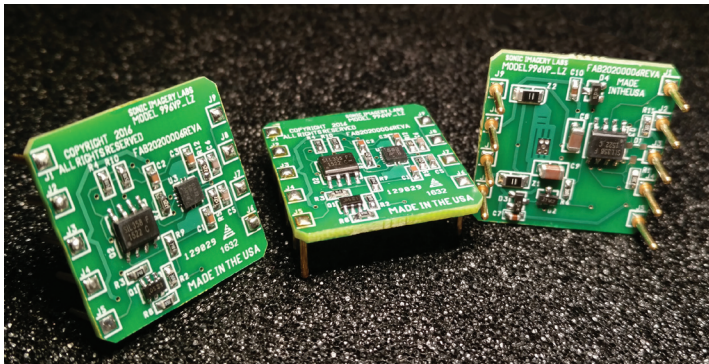




High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

The Sonic Imagery Labs 996VP-LZ is a high performance semi-discrete operational amplifier module designed for professional audio applications and areas where ultra-low noise and extremely low distortion is required. It is a higher performance drop in upgrade replacement for the Valley People Trans-Amp LZ. Unlike the familiar OP-AMP geometry, the Sonic Imagery Labs 996VP-LZ is inherently a fully balanced differential in/differential output device employing symmetrically opposed feedback loops. Instead of the feedback being returned to the input ports, as done with traditional balanced topologies, the feedback signal is returned to a pair of feedback ports. This results in a pair of input ports configured as a high impedance fully balanced bridging input.



For differential current summing amplifier applications, the input signals are brought to the feedback ports, which now double as balanced virtual ground current summing junctions.

Where true balanced inputs are not required, the Sonic Imagery Labs 996VP-LZ can also be operated as two independent amplifiers, with each half maintaining the extremely low noise, low distortion, and high gain bandwidth performance characteristics associated with this device.

Unlike the original Paul Buff/Valley People design, the 996VP-LZ uses two precision matched pair transistors as the differential input stage. A total of 4 matched devices, with an option for an additional pair for ultra-ultra low noise applications. These devices are selected by the manufacturer at final test to Sonic Imagery Labs noise and V_{be} matching specifications.

Features:

- Ultra Low Total Harmonic Distortion
- Ultra Low Noise, 0.80nV/rtHz
- High Current Output Drive (150mA)
- Near Rail to Rail Output (within 0.25V)
- +29dBu Output Levels (600 Ω Differential Load @ $\pm 18V$ Supply)
- Standard Valley People Trans-Amp LZ Gain Block Footprint
- Operates over $\pm 5V$ to $\pm 18V$ supply rails
- Lower output offset voltage than existing counterparts
- Lower input leakage current than existing counterparts
- Particular emphasis on audio performance
- Designed, assembled and produced in the USA
- 3 Year Warranty

Applications:

- Balanced Line Amplifiers
- Balanced Cable Drivers
- Balanced High Input Impedance Buffer
- Balanced Active Filters and Equalizers
- Balanced Summing/Mixer Amplifiers
- High Performance Balanced Microphone Preamplifiers
- High Performance Balanced A/D front end preamplifier
- High Performance Balanced D/A back-end driver
- High Performance Balanced Phono Preamplifiers

In addition to the enhanced input stage, the 996VP-LZ uses high precision temperature stable, power supply independent current sources. The original design did not use a true current source thus making its operational specifications voltage dependent for performance. Supply independent current sources allow the 996VP-LZ differential amplifiers bias to remain locked at the optimum operating point regardless of power supply voltage.

Another feature not found in the original Paul Buff/Valley People design is the addition of a matched pair active current load to give the 996VP-LZ differential input stage it's outstanding power supply noise rejection ratio performance.

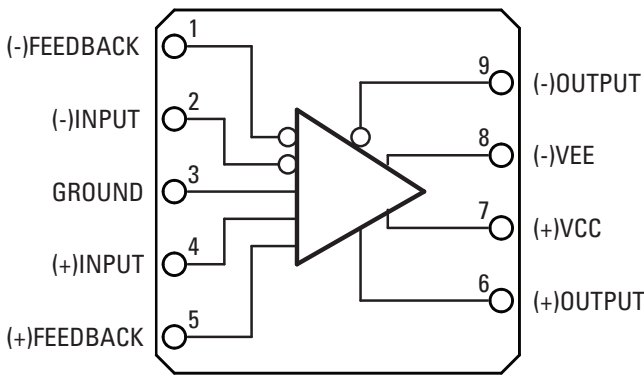


High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

The output driver stage has been redesigned specifically to source and sink large amounts of current without degrading the output drivers linearity. High order harmonics produced by the output stages crossover distortion found in the original Valley People opamp design are eliminated. The new output stage provides exceptionally low open loop output impedance that improves stability with capacitive loads and is also protected against short-circuit and thermal overload events. This allows the Sonic Imagery Labs 996VP-LZ to drive transformers and balanced cabling directly and still remain stable.

Connection Diagram:



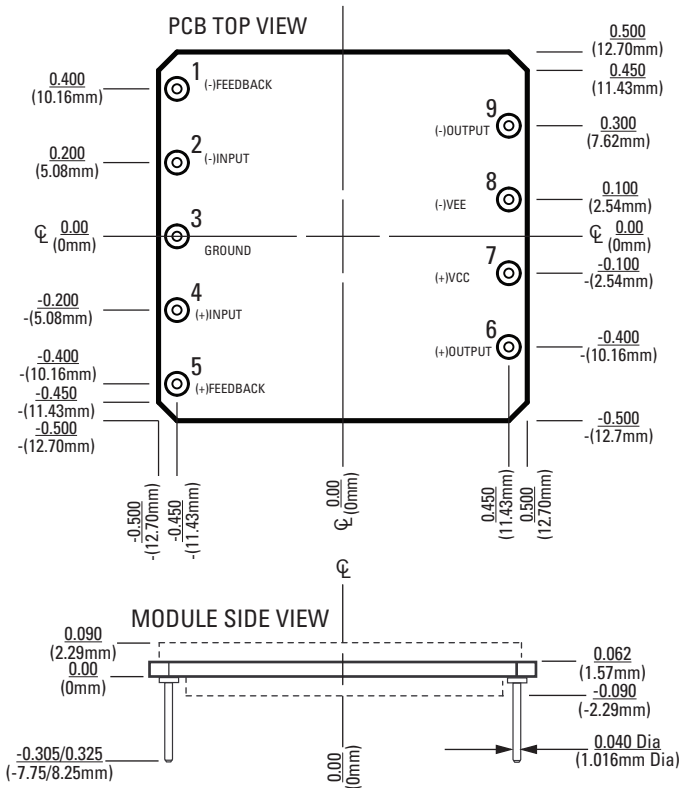
The newly designed output stage also provides nearly rail to rail output voltage. Output levels of +28dBu differential are easily obtainable and are not limited by gain setting dependency.

The Sonic Imagery Labs 996VP-LZ can be operated from $\pm 5V$ to $\pm 18V$ power supplies. The redesigned input stage circuitry provides outstanding common-mode rejection and maintains low input bias current over its wide input voltage range, minimizing distortion. The 996VP-LZ is unity-gain stable and provides excellent dynamic behavior over a wide range of load conditions.

The pinouts conform to the original Valley People Trans-Amp LZ package type, allowing direct replacement.

Both the Valley People Trans-Amp LZ and the Sonic Imagery Labs 996VP-LZ is internally AC coupled, with an effective low end open-loop bandwidth of 0.0003 Hz. This results in a closed loop 3dB point of 0.3 Hz when operated at 60 dB gain, or 3 Hz for 80 dB gain.

