OnChip Systems

PA 381 / PA 382

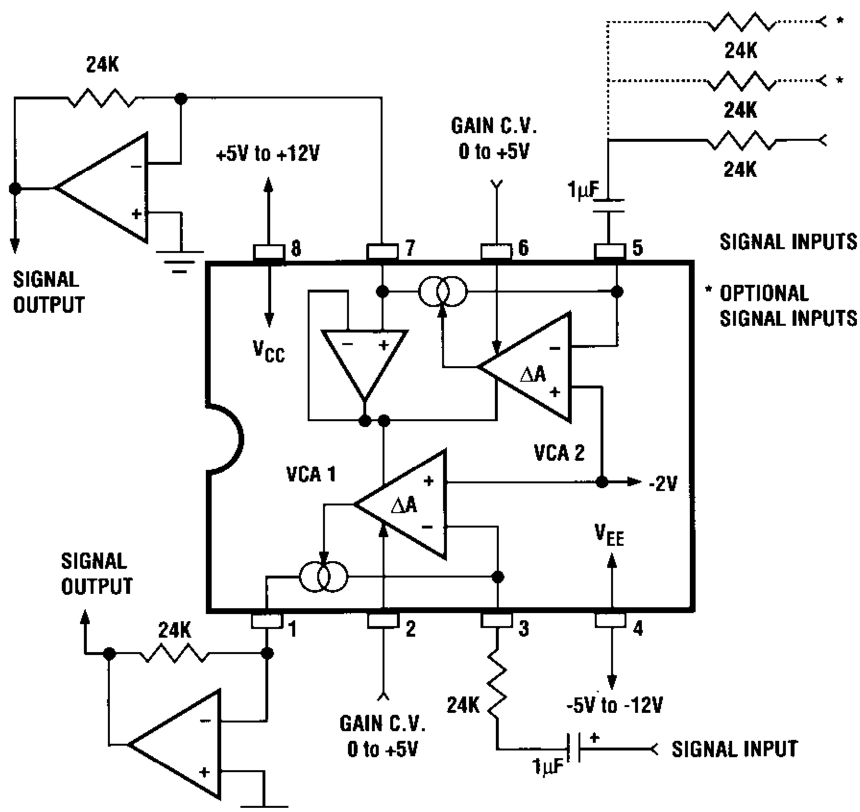
Dual Low Noise VCA

PRODUCT HIGHLIGHTS

- ♦ Two High Performance VCAs in a Minidip
- ♦ Low Cost
- ♦ Extremely Low Noise: >100dB S/N Ratio
- ♦ Low Distortion: <0.3% THD
- ♦ Low Feedthrough: <0.3% of Full Scale Output
- ♦ Easy to Use

APPLICATIONS:

- ♦ Voltage Controlled Stereo Levels
- ♦ Programmable Mixers
- ♦ High Performance AGC, Companders and Limiters
- ♦ Voltage Programmable Filters and Oscillators



PA 381/382 Block Diagram and Typical Connection

ORDERING INFORMATION:

PART NUMBER	PACKAGE TYPE	TEMP RANGE
PA 381P	8 pin PDIP	0°C to +70°C
PA 381S	8 pin SOIC	0°C to +70°C
PA 382P	8 pin PDIP	0°C to +70°C
PA 382S	8 pin SOIC	0°C to +70°C

DESCRIPTION

The PA 381 and PA 382 are low cost dual voltage controlled amplifiers intended for applications requiring high audio performance in a small space. Both independently contained in a standard 8 pin minidip, the two gain cells feature extremely low noise for signal-to-noise ratios better than 100dB, low distortion with less than 0.3% THD, and low control feedthrough for "pop" free performance when gain modulated.

The 381 and 382 are 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 these devices to be used in high performance V.C. filters and waveform generators as well as amplifiers.

