



## AS3381 - Dual Low Noise Voltage Controlled Amplifier (VCA)

### FEATURES

- two high performance VCAs
- extremely low noise: > 100dB S/N ratio
- low distortion: <0.3% THD
- low feedthrough: <0.3% of full scale output

AS3381D  
 SOIC-8 (150mil)



### APPLICATIONS

- voltage controlled stereo levels
- programmable mixers
- high performance AGC, companders and limiters
- voltage programmable filters and oscillators
- for electronic music

### General Description

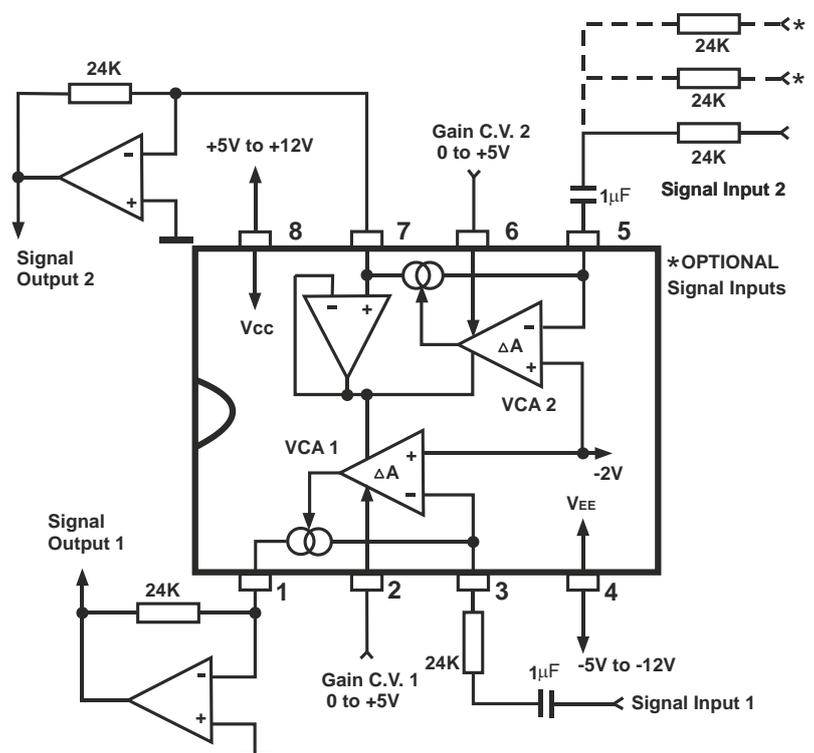
AS3381 is a dual low noise voltage controlled amplifier, with linear scale, intended for applications requiring high audio performance in a small space. AS3381 contains two gain cells with extremely low noise for signal-to-noise ratio better than 100 dB, low distortion with less than 0.3% THD, and low control feedthrough for "pop" free performance when gain modulated.

AS3381 is also extremely easy to use, requiring few external components and no external trimming to meet their excellent performance. The signal inputs are summing node inputs for convenient signal mixing; and the control voltage inputs, covering over 100dB with a 5 volt nominal range, are referenced to ground when the outputs feed virtual ground summing nodes. The current mode outputs offer additional flexibility, allowing AS3381 to be used in high performance VC filters and waveform generators as well as amplifiers.

### Pin Information

SOIC-8 Pin No	Pin Name	Description
1	Io1	Signal Output 1
2	Gain C.V. 1	Frequency C.V. Input1
3	Ii1	Signal Input 1
4	V <sub>EE</sub>	Negative Supply Voltage
5	Ii2	Signal Inputs 2
6	Gain C.V. 2	Frequency C.V. Input2
7	Io2	Signal Output 2
8	V <sub>CC</sub>	Positive Supply Voltage

### Block and Connection Diagram





**Absolute Maximum Ratings**

Voltage Between V <sub>CC</sub> and V <sub>EE</sub> Pins	25V
Voltage at any Pin	V <sub>CC</sub> +0,3V to V <sub>EE</sub> -0,3V
Voltage V <sub>CC</sub>	+4,5V to +16V
Voltage V <sub>EE</sub>	-4,5V to -16V
Linear Control Voltage	-2V to +2,5V
Storage Temperature Range	- 65°C to 150°C
Operating Temperature Range	- 0°C to +70°C