Package Diagram:



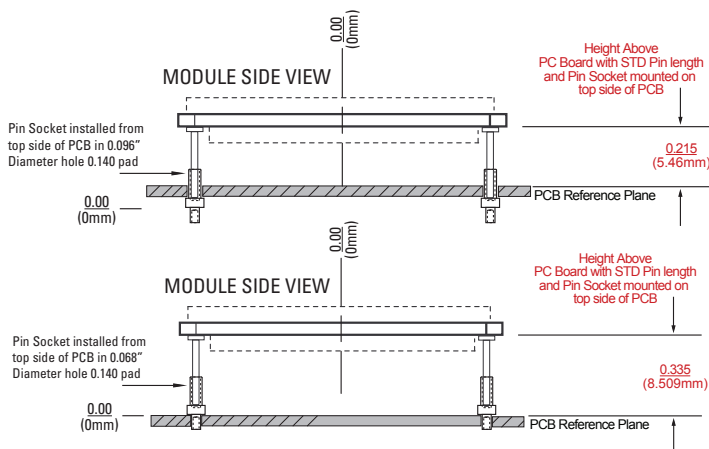
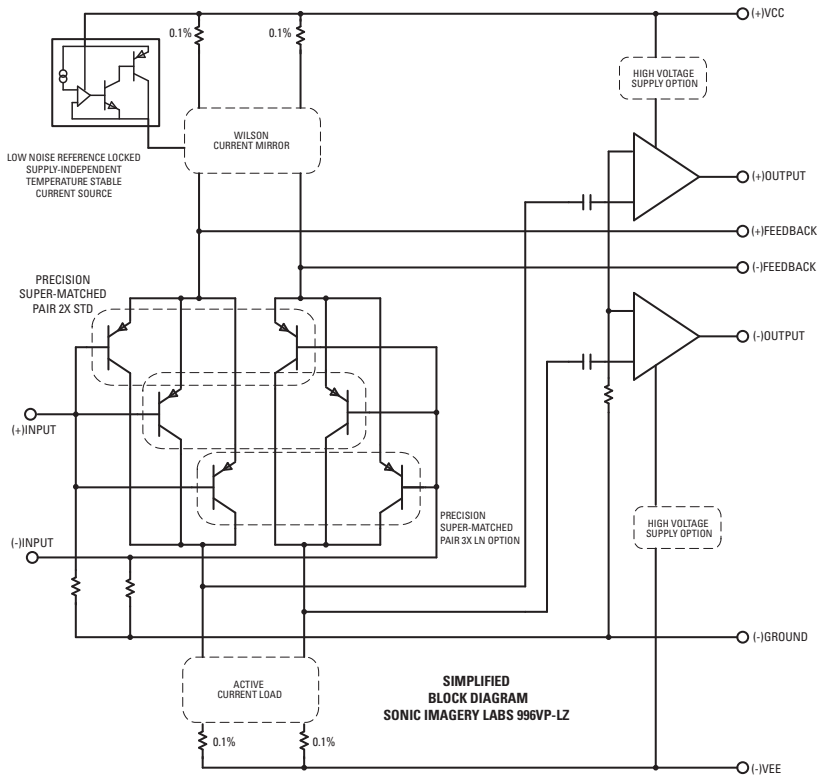
For a DC coupled fully differential balanced operational amplifier with user defined common mode offset control refer to the Sonic Imagery Labs Model 991GC_Diff_Ticha balanced operational amplifier datasheet. (Available Late Winter 2016)

Sonic Imagery Labs also can provide a variation of this model that can provide 390pV/v/Hz equivalent input referred noise voltage performance for ultra-ultra low noise amplifier applications. Contact us and ask about the Model 996VP-LZ UULN Variant.



High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier



DETAIL A. (Above) Standard 0.300" pin length height specifications and mounting options for Sonic Imagery Labs Model 996VP-LZ balanced opamp module.

Recommended Operating Conditions:

Positive Supply Voltage	VCC	+5V to +18V
Negative Supply Voltage	VEE	-5V to -18V
Signal Current	Iin	1nA to >500 uA

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only; the functional operation of the device at these or any other conditions above those indicated in the operational sections is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Absolute Maximum Ratings

Supply Voltage	VCC-VEE	40V
Differential Input Voltage	V _{ID}	15Vpp (30Vpp differential at Unity)
Input Voltage Range	V _{IC}	±12.5V
Power Dissipation Max	P _D	2W Max into 32Ω load
Operating Temperature Range	T _{OPR}	-40~85°C
Storage Temperature Range	T _{STG}	-60~150°C

DC Electrical Characteristics (T_a=25°C, V_s=±18V unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
V _{OS}	Input Offset Voltage (Gain Independent)	R _S =0Ω (shorted)	-40	5.0	40	mV
I _{OS}	Input Offset Current	-	0.2	1	5	uA
I _B	Input Bias Current	-	-	500	-	nA
A _{VOL}	Voltage Gain (ac open loop)	-3dB@28Hz	110	120	124	dB
V _{OM}	Output Voltage Swing	V _{sup} =±18V R _L =600Ω Av=10	33.8	34	34.2	Vpp
V _{OM}	Output Voltage Swing	V _{sup} =±18V R _L =150Ω Av=10	33.5	34	34.2	Vpp
V _{CM}	Input Common-Mode Range	R _{IN} =600Ω differential	±12	±12.5	-	Vrms
CMRR	Common-Mode Rejection Ratio	-	-	90	-	dB
PSRR	Power Supply Rejection Ratio	-	-	120	-	dB
I _Q	Supply Current	V _o =0, inputs gnd, V _{cc} =+18V	11.5	12	13.5	mA
		V _o =0, inputs gnd, V _{ee} =-18V	11.5	12	13.5	mA

AC Electrical Characteristics (T_a=25°C, V_s=±18V unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
SR	Slew Rate	R _L =600Ω	19	20	21	V/uS
SR	Slew Rate	R _L =75Ω	19	20	21	V/uS
GBW	Gain Bandwidth Product	10kHz to 200kHz	-	>50	-	MHz
	Maximum Peak Output Drive Current	Load Specific Short Circuit Protected	-	190	-	mA

Design Electrical Characteristics (T_a=25°C, V_s=±18V unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
THD	Distortion+Noise (Unity Gain)	R _L =600Ω Gain=1 @1kHz 1Vrms		0.0004		%
THD	Distortion+Noise (20dB Gain)	R _L =600Ω Gain=10 @1kHz 1Vrms		0.00035		%
THD	Distortion+Noise (40dB Gain)	R _L =600Ω Gain=100 @1kHz 0.1Vrms		0.0003		%
e _n	Input Referred Noise Voltage	Input 150Ω to ground		<0.9		nV/ Hz
i _n	Input Referred Noise Current	-		<5		pA/ Hz
PBW	Power Bandwidth	Large-signal BW R _L =600Ω 20dB Gain		>800		kHz
f _U	Unity Gain Frequency	Small-signal BW at unity gain (ft)		>50		MHz
Z _{in}	Input Resistance DC	Noninverting Input		50K		Ω
Z _{in}	Input Resistance DC	Inverting Input		50K		Ω
C _{in}	Input Capacitance	Each Input		18pF		C

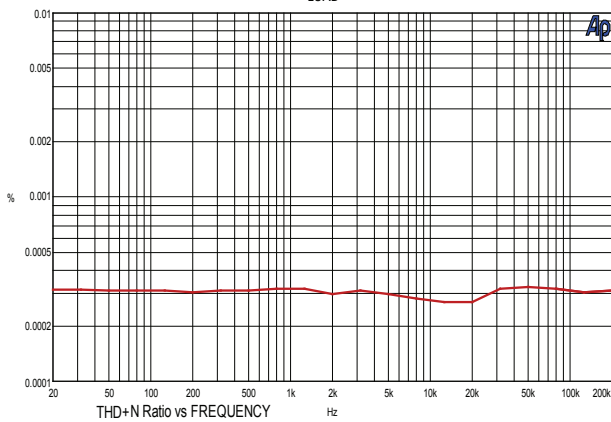


High Performance Audio Electronics

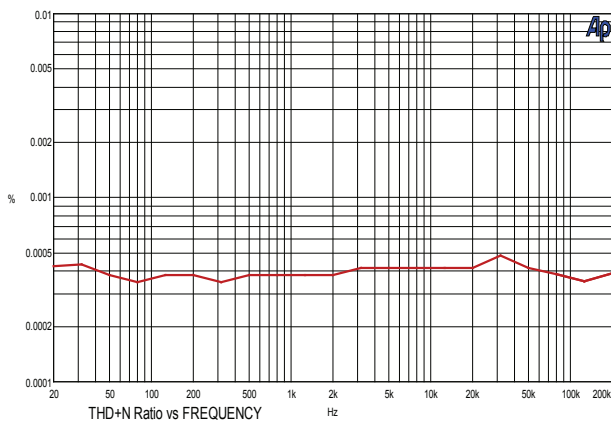
Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

THD+N Characteristics (Ta=25°C, Vs=±18V unless otherwise noted)

Total Harmonic Distortion+Noise versus Frequency
(6dB Gain (Av=2) 1Vrms (0dBV)In, R_{LOAD} 2K Ω, 22Hz-22kHz BW)

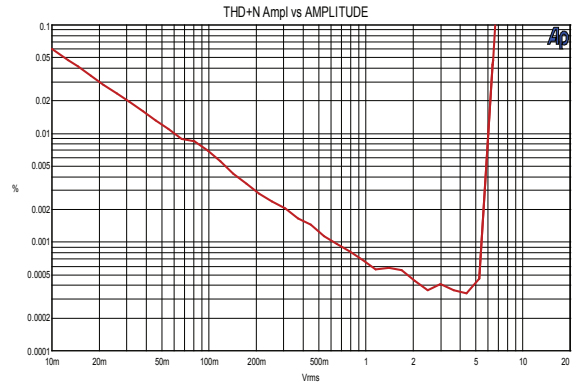


Total Harmonic Distortion+Noise versus Frequency
(20dB Gain (Av=10) 1Vrms (0dBV)In, R_{LOAD} 2K Ω, 22Hz-22kHz BW)

