it reaches unity or x1. For the best operation, the signal input to the VCA should be in a 5-10V range so the fully “open”, unity signal is significantly stronger than any fully “closed” signal. Similarly, the CV ranging 10V will optimize the gain adjust range.

To boost audio or control signals, patch them through a pre-amplifier or mixer with gain. Attenuate or reduce the 10V signal before connecting to your amplifier and speaker or other monitoring device if these are expecting a nominal 0dB or about 1V signal level. Otherwise, the sine wave in this example is likley to sound like a LOUD squarewave with the input to the device being overdriven and it clipping the amplified sound to the speaker or headphones.

Don't overlook the VCA as a means for varying the level of a LFO or ADSR. The illustration below could be either of these modulators varied by a Modulation Wheel CV for a modulation depth function.

The Offset control is usually set about mid-rotation to quiet an audio signal, but for control signals that stay fully positive (or negative), such as the ADSR envelope generator or an Envelope Follower, it is convenient having the ability to shift the range to accommodate these signals, and, control signals to the VCA not in the usual 0-10V positive range, using this panel control.



An Envelope Follower can work to open the VCA according to the input signal intensity: When the signal is strong, the envelope voltage is too and this working to control the VCA opens the path for the sensed signal which also is going into the VCA. When it is weak, and hiss or hum might be apparent, the envelope voltage is low and the VCA squeezes down the input — a noise reduction patch.

If the envelope follower output is run through a module for an inversion of the control envelope, this inverted action can be put to use to make loud signals have lower output from the VCA. When the sensed/VCA input signal drops, the VCA control excursion is positive and more output is available from the VCA. Here, we have a compressor, sustain, or Auto-level-control sort of patch.

Two sections with the control to the, inverted for one, work as a two-channel pan patch. An LFO is a repeating swing back and forth and can be gradual with a sine, triangle or ramp waveform as the modulator, or, instantly switching with pulse or square waves. Try four or more with phase-spaced modulation to multiple channel set-ups to get things spinning....

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DESIGN ANALYSIS

The Model 9741 Dual Voltage Controlled Amplifier consists of two identical operational transconductance amplifier (OTA) stages whose gain is controlled either on-board with a potentiometer or externally with 0 to 10 volt control voltage.

Taking the first section (composed of U2A, U1A, and U1B) as typical, signals are applied to the non-inverting input of U2A to the OTA through a resistive attenuator. The output current of U2A develops a proportional voltage across resistors R24. Resistor R3 is used to cancel out any negative offset present at the input. The output is buffered by a darlington pair to prevent any loading on the OTA output.

Control voltages are input into inverting amplifier U1A and then into another inverting amplifier, U1B. Amplifier U1B has a potentiometer connected to the positive input to offset incoming control voltages as necessary. The output of U1B is fed into a resistive current limiter (which also provides some additional negative offset) before feeding the amp bias input pin of U2A.

9741 Test Point Data

TP1	+12 VDC
TP2	-12 VDC
TP3	0 VDC

9741 Power Requirements

Voltage	**Current**
+15 VDC	25.9 mA
-15 VDC	26.4 mA

Builder's Notes

9741 Parts List

Please check the parts against this list. As you locate a part type and verify the quantity (and mounting hardware -- if required) check it off in the space provided.

Because we have introduced surface-mount parts with these kits, we are providing the printed circuit card as a subassembly with the surface-mount parts already in place.

Also, we want to make you aware that we are using both linear- and audio-taper potentiometers in some of the modules. They are marked differently so we are asking that you check carefully.

If anything is missing please notify PAiA at missing@paia.com or by phone at (405) 340-6300, fax (405) 340-6378.

	Quan	Description	Ref Des	Marking
( )	1	9741 PCB Sub-assembly, Dual VCA		
( )	1	9741 Front Panel, Dual VCA		
( )	2	100K ohm Potentiometer, 9 mm Snap-In, Linear	P1, P2	B100K
( )	6	Phone Jack, Stereo, 3.5mm	J1, J2, J3, J4, J5, J6	
( )	2	Knob, Set Screw		
( )	1	Shim, Knob, Polyethylene Sleeve		
( )	1	Header, Vertical, 1row, 4pin	PWR1	
( )	1	Cable Assembly, Power, 4-wire		
( )	2	Screw, Self tap, #4 x 3/8, Pan Head Phillips, Black Oxide		

9741 Dual VCA