**Typical Electrical Characteristics**

V<sub>CC</sub>=+5V V<sub>EE</sub> = -5V T<sub>A</sub>= 20°C V<sub>pin7</sub>=0V

Parameter	Min.	Typ.	Max.	Units
Signal Input for 0.2% THD	-	±200	-	μA
Input Summing Node D.C. Level	-	-2,1	-	V
Max. Current Gain		1	-	
Gain C.V. for Max. Gain	-	+ 5	-	V
Gain C.V. for -96dB Gain	-	+0,1	-	V
Linear Control Scale	-	20		%/V
Tempco of Linear Control Scale	-	±500	-	ppm
Gain C.V. Input Bias	-	-1,5	-	μA
C.V. Reference Buffer Bias <sup>1</sup>	-	±100	-	nA
Output Voltage Compliance for VCA1 <sup>2</sup>	-0,2	-	+ 1	V
Signal-to-Noise Ratio <sup>3</sup>	-	100	-	dB
Control Feedthrough	-	±1	-	μA
Positive Supply Voltage Range <sup>4</sup>	+4,5	-	+16	V
Negative Supply Voltage Range <sup>4</sup>	-4,5	-	-16	V
Supply Current	-	2,8	-	mA

**Notes:**

- 1) Also represents constant output offset current to amplifier B.
- 2) Relative to D. C. voltage at output of amplifier B, which must drive a zero impedance feedback node, normally at ground potential.
- 3) For a 400 μA P.P. input signal.
- 4) Relative to D. C. voltage at output of amplifier B. Maximum supply allowed across the device is 25V.

Specifications subject to change without notice.



## APPLICATION HINTS

### Power Supplies

Provided the voltage between supply pins (pin 4 and pin 8) is not allowed to exceed 25V, the positive supply ( $V_{CC}$ ) may be any value between +4.5V and +16V while the negative supply ( $V_{EE}$ ) may be any voltage between -4.5V and -16V. Thus, +5V; +12V, -5V; +15V, -5V; or  $\pm 12V$  are all acceptable supplies resulting in nearly identical device performance. It should be noted that the OpAmps driven by the AS3381 may have higher supplies (e.g.  $\pm 15V$ ) even though the VCA device itself is operating from a lower supply.

### Basic Operation

Each VCA is a current input, current output type, whose current gain is controlled from less than -96dB to unity with the control voltage. It will be noted that, in order to fit two completely independent VCAs in an 8 pin SOIC, the reference voltage for the two control inputs is made equal to the voltage at the output of VCA2 (pin 7) through a high input impedance buffer. Thus, it is mandatory that VCA2 output drive a node which is at a constant DC level, typically 0 volts (any AC component should be well under 1mV.P.P.). This requirement is most easily met by feeding the output into the summing node of an op amp, which is also serving to convert the output current to a voltage. Although the bias current to the internal buffer will generate a constant D.C. offset at the output of this op amp, the amount is so small (typically < 5mV) that it can usually be ignored.

The non-inverting input of this op amp will be most commonly connected to ground; however, it could be connected to any DC voltage as long as there is no AC signal component present, and the positive supply is at least 4.5V greater and the negative supply is 4.5V more negative than this reference voltage. Throughout the remainder of these hints, a reference voltage of 0 volts will be assumed.

### Signal inputs/Outputs

As the signal input to each VCA is a virtual low impedance node, any signal input voltage may be converted to the required input current simply with an external input resistor. Since the D.C. voltage level at the input is nominally -2.1V, a series coupling capacitor will also be required (such a capacitor would be required anyway to prevent any DC. offset in the source from degrading control voltage feedthrough). The resistor value should be selected so that the maximum input current does not exceed  $\pm 200\mu A$ , or :

$$R_{IN} = V_{INMAX}(V.P.P.) / 400\mu A$$

The series coupling capacitor is then chosen to give the desired -3dB low frequency corner with the selected resistor. If more than one signal is summed into a VCA input using individual resistors, then the resistor values should be selected so that the maximum summed current is still maintained less than  $\pm 200\mu A$ .