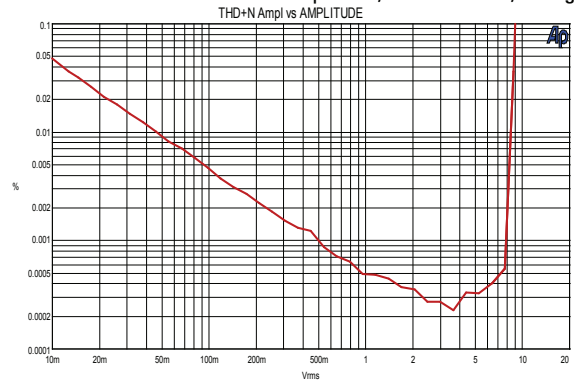


THD versus Amplitude Performance (Ta=25°C, Vs=±18V, Rload variant, Gain variant as noted below)

Total Harmonic Distortion versus Amplitude, Rload=150 Ω, 6dB gain



Total Harmonic Distortion versus Amplitude, Rload=600 Ω, 6dB gain



Total Harmonic Distortion versus Amplitude, Rload=2KΩ, 6dB gain



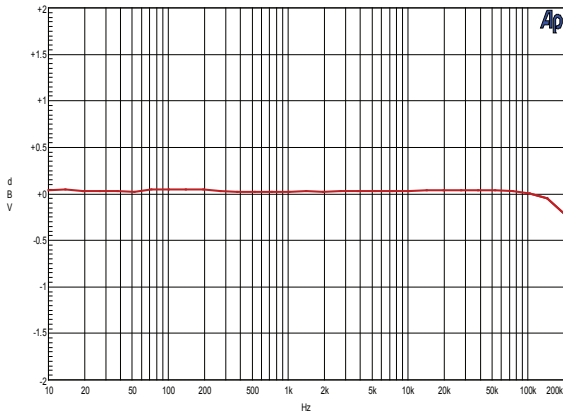


High Performance Audio Electronics

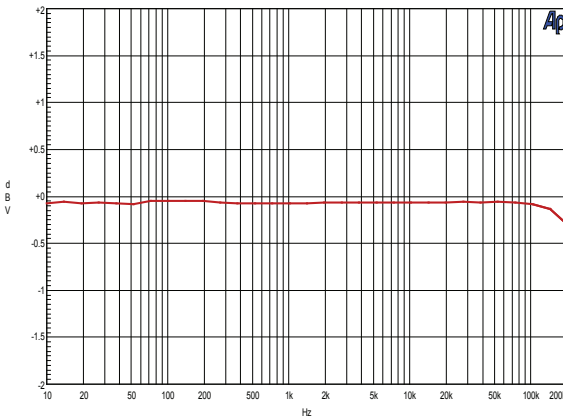
Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Gain Accuracy vs Frequency ($T_a=25^\circ\text{C}$, $V_s=\pm 18\text{V}$ unless otherwise noted)

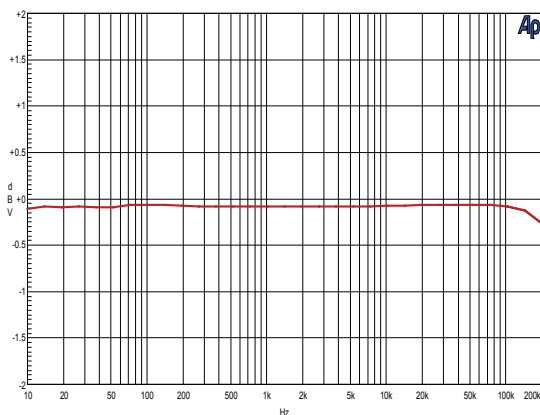
20dB ($A_v=10$) Differential Gain Accuracy versus Frequency



40dB ($A_v=100$) Differential Gain Accuracy versus Frequency

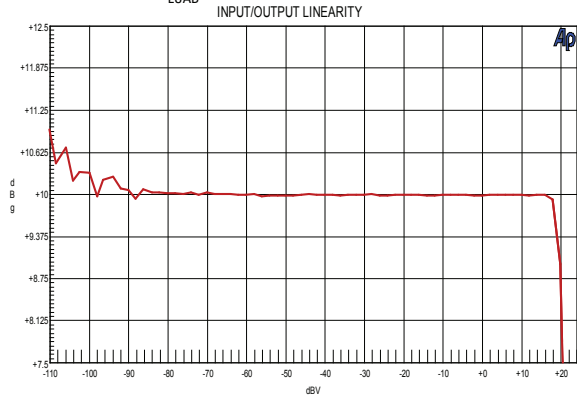


80dB ($A_v=10000$) Differential Gain Accuracy versus Frequency

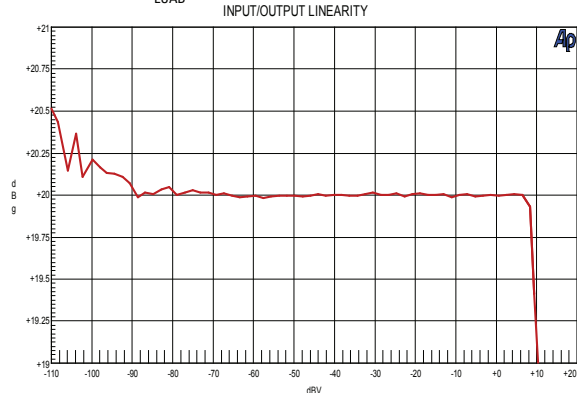


Linearity vs Amplitude ($T_a=25^\circ\text{C}$, $V_s=\pm 18\text{V}$ unless otherwise noted)

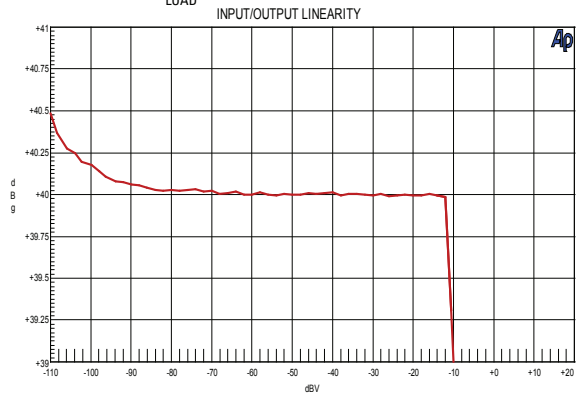
Gain 10dB $A_v=3.16$ ($R_{LOAD}=600\ \Omega$)



Gain 20dB $A_v=10$ ($R_{LOAD}=600\ \Omega$)



Gain 40dB $A_v=100$ ($R_{LOAD}=600\ \Omega$)



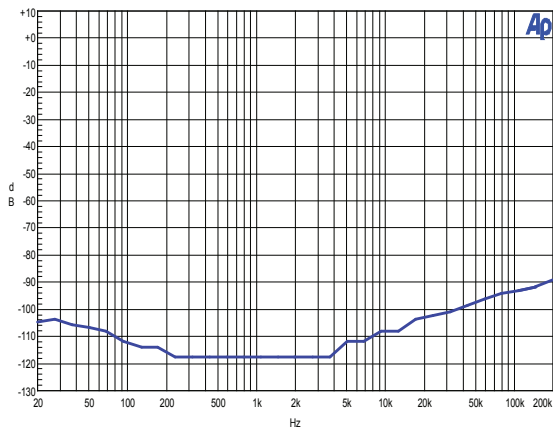


High Performance Audio Electronics

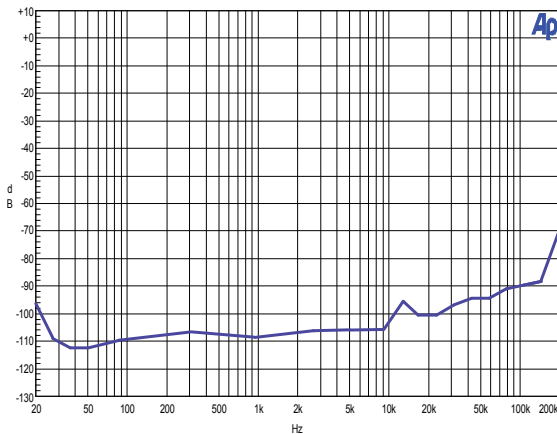
Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Power Supply Rejection Ratio Characteristics ($T_a=25^\circ\text{C}$,
 $V_s=\pm 18\text{V}$, $R_s=150\ \Omega$ $R_{load}=2\text{K}\Omega$ unless otherwise noted)