The PA 381 and PA 382 are essentially the same device, differing only in choice of control scales and amplifier A output structure: The 381 provides a linear scale while the 382 offers exponential, or dB/volt, type scaling. Choice of inverting or non-inverting configuration is possible in the 382, allowing second order filters to be implemented with only one external dual op amp.

Able to operate over a wide dynamic range, the PA 381 and PA 382 offer CD performance in little board area and at low cost.

ELECTRICAL CHARACTERISTICS

V_{CC} = +5V V_{EE} = -5V T_A = +20°C $V_{pin\ 7}$ = 0V

Parameter	Min.	Typical	Max	Units
Signal Input for 0.2% THD	—	± 200	—	µA
Input Summing Node D.C. Level	—	-2.1	—	V
Max. Current Gain	—	1.0	—	
Gain C.V. for Max. Gain	—	+5.0	—	V
Gain C.V. for -96dB Gain	—	+0.1	—	V
Control Scale, PA 381	—	20	—	%/V
Control Scale, PA 382[1]	—	18	—	dB/V
Control Scale Tempco				
PA 381	—	± 500	—	ppm
PA 382	—	-3300	—	ppm
Gain C.V. Input Bias	—	-1.5	—	µA
C.V. Reference Buffer Bias[2]	—	± 100	—	nA
Output Voltage Compliance for VCA 1[3]				
PA 381	-0.2	—	+1.0	V
PA 382	V_{EE} + 1.2	—	V_{CC} - 1.2	V
Signal-to-Noise Ratio[4]	—	100	—	dB
Control Feedthrough	—	± 1	—	µA
Positive Supply Range[5]	4.5	—	16	V
Negative Supply Range[5]	-4.5	—	-16	V
Supply Current	—	2.8	—	mA

Notes: *1) From 0 to approximately +4V. Thereafter, scale becomes linear.*
2) Also represents constant output offset current to amplifier B.
3) Relative to D.C. voltage at output of amplifier B, which must drive a zero impedance feedback node, normally at ground potential.
4) For a 400 µA.P.P. input signal.
5) Relative to D.C. voltage at output of amplifier B. Maximum supply allowed across the device is 25V.

ABSOLUTE MAXIMUM RATINGS

V_{CC} to V_{EE}	25V
Voltage at any pin	V_{CC} + 0.3 V to V_{EE} - 0.3V
Current through any pin	± 50mA
Operating Temperature Range	0°C to 70°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature (soldering, 10s)	300°C
Power Dissipation	500 mW

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 ± 12V are all acceptable supplies resulting in nearly identical device performance. It should be noted that the op amps driven by the 381/382 may have higher supplies (e.g. ± 15V) even though the VCA device itself is operating from a lower supply. The only design consideration affected by the supplies is that concerning VCA1 in the PA 382, where the maximum output voltage may swing to within 1.2V of either supply rail.

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 minidip, 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 D.C. offset in the source from degrading control voltage feedthrough). The resistor value should be selected so that the maximum input current does not exceed ± 200μA, or

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

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 ± 200μA.

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:

$$R_f = \frac{V_{O\ MAX} \times R_{IN}}{V_{IN\ MAX}}$$

Note that any maximum voltage gain is achievable simply by ratioing 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 381, an op amp inverter is still recommended. In the 382, however, the output of VCA1 has been designed for large voltage swings (compliance). 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 for both devices 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 (381) or +6.5V (382) 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 381, the control scale is exponential form 0 to approximately +200mV (re. reference voltage), controlling the current gain from -100dB nominal to about -30dB. 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 transistions to the fully off condition regardless of the small variations in VCA turn-on threshold.

For the 382, the control scale is exponential from 0 to approximately +4.5V controlling the current gain from -96dB nominal to about -12dB. Thereafter, from 4.5V to 6.5V, the gain increases to its maximum value in a linear manner. Thus, by using the entire control range from 0 to +6.5V, an audio taper type of response may be obtained, providing expanded dB control over most of the range while subduing the exponential effect during the last 12dB. On the other hand, restricting the maximum control voltage to 4.5V keeps the scale nearly perfectly exponential (especially below -20dB), making this device appropriate for use in wide range voltage controlled filters, where the resulting control response will be in octaves per volt rather than hertz per volt over more than a 12 octave range.