As mentioned above, the output current of VCA2 must feed an op amp summing node. The value of feedback resistor is chosen for the maximum desired output voltage at maximum current gain, which is unity:

$$R_f = V_{OMAX} \times R_{IN} / V_{INMAX}$$

Note that any maximum voltage gain is achievable simply by rationing the feedback resistor to input resistor. Since the VCA does not invert the input current, the resulting voltage output of the op amp current-to-voltage converter is opposite in phase to the input voltage (i.e. inverting).

The output current of VCA1 need not feed a summing node, but because of its limited voltage compliance in the AS3381, an op amp inverter is still recommended. Hence, for this VCA, an alternative non-inverting configuration is possible by simply connecting the output resistor from pin 1 to ground and buffering the resulting output voltage with an op amp unity gain follower. The value of the feedback resistor or output resistor for VCA1 is calculated in the same manner as for VCA2.

### Control Inputs

Gain control is such that the VCAs are essentially "off" when the control voltage equals the reference voltage (pin 7 voltage) and fully "on" when the controls are either nominally +5V above the reference voltage, regardless of the supply voltages (provided, of course, that  $V_{CC}$  is at least as great as the maximum control voltage).

For the AS3381, the control scale is exponential from 0 to approximately +200mV (re. reference voltage), controlling the current gain from -100 dB nominal to about -30 dB. Thereafter, the current gain increases in a linear fashion until it reaches the maximum of 0dB at +5V nominal (re. reference voltage). This slight rounded knee at the scale bottom allows for smooth transitions to the fully off condition regardless of the small variations in VCA turn-on threshold.

### Trimming

The AS3381 have been designed to achieve their excellent performance without the need for any trimming.

In fact, there is no way to reduce distortion through external trimming. Distortion may be improved only by reducing the signal input current level, but at the sacrifice of lower signal-to-noise ratio.



Although inherently very low, control voltage feedthrough (change in quiescent D.C. output current with control voltage) may be reduced by a factor of 5 to 20 by adding an adjustable +3µA current to the signal input.

**Application in VC Filters**

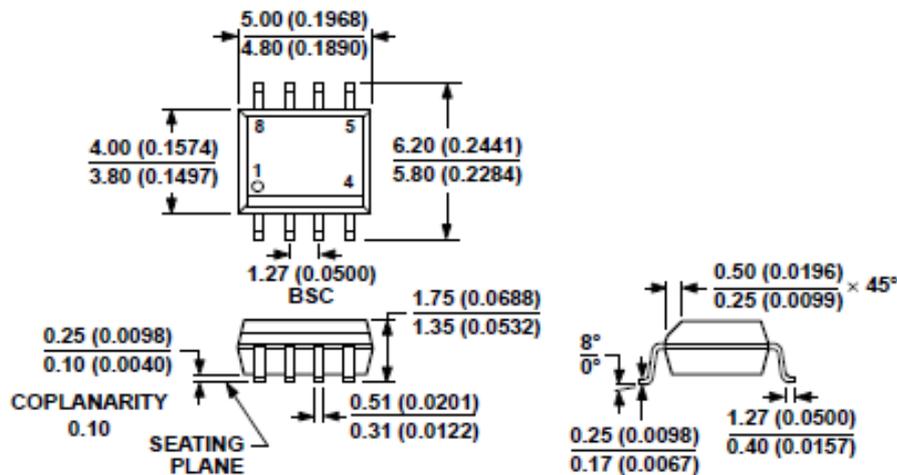
The AS3381 may be used in first order and second order low pass voltage controlled filters. For the second order filter, the wide compliance output of VCA1 is put to good advantage, eliminating the need for a third inverting op amp. For widest range with least amount of control feedthrough, the op amps used in these circuits should have low input bias current, such as found, in BIFET types. If the input signal nodes have a D.C. level equal to -2,1V, the outputs will be also quiescently at -2.1 volts. These outputs may be shifted to 0V either by adding the optional resistors, or by biasing the non-inverting input of the op amp integrator at +2.1 volts (which also shifts the control voltage ranges up by the same amount).

Device type	Package
AS 3381 D	SOIC-8 (150 Mil)

**Package Information**

Units: inch (mm)

**SOIC-8 (150 mil)**



**Revision history**

Date	Revision	Changes
23-Dec-2020	1	Preliminary version 1