10dB Gain ($A_v=3.16$) vs Frequency, Positive Supply

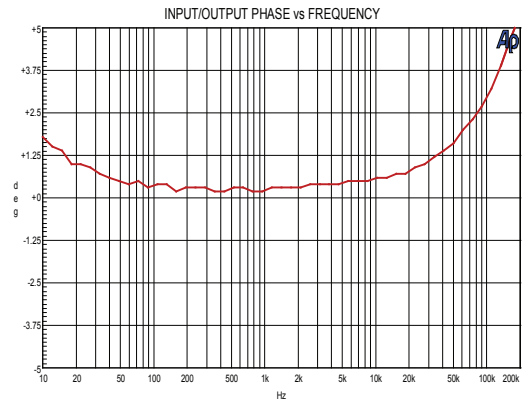


10dB Gain ($A_v=3.16$) vs Frequency, Negative Supply

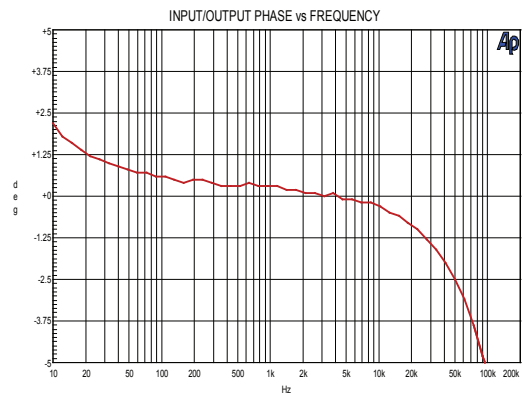


Input-Output Phase Characteristics ($T_a=25^\circ\text{C}$, $V_s=\pm 24\text{V}$, 0dBV input,
 $R_s=600\ \Omega$ $R_{load}=10\text{K}\ \Omega$ unless otherwise noted)

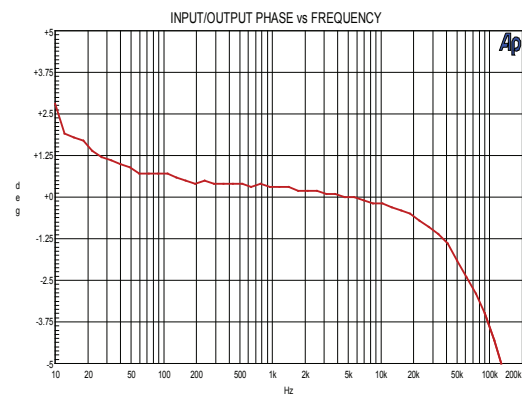
0dB gain ($A_v=unity$) vs Frequency



20dB gain ($A_v=10$) vs Frequency



40dB gain ($A_v=100$) vs Frequency



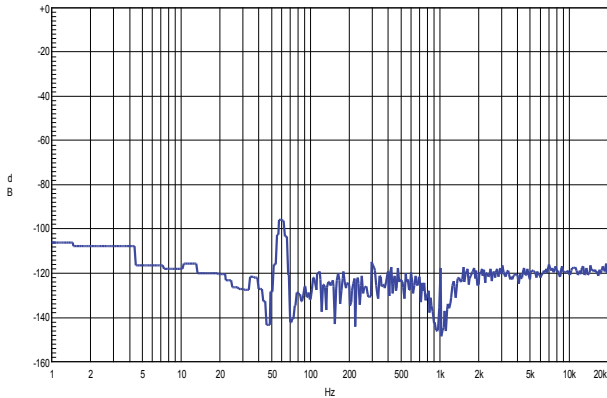


High Performance Audio Electronics

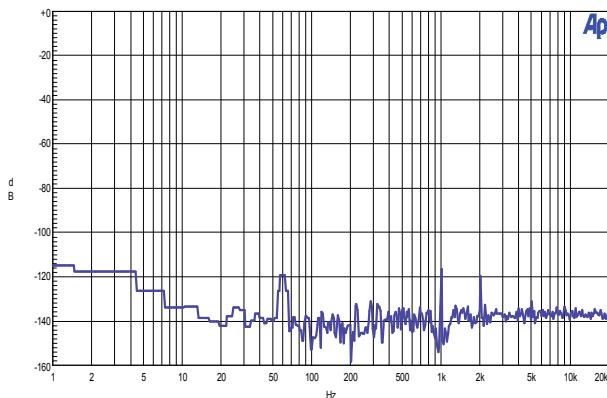
Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

THD Residual+N Characteristics ($T_a=25^\circ\text{C}$, $V_s=\pm 18\text{V}$, 0dBV input, $R_s=150\ \Omega$ $R_{load}=2\text{K}\ \Omega$ unless otherwise noted)

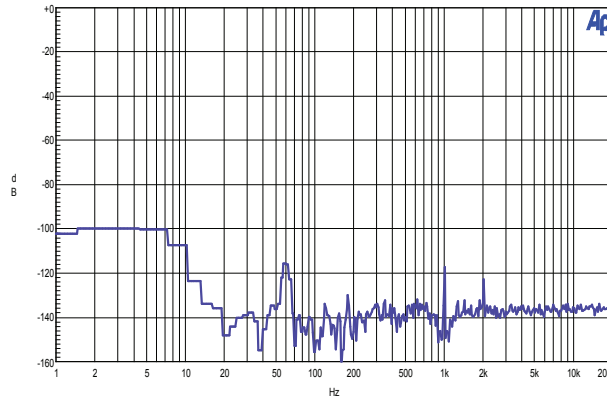
1kHz Fundamental @ 0dBV , 0dB gain ($A_v=Unity$) vs Frequency



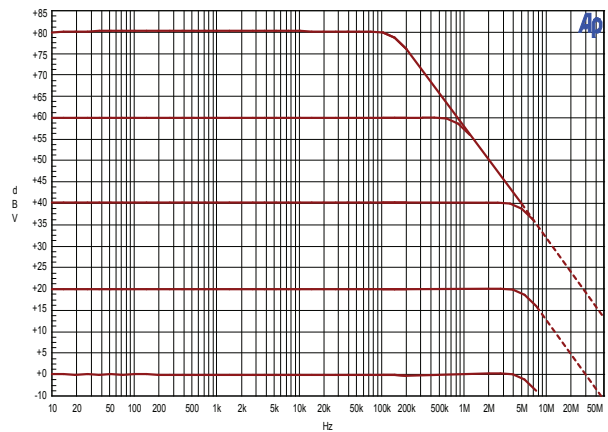
1kHz Fundamental @ 0dBV , 20dB gain ($A_v=10$) vs Frequency



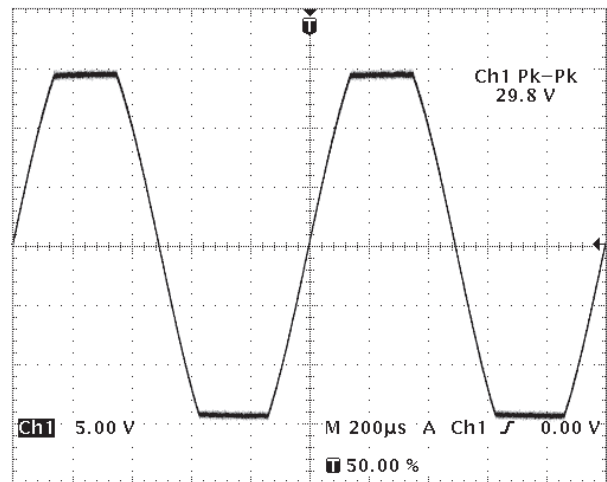
1kHz Fundamental @ -10dBV , 40dB gain ($A_v=100$) vs Frequency



Closed Loop Gain versus Frequency Characteristics ($T_a=25^\circ\text{C}$, $V_s=\pm 18\text{V}$, -60dBV input, $R_s=150\ \Omega$ $R_{load}=2\text{K}\ \Omega$ unless otherwise noted)



Clipping Overdrive Characteristics ($T_a=25^\circ\text{C}$, $V_s=\pm 15\text{V}$, $R_s=150\ \Omega$, $R_{load}=2\text{K}\ \Omega$ unless otherwise noted)