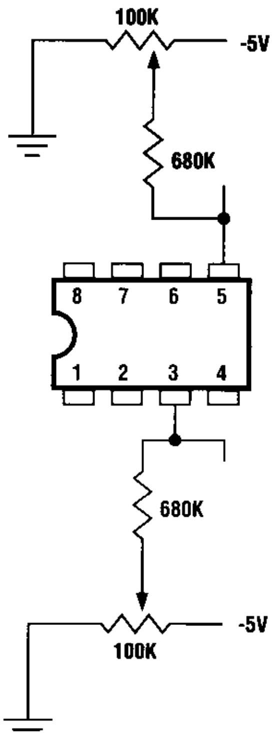


Fig. 1: 381/382 Optional Feedthrough Trim

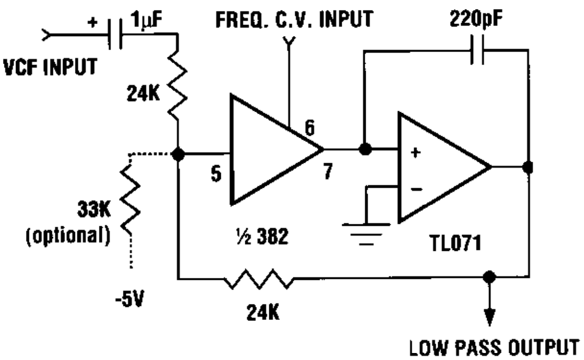
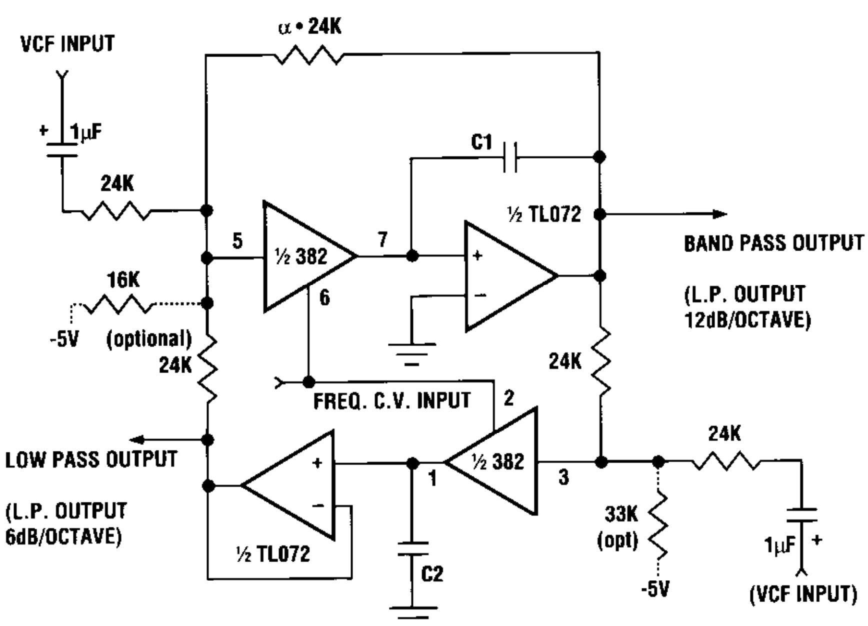


Fig. 2a: 382 in first order low pass



A = 382 Current Gain

$$\omega = A \frac{1}{24K \sqrt{C1 \times C2}}$$

$$Q = \alpha \sqrt{C1/C2}$$

Fig. 2b: 382 in second order low VCF

Trimming

The PA 381 and PA 382 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 as shown in Figure 1.

Application in V.C. Filters

Examples of the PA 382 used in first order and second order low pass voltage controlled filters are shown in Figure 2. 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. Note that because 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 shown, 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).

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