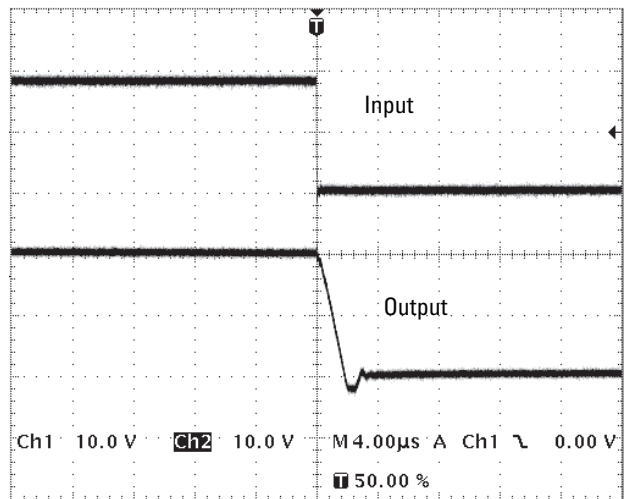
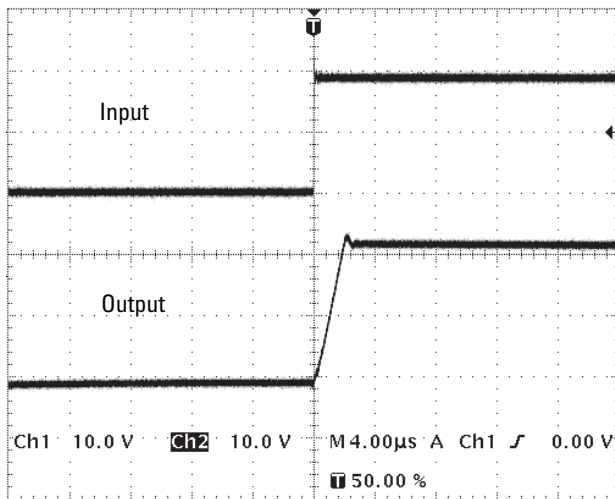


High Performance Audio Electronics

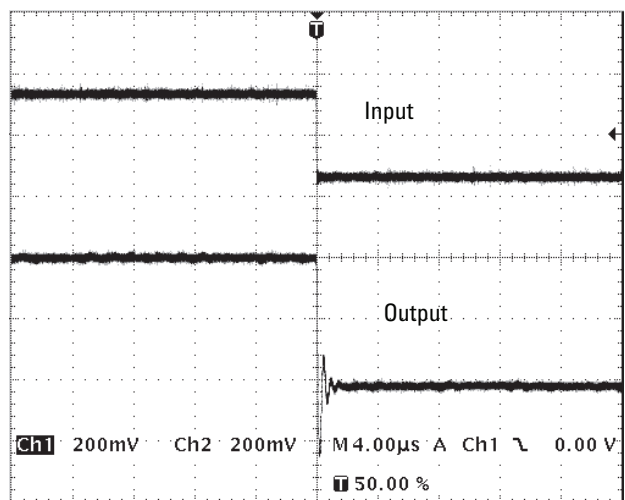
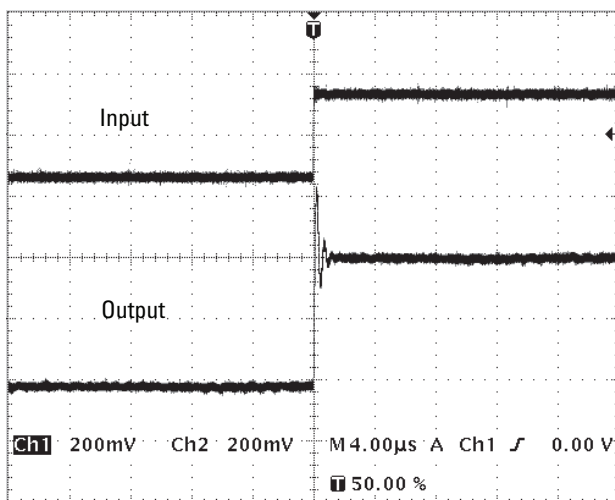
Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Input Pulse Response Characteristics ($T_a=25^\circ\text{C}$, $V_s=\pm 18\text{V}$, $R_s=150\ \Omega$
 $R_{load}=2\text{K}\ \Omega$ Uncompensated for BW unless otherwise noted)

Large Signal $A_v=1$ (0dB) 20V Step



Small Signal 3dB Gain Step

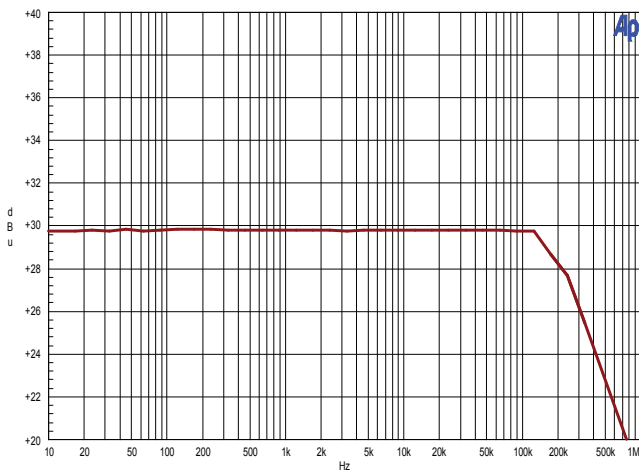




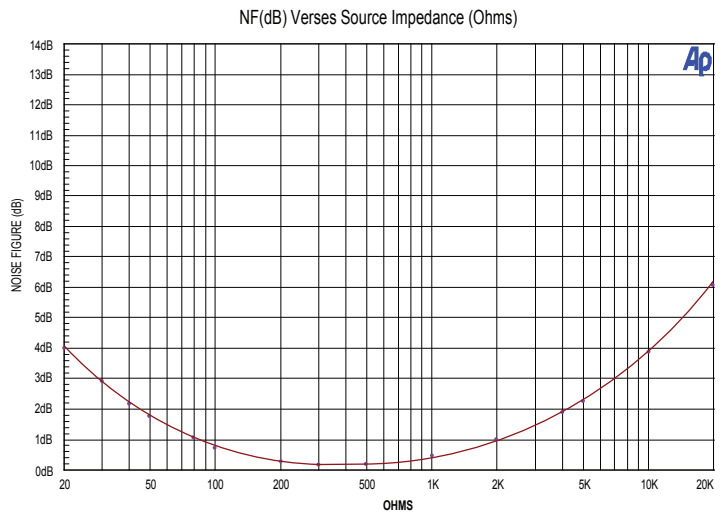
High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

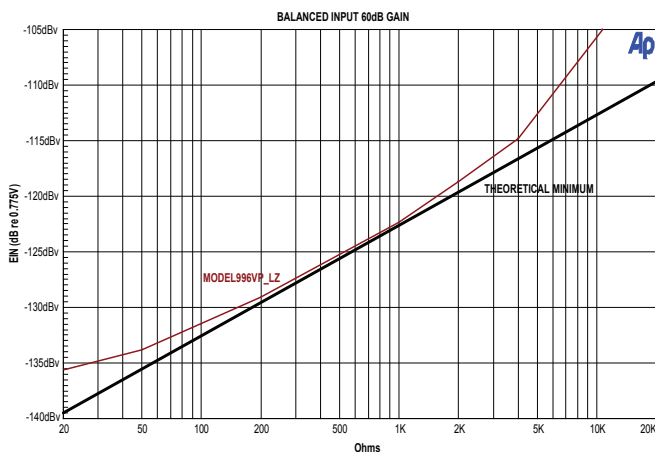
Full Power Frequency Response ($T_a=25^\circ\text{C}$, $V_s=\pm 18\text{V}$, $R_{\text{load}}=2\text{K}\Omega$, -10dBu input, 40dB Gain, $R_{\text{fb}}=10\text{K}\Omega$, $\text{THD}<0.0007$ unless otherwise noted)



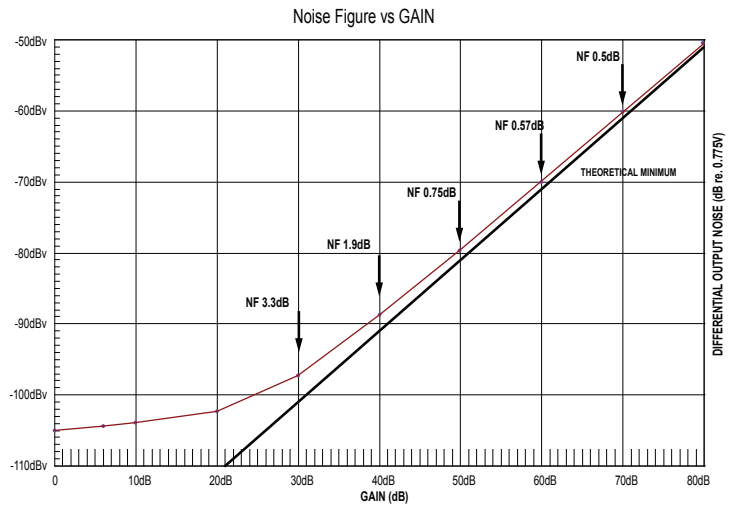
Noise Figure versus Source Impedance ($T_a=25^\circ\text{C}$, $V_s=\pm 15\text{V}$, Balanced Input, True RMS 20Hz-20KHz)



EIN versus Source Impedance ($T_a=25^\circ\text{C}$, $V_s=\pm 15\text{V}$, Balanced Input 60dB Gain ($A_v=1000$) True RMS 20Hz-20KHz)



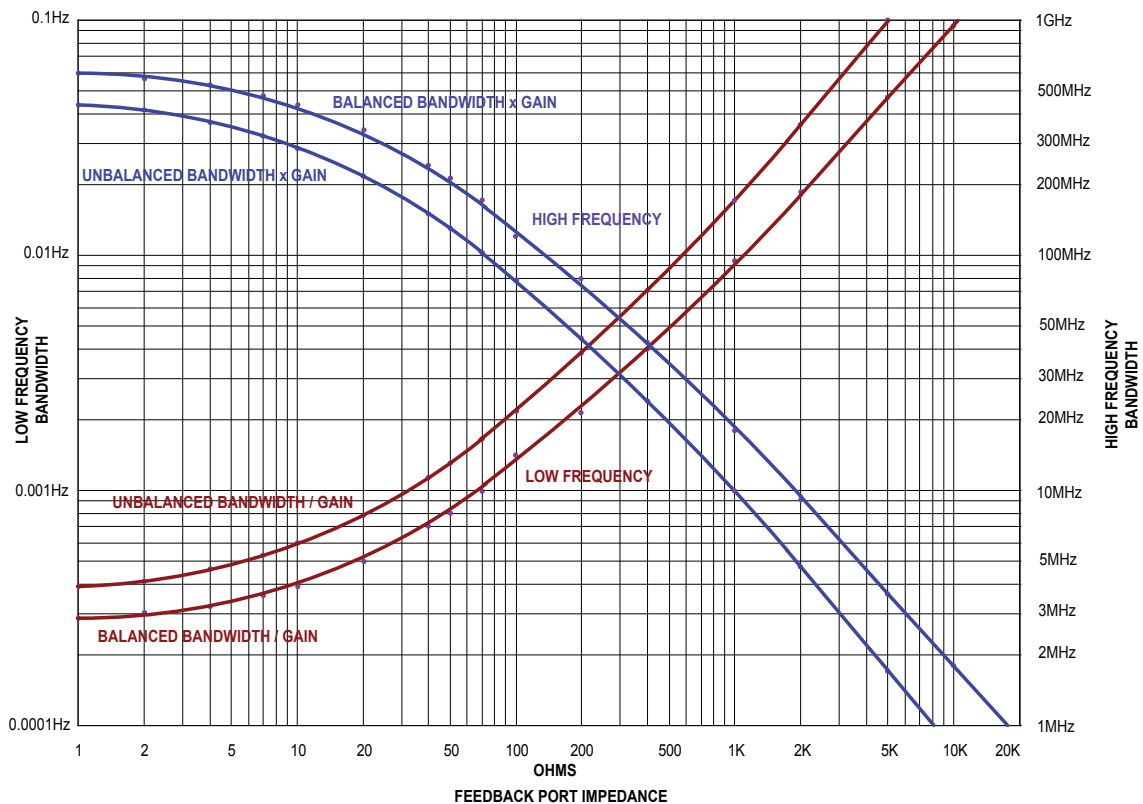
Differential Output Noise versus Gain ($T_a=25^\circ\text{C}$, $V_s=\pm 15\text{V}$, $R_{\text{source}}=150\Omega$, $R_{\text{feedback}}=2.21\text{K}\Omega$, True RMS 20Hz-20KHz BW)





High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier



**Hi Frequency BW x Gain and Low Frequency BW / Gain
verses Feedback Port Impedance**



High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Application Notes

The Sonic Imagery Labs 996VP-LZ Opamp is a high gain wide bandwidth device and the designer should analyze the application carefully to ensure operational success when used in new applications. The Sonic Imagery Labs 996VP-LZ has been purposely redesigned as higher performance drop in upgrade replacement for the Valley People Trans-Amp LZ. The following application information will keep new application designers out of trouble and also serves as a good debugging tool for upgrading and servicing vintage gear that used the original Paul Buff designed Valley People Trans-Amp LZ.

STABILITY CONSIDERATIONS

In spite of its extremely large gain bandwidth product, the Sonic Imagery Labs 996VP-LZ is inherently a highly stable device. There are, however, certain precautions and conditions which should be observed in order to maintain that stability in real world circuit applications.

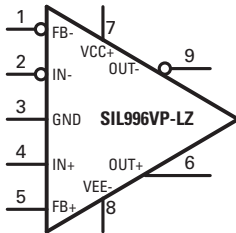


Figure 1. Connections for the Sonic Imagery Labs 996VP-LZ.

The most critical stability determining parameter, and the one which requires the most attention from the design engineer, is the value of the feedback resistors externally connected between the output terminals and the feedback terminals. Unlike familiar standard op-amp configurations, the values of these feedback resistors set the gain/bandwidth parameters of the 996VP-LZ, and must be maintained within defined limits, for unconditional stability. A value of 2.49K ohm for Rfb will result in a 500 MHz effective gain/bandwidth product, and will yield a good stability margin, while satisfying the impedance requirements for optimum noise characteristics, as outlined in the noise considerations section. Lower values will proportionally increase the gain/bandwidth product, while higher values will decrease it. Values below 1.8K ohm should not be selected, as they will raise the gain/bandwidth product and decrease the stability phase margin. The 996VP-LZ will typically go into oscillation with a feedback resistor value of 1600 ohms or less.

Another source of potential instability is the inductive effect which may be exhibited by long cable runs (such as mic cables), at the bridging input terminals. It is recommended that a capacitor be connected directly across the two bridging input terminals, of such a value as to limit the high frequency bandwidth to under 500 kHz, in such applications. (2000pF or greater for a 150 ohm input) This capacitor will also serve to increase the rejection of unwanted RF/EMI pickup. See FIGURE 3 illustrating Cin.

Additionally, as with any high gain amplifier used in new designs, it is prudent to provide a low impedance to ground for the power supply connections. This may be done by placing capacitors of at least 0.1uF from the power supply lines to ground, in close proximity (within 1") to the 996VP-LZ. If the user also elects to employ series decoupling resistors, their effect on low frequency distortion characteristics should be examined. For vintage upgrades this probably has already been done. There is no disadvantage to paralleling an electrolytic capacitor of 4.7uF or larger in this case.

The original Valley People Trans-Amp LZ suffered an additional source of instability. In certain applications, a capacitive load placed on the outputs would disturb the phase margin of the loops and oscillate. The original Valley People Trans-Amp LZ was not designed to directly drive long cable runs and required the outputs to be buffered for unconditional stability. The Sonic Imagery Labs 996VP-LZ output stage has a much increased current drive specification and the ability to drive a capacitive load directly. By adding a small series resistance at the output, the 996VP-LZ can drive moderate cable runs and resistive loads to 75ohms.

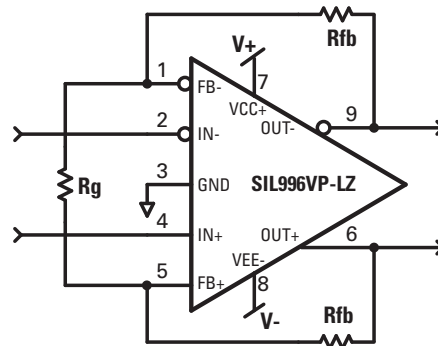


Figure 2. Feedback connections for balanced input/balanced output operation.



Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Application Notes (continued)

FEEDBACK TERMINAL CONNECTIONS

The feedback terminals on the Sonic Imagery Labs 996VP-LZ will, in most applications have a DC potential of around +1 Volts, with respect to ground. They may be connected, without blocking capacitors, to each other through any resistance to establish gain settings in balanced configurations. They may also be connected, via a minimum resistance of 2.00K, ohms, to the 996VP-LZ outputs or to ground. When they are to be returned to ground through resistance lower than 2.00K ohms, blocking capacitors should be placed at the feedback terminals, observing proper polarity. 47uF to 100uF 6V is typical for this purpose. See FIGURE 4. illustrating a unbalanced gain block as an example of when this is needed.

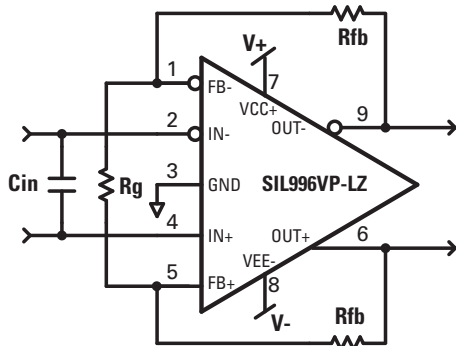


Figure 3. It is recommended that Cin be connected directly across the two bridging input terminals, of such a value as to limit the high frequency bandwidth to under 500 kHz.

SLEW RATE

The Sonic Imagery Labs 996VP-LZ exhibits a differential output slew rate in excess of 20 Volts/uS. This results in a full output bandwidth of 185 kHz for a +27dBv (re 0.775Vrms) output. The total harmonic distortion at 20kHz full output is below 0.001%.

COMMON MODE REJECTION RATIO

In typical circuit configurations, the CMRR of the Sonic Imagery Labs 996VP-LZ is better than 100dB in the 20Hz-20kHz audio range.

LOW FREQUENCY CONSIDERATIONS

The Sonic Imagery Labs 996VP-LZ is internally AC coupled, with an effective low end open loop bandwidth of 0.0003 Hz. This results in a closed loop 3 dB point of 0.3 Hz for 60dB gain, or 3 Hz for 80 dB gain.

GAIN AND BANDWIDTH

Another unique attribute of the Sonic Imagery Labs 996VP-LZ configuration is it's ability to vary its open loop gain and bandwidth in proportion to the supplied feedback and resultant closed loop gain.

With the feedback loop closed to unity gain, the bandwidth is 5 MHz. As the closed loop gain is increased, the internal open loop bandwidth increases proportionally in such a manner as to maintain an amplification bandwidth of 5 MHz. This action continues until a closed loop gain of 40 dB is reached, at which point the effective open loop gain of the device is 500 MHz. Beyond 40 dB of closed loop gain, the 996VP-LZ behaves as an amplifier having an open loop gain of 500 MHz. See Frequency Response versus Gain graph in the specifications section of this datasheet. This action is not unlike high speed current feedback amplifiers.

This results, of course, in an amplifier having exceptional stability over a wide range of adjustable gain (unity to 100 dB), and inherently minimal Transient Intermodulation Distortion.

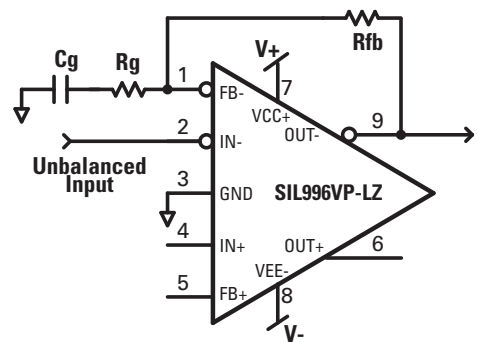


Figure 4. Example of the feedback junction tied to ground through resistance lower than 2.00K ohms. Blocking capacitors Cg should be placed at the feedback terminals. Observe proper polarity.

$$A_v \text{ Gain} = 1 + R_{fb}/R_g$$

$$\text{Low Freq 3db Cutoff} = 1/2\pi(R_g)(C_g)$$



Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Application Notes (continued)

NOISE CHARACTERISTICS

The input differential stage matched transistor pairs circuitry of the Sonic Imagery Labs 996VP-LZ was designed for extremely low noise at very low impedances that normally required the use of input transformers. (20ohms to 10 Kohms). These super matched transistor pairs are selected by the manufacturer at final test to Sonic Imagery Labs noise and Vbe matching specifications. The design of the input stage is particularly suited for interface with floating transducers such as microphones, tape heads and phono pickup cartridges, due to its inherent ability to effectively cancel the majority of noise currents produced by the input transistors, under such usage.

As can be seen from the Noise Figure versus Source Impedance graph (See page 9) in the specifications section, noise figures under 1dB can be obtained with sources from 90ohms to 2Kohms. The optimum noise impedance is in the region of 300 to 500 ohms, where-in the noise figure is within 0.25dB of theoretical minimum for floating input sources.

It should be noted that equivalent input noise of the Sonic Imagery Labs 996VP-LZ has been optimized at moderate to very high gain configurations. The noise figure increases at low gain settings as the output stages begin to become the predominant noise source which are also low noise devices. In most applications this effect is of little concern since the absolute output noise is very low, with respect to typical signal levels, at the lower gain settings. See Output Noise versus Gain Graph on Page 9.

For optimum noise performance at low source impedances, the user should be aware that thermal noise generation occurs not only in resistance of the driving source, but also in the resistance at the feedback terminals. This feedback port resistance is taken to mean the parallel combination of all resistors connected to the feedback terminal.

The equivalent input noise of a new proposed circuit configuration may be determined by considering the source impedance to be the series combination of (A) the resistance at the input terminal(s), and (B) the parallel combination of resistors at the feedback terminal(s). Once the effective source impedance is thus determined, the user may refer to the "Equivalent Input Noise versus Source Impedance" graph on Page 9 to determine equivalent input noise (EIN).

It should be noted that the noise measurements shown have been made with carefully calibrated test equipment correlated to TRUE RMS, and employing filters to represent the true measurement bandwidth of 20 Hz to 20kHz. The test circuit for these types of measurements can be found in Audio IC Op-Amp Applications 3rd Edition 1989, Walter G. Jung.

SINGLE ENDED UNBALANCED USE

The Sonic Imagery Labs 996VP-LZ can be used as a dual independent operational amplifier (Figures 5 thru 10) where the true balanced input feature is not required. In such applications the input noise voltage will decrease by 3dB, with respect to the balanced topology. Channel separation is typically >100dB and PSRR is still maintained because of the active current load and supply independent current source isolating the differential input amplifier transistor pairs.

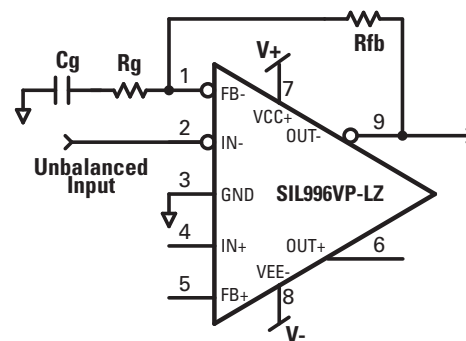


Figure 5. Example of a single unbalanced non-inverting amplifier configuration.



Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Application Notes (continued)

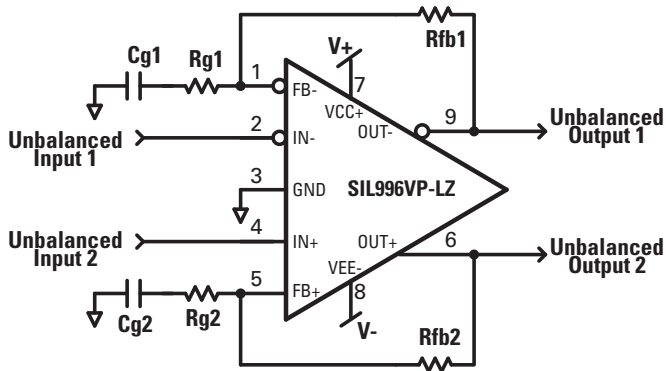


Figure 6. Example of a dual unbalanced non-inverting operational amplifier configuration.

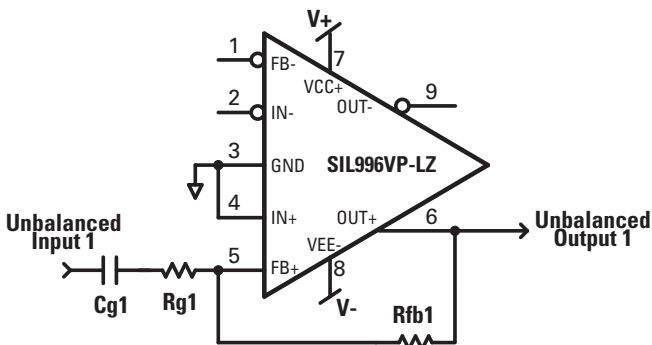


Figure 7. Example of a single ended unbalanced inverting operational amplifier configuration.

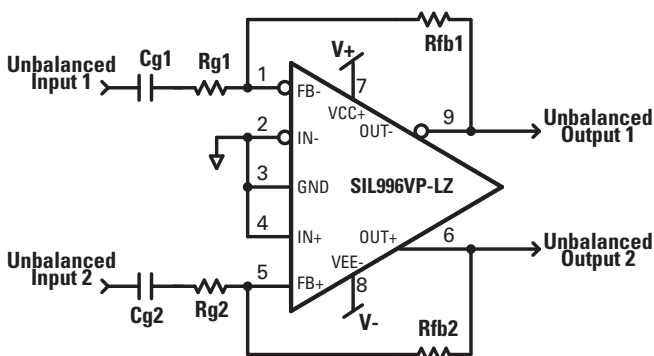


Figure 8. Example of a dual single ended unbalanced inverting operational amplifier configuration.

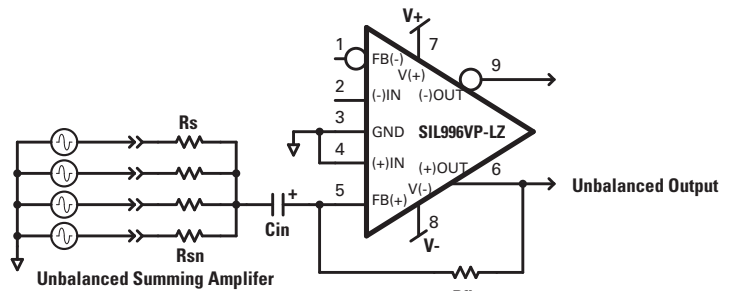


Figure 9. Inverting unbalanced summing operational amplifier configuration.

Circuit calculations for single and dual channel applications found in Figures 5, 6, 7, 8, and 9

$$A_v \text{ Gain} = 1 + R_{fb}/R_g$$

$$\text{Low Freq 3db Cutoff} = 1/2\pi(R_g)(C_g)$$

$$\text{High Freq 3dB Roll-off Point} = \text{Bandwidth} + \text{Gain}$$

(See BW vs. FBR chart on page 10)

$$\text{High Freq BW determining resistance} = R_{fb} * R_g / (R_{fb} + R_g)$$

$$\text{Effective Source Impedance for noise calc}$$

$$(R_s) = R_s + ((R_{fb} * R_g) / (R_{fb} + R_g))$$

Equivalent Input Noise,
See Graph (EIN verse Source Impedance (Rs))

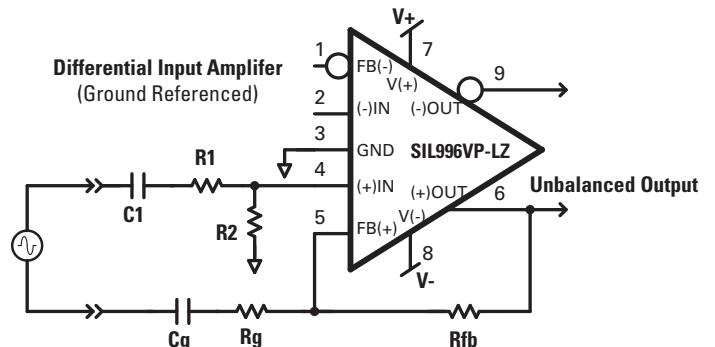


Figure 10. Differential input operational amplifier configuration. Ground sensing/referenced. instrumentation topology

Circuit calculations for single and dual Differential Amp found in Figure 10.

$$A_v \text{ Gain} = 1 + R_{fb}/R_g, R_2/R_1 = R_{fb}/R_g \text{ and } R_1 + R_2 = R_g, C_1 = C_g$$

$$\text{Low Freq 3db Cutoff} = 1/2\pi(R_g)(C_g)$$

C1 may be required for good CMRR below 18Hz and down.



Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

Application Notes (continued)

As shown in in FIGURE 11. the Sonic Imagery Labs 996VP-LZ can be configured as a true balanced differential summing amplifier by simply grounding its input terminals and treating its feedback terminals as virtual ground current summing junctions. In this application, coupling capacitors C_{in} are required to prevent differences in bias voltages present at the +FB and -FB points of the 996VP-LZ to cause DC currents to flow through the sources. These configurations lend themselves to balanced mixing boards and mastering applications.

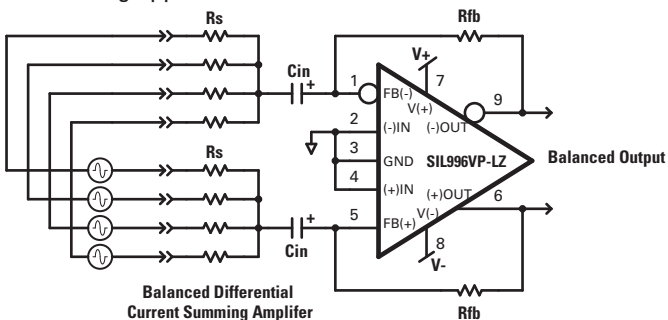


Figure 11. The 996VP-LZ as a true balanced differential current summing amplifier.

As shown in in FIGURE 12. with the addition of a standard opamp the Sonic Imagery Labs 996VP-LZ can be configured to produce a single ended output. This circuit maintains it high common mode performance to the unbalanced output.

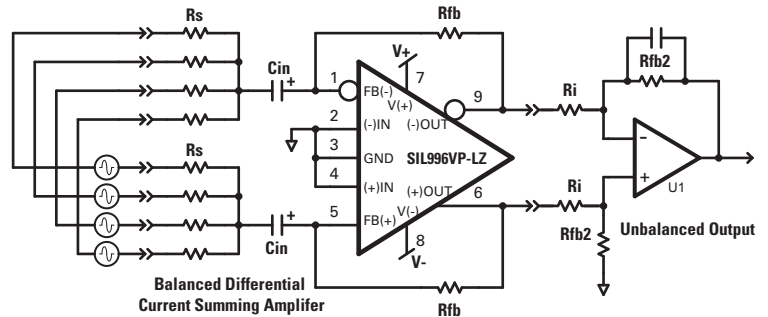


Figure 12. The 996VP-LZ as a true balanced differential current summing amplifier with a single ended unbalanced output.

As shown in in FIGURE 13. below, with the addition of an additional Sonic Imagery Labs 996VP-LZ stage the designer can construct a mixer summing stage with a single pot fader pack that can drive a balanced line. This circuit still maintains it high common mode rejection performance to the balanced output.

Application engineers and designers are encouraged to read Sonic Imagery Labs Application Note AN-18 for using the 996VP-LZ as a transformerless microphone preamp circuit. (Dec 2016).

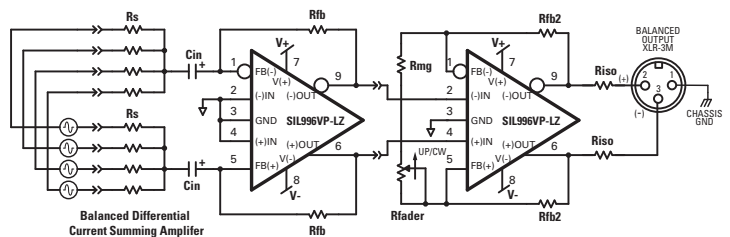


Figure 13. The 996VP-LZ as a true balanced differential current summing amplifier with a single pot fader gain stage output driving a balanced XLR/cable.



High Performance Audio Electronics

Model 996VP-LZ High Performance Balanced/Dual Unbalanced Operational Amplifier

PCB Sockets for 996VP-LZ OpAmp

It is highly recommended that the user not solder the pins directly to the mating printed circuit board. Overheating the pin creates a cold solder joint at the other end. Permanent soldering of the pin prevents easy removal of the module. Lastly, soldering prevents one from servicing components which may lie underneath the module.

Many types of sockets for 0.040" diameter pins are available from several manufacturers. Sonic Imagery Labs uses and stocks the sockets from all three listed manufacturers below. These sockets can be soldered or swaged in your printed circuit board. Additionally, users can contact Sonic Imagery Labs and purchase a set of nine .

PCB Sockets for 996VP-LZ OpAmp

Mill-Max
190 Pine Hollow Road,
PO Box 300
Oyster Bay NY 11771

Part Number 0344-2-19-15-34-27-10-0

Wearnes Cambion Ltd
Peveial House
Mill Bridge, Castleton
Hope Valley S33 8WR
United Kingdom

Part Number 450-3756-02-03

Concord Electronics Corp
33-00 47th Ave
Level 1A
Long Island City, NY 11101

Part Number 09-9035-2-03

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH Sonic Imagery Labs PRODUCTS. Sonic Imagery Labs MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT Sonic Imagery Labs DEEMS NECESSARY TO SUPPORT Sonic Imagery Labs PRODUCT WARRANTY. TESTING OF ALL PUBLISHED PARAMETERS AND SPECIFICATIONS OF EACH PRODUCT IS PERFORMED BEFORE SHIPMENT. Sonic Imagery Labs ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING Sonic Imagery Labs PRODUCTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE Sonic Imagery Labs COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN Sonic Imagery Labs TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, Sonic Imagery Labs ASSUMES NO LIABILITY WHATSOEVER, AND Sonic Imagery Labs DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF Sonic Imagery Labs PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT AND CRITICAL COMPONENTS POLICY

Sonic Imagery Labs PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR CRITICAL SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF Sonic Imagery Labs